nano

Educator Guide

Nano Mini-Exhibition

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Key Concepts for Engaging the Public in Nano

Nanoscale science, engineering, and technology (or "nano," for short) is a new, interdisciplinary field of research and development. Just within the past couple decades, scientists have developed methods and tools that allow them to explore some of the most fundamental aspects of our natural world, and to develop new materials and technologies. Some experts think that nanotechnologies may transform our lives—similar to the way that the automobile and personal computer changed how we live and work.

The great potential of nanotechnology comes from its tiny size. Nano research and development happens at the scale of atoms and molecules. Some things have different properties at the nanoscale, which allows scientists and engineers to create new materials and devices.

Nano isn't just in the lab—we can already find it in our homes, stores, and hospitals. In the next 10 years or so nanotechnologies and materials will become even more present in our lives. We'll find nano in everyday products such as computers, food, cosmetics, and clothing. Nano might also be part of solutions to big problems, helping address needs such as clean energy, pure water, and cancer treatments.

It's important for everyone to be informed about nanotechnologies, because they'll be an important part of our future. Like any technology, nanotechnologies have costs, risks, and benefits. Since nanotechnologies are still developing, we can influence what they are and how they're used. We all have a role in shaping how nanotechnologies will play out in our future.

Nano is a big and exciting field of study and there's a lot to know. But the most important concepts of nanotechnology are also some of the most important concepts for understanding our natural world, the process of science and engineering, and the ways that society and technologies are interconnected.

To begin to understand nano, we can explore four key concepts:

1. **Small and different:** Nanometer-sized things are very small, and often behave differently than larger things do.
2. **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. **New technologies:** Nanoscience, nanotechnology, and nanoengineering lead to new knowledge and innovations that weren't possible before.
4. **Part of our society and our future:** Nanotechnologies have costs, risks, and benefits that affect our lives in ways we cannot always predict.

    - These ideas are presented in more detail in the document *Engaging the Public in Nano: Key Concepts in Nanoscale Science, Engineering, and Technology*, which can be found in the host manual for the mini-exhibition, as well as in the NISE Net online catalog:
      http://www.nisenet.org/catalog/tools_guides/engaging_public_nano

Exhibition Visitor Learning Objectives

The *Nano* exhibition explores nanoscale science, engineering, and technology through hands-on exhibits, graphic and text panels, and other educational experiences. The primary visitor learning objectives of *Nano* are:

1. **Materials can act differently when they're nano-sized.**
2. **Nanotechnology lets us build things the way nature does, atom by atom.**
3. **Nano is all around us, in nature and in technology.**
4. **Nanotechnology will affect our economy, environment, and personal lives.**

Nano is conceptually organized around four exhibit areas, each of which explores one of these learning objectives. Each exhibit area includes a large graphic posing a question, plus one or more interactive exhibits that allow visitors to explore the question.

(Note that *Nano* can be arranged in many ways, so the exhibit may not be physically arranged according to these conceptual groupings. The elements of the mini-exhibition are designed to be visited in any order, and the main messages of the mini-exhibition are reiterated throughout.)

Materials can act differently when they're nano-sized

At the *Small, Smaller, Nano* exhibit, visitors use magnets to explore how a material called magnetite behaves differently at different sizes. While magnetite sand, powder, and liquid are all fun to manipulate with magnets, the ferrofluid (with nano-sized particles) is especially fascinating.

Static vs. Gravity provides another opportunity to learn how size matters, by spinning circular cases filled with plastic beads and comparing the relative effects of static electricity and gravity. Gravity overcomes static electricity to pull down the large beads, but static electricity wins out with the smaller beads.

Visitors can learn more about the relationship between size and properties at the sign entitled, "What happens when things get smaller?" They can also discover tiny technologies that are helping to solve global problems related to energy, food, medicine, and water.

Primary learning objective:

- Materials can act differently when they're nano-sized.
  (Examples in the exhibition include: gold, magnetite, and plastic.)

Secondary learning objectives:

- Scientists are learning to take advantage of nano properties to create new materials and technologies.
  (Examples in the exhibition include: cancer treatments, food products, thin film solar cells, and water filters.)
- Nanotechnologies can help us solve big problems.
  (Examples in the exhibition include: energy, food, medicine, and water.)

Nanotechnology lets us build things the way nature does, atom by atom

Build a Giant Carbon Nanotube lets visitors use foam construction pieces to make a large model of a nanoscale structure called a "carbon nanotube." They work atom by atom—just like scientists who are creating tiny new nanotechnologies.

A related sign asks, "What's new about nano?" Here, visitors learn how nature inspires different nanotechnologies, from stain-resistant pants to climbing robots.

Primary learning objective:

- Nanotechnology lets us build things the way nature does—atom by atom.
  (Example in the exhibition: carbon nanotubes.)

Secondary learning objectives:

- To make different materials, atoms combine in different ways.
  (Examples in the exhibition include: diamond, graphite, and carbon nanotubes.)
- Nature can inspire nanotechnology.
  (Examples in the exhibition include: stain-resistant fabrics inspired by lotus leaves, climbing robots inspired by geckos, computer chips inspired by snowflakes, and low-energy electronic displays inspired by butterfly wings.)

Nano is all around us, in nature and in technology

More examples of nano in nature and technology are found at the sign entitled, "Where can you find nano?" Visitors can use a series of hands-on interactives and play and "I Spy" game to discover nano in familiar places.

Primary learning objective:

- Nano is all around us—in nature and in nanotechnology.
  (Examples in the exhibition include: butterfly wings, electronic gadgets, scent molecules, and toys.)

Nanotechnology will affect our economy, environment, and personal lives

At *Balance our Nano Future,* visitors balance blocks on a tippy table, trying to create a stable "nano world." They can learn more about different perspectives on nanotechnology at the sign entitled, "What does nano mean for us?"

Primary learning objective:

- Nanotechnology will affect our economy, environment, and personal lives.

Secondary learning objectives:

- To create a stable nano future, we'll need to balance costs, risks, and benefits.
  (Examples: environment, medicine, water and humanitarian efforts, food and financial investment.)
- Individuals, companies, and governments help shape our nano future.

Connections to National Science Education Standards

The Nano mini-exhibition provides entry points to many of the National Science Education Standards, which can be further explored through educational programming at the museum or in the classroom. Related standards include:

2. Physical Science
    - K-4: Properties of objects and materials
    - K-4: Position and motion of objects
    - K-4: Light, heat, electricity, and magnetism
    - 5-8: Properties and changes of properties in matter
    - 5-8: Motions and forces
    - 9-12: Structure and properties of matter
    - 9-12: Motions and force
    - 9-12: Interactions of energy and matter

5. Science and Technology
    - K-4: Abilities to distinguish between natural objects and objects made by humans
    - K-4: Abilities of technological design
    - K-4: Understanding about science and technology
    - 5-8: Abilities of technological design
    - 5-8: Understanding about science and technology
    - 9-12: Abilities of technological design
    - 9-12: Understanding about science and technology

6. Personal and Social Perspectives
    - K-4: Personal health
    - K-4: Types of resources
    - K-4: Changes in environments
    - K-4: Science and technology in local challenges
    - 5-8: Personal health
    - 5-8: Populations, resources, and environments
    - 5-8: Natural hazards
    - 5-8: Risks and benefits
    - 5-8: Science and technology in society
    - 9-12: Personal and community health
    - 9-12: Natural resources
    - 9-12: Environmental quality
    - 9-12: Natural and human-induced hazards
    - 9-12: Science and technology in local, national, and global challenges

Programming and Other Related Educational Experiences

The NISE Network online catalog has many resources to supplement the *Nano* exhibition, including educational programs, media, and more. Here you'll find a selection of educational programs that related directly to the learning objectives of the mini-exhibition, but there's much more available online at *http://www.nisenet.org/catalog*

Overviews of nano

Hands-on activities:

Build a Giant Puzzle!
I-Spy Nano!

Public programs:

Attack of the Nanoscientist
Nano Dreams and Nano Nightmares
Nanotechnology: Small Science, Big Deal!
Wheel of the Future

Materials can act differently when they're nano-sized

Hands-on activities:

Exploring Forces—Gravity
Exploring Materials—Nano Gold
Exploring Materials—Thin Films
Exploring Products—Nano Sand
Exploring Properties—Surface Area
Exploring Size—Measure Yourself
Exploring Size—Memory Game
Exploring Size—Scented Balloons
Exploring Size—StretchAbility Game
Exploring Size—Tiny Ruler

Public programs:

Nano Ice Cream
Surface Area

Nanotechnology lets us build things the way nature does, atom by atom

Hands-on activities:

Exploring Fabrication—Gummy Capsules
Exploring Materials—Graphene
Exploring Materials—Hydrogel
Exploring Size—Powers of Ten Game
Exploring Tools—Mitten Challenge
Exploring Tools—Special Microscopes

Public programs:

Balloon Nanotubes
Snowflakes: Nano at its Coolest
Tiny Tech, Big Trouble!
World of Carbon Nanotubes

Nano is all around us, in nature and in technology

Hands-on activities:

Exploring Products—Nano Fabric
Exploring Products—Sunblock
Exploring Structures—DNA

Public programs:

Biobarcodes: Antibodies and Nanosensors
Biomimicry: From Nature to Nanotech
The Future of Computing
Liquid Body Armor
Nanotech and Consumer Products
Shrinking Robots!

Nanotechnology will affect our economy, environment, and personal lives

Hands-on activities:

Societal and Ethical Implications Posters (can be used alone or paired with *Exploring Size—Ball Sorter, Exploring Materials—Thin Films*, and *Exploring Products—Sunblock)*

Public programs:

Cleaning Our Water with Nanotechnology
Flying Cars
Nanosilver: Breakthrough or Biohazard?
Tiny Solutions to Our Big Energy Problem
Treating Tumors with Gold
Would You Buy That?

Training Staff and Volunteers

There are many training resources available through *http://www.nisenet.org* to help familiarize your staff with nanoscale science, engineering, and technology:

NanoDays staff training materials, including tips on effective presentation techniques:

- *http://www.nisenet.org/catalog/tools-guides/training_materials*

Nano 101 for Staff slide presentations:

- *http://www.nisenet.org/catalog/tools-guides/training_materials*

A collection of videos, cart and stage presentations, and articles introducing nano:

- *http://www.nisenet.org/catalog/tools-guides/intro-to-nano*

The National Science Teachers' Association archived web seminar on nanoscale science:

- *http://learningcenter.nsta.org/products/symposia_seminars/NSDL4/webseminar2.aspx*

DECIDE discussion game, which can be used to train staff to talk about controversial topics:

- *http://www.playdecide.eu/play/topics/nanotechnology*

NanoVenture board game, which can be used to help staff consider the relationship between nanotechnology and society:

- http://www.nisenet.org/catalog/programs/nanoventure

More Resources

The NISE Network website features a catalog of online resources for professionals. The catalog includes educational experiences for you to implement with the public, as well as resources to prepare you and your staff. We also have a web page (*whatisnano.org*) with direct-to-public resources created by the NISE Network and other institutions, which we encourage you to share with your public audiences.

NISE Network online catalog of educational resources for professionals

Programs and activities for public audiences:

- *http://www.nisenet.org/catalog/programs*
- http://www.nisenet.org/catalog/forums

Spanish translations of educational products:

- *http://www.nisenet.org/catalog/spanish*

Training materials:

- *http://www.nisenet.org/catalog/tools-guides/training_materials*

Intro to nano for educators:

- http://www.nisenet.org/catalog/tools-guides/intro-to-nano

Tools and guides:

- *http://www.nisenet.org/category/catalog/tools_guides*

Guide for museums partnering with researchers:

- http://www.nisenet.org/catalog/tools_guides/small_steps_big_impact

Resources for K-12 teachers:

- *http://www.nisenet.org/community/k-12-teachers*

NISE Network public portal website (*www.whatisnano.org*)

The NISE Network portal of materials for public audiences is a great place to send your visitors for more information about nano: *http://www.whatisnano.org*

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