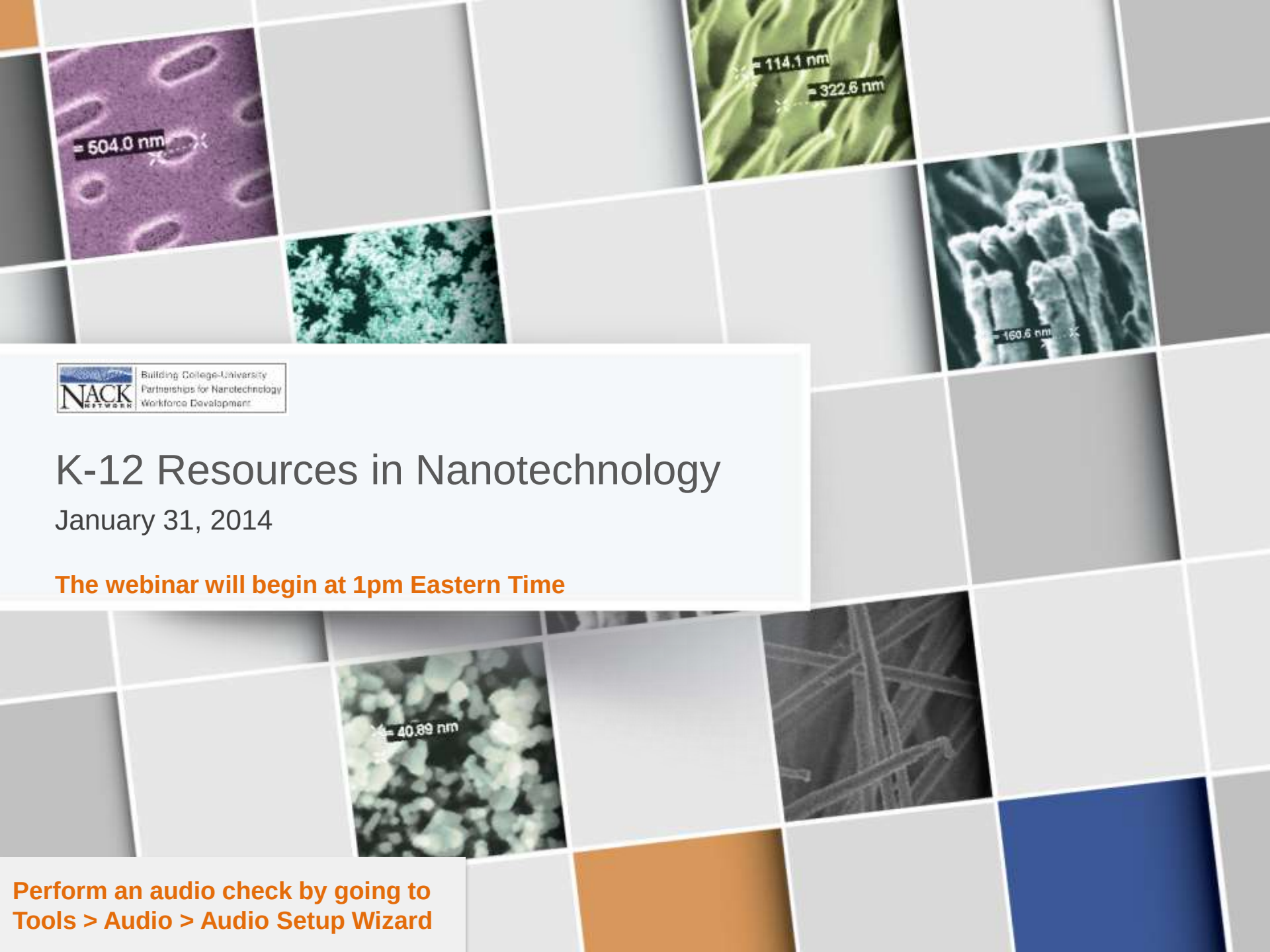


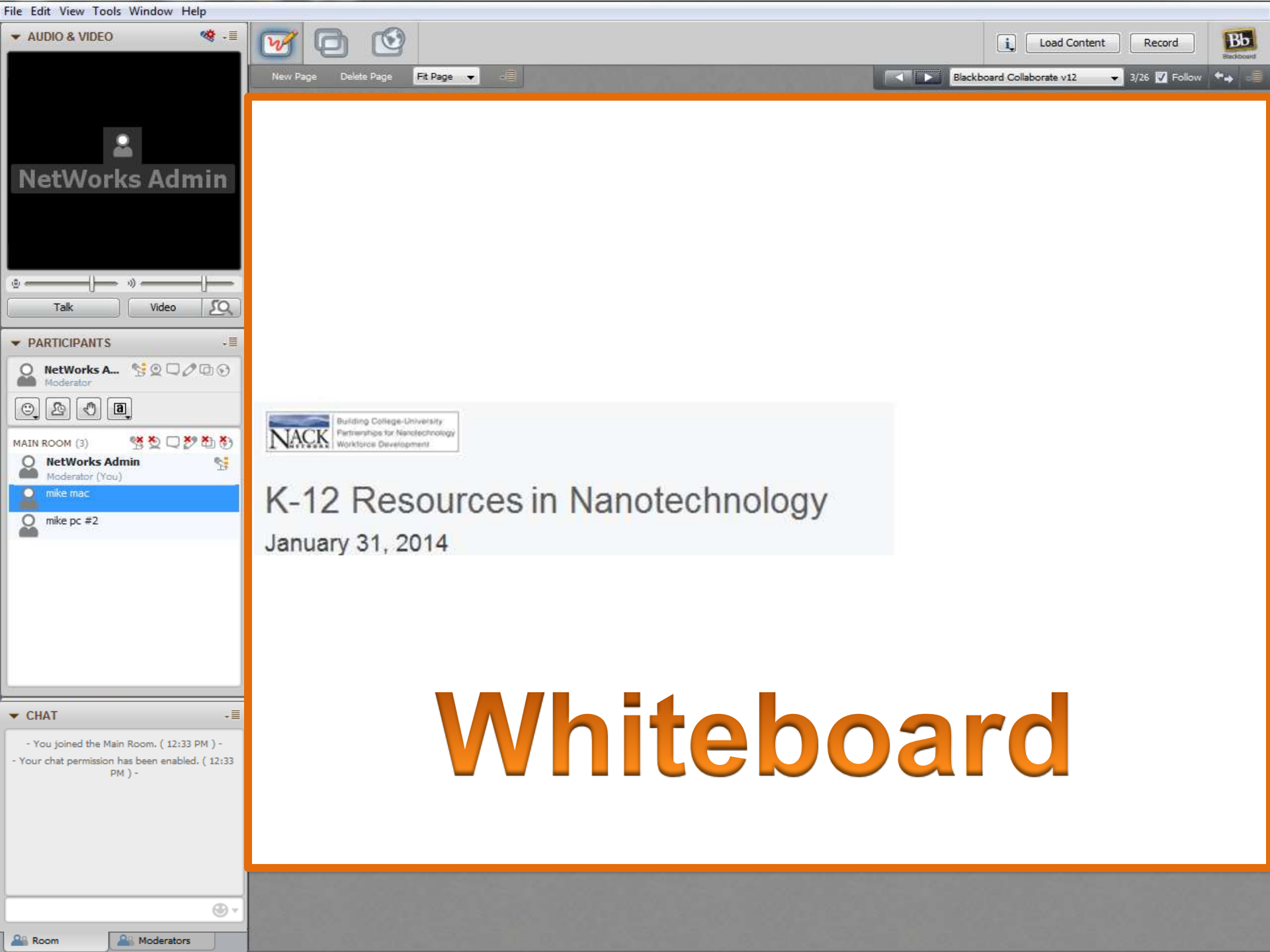

NACK NETWORK
Building College-University Partnerships for Nanotechnology Workforce Development

# K-12 Resources in Nanotechnology

January 31, 2014

**The webinar will begin at 1pm Eastern Time**

**Perform an audio check by going to Tools > Audio > Audio Setup Wizard**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mike mac
mike pc #2
CHAT
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January 31, 2014
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NACK Building College-University Partnerships for Nanotechnology Workforce Development

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January 31, 2014

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NACK Building College-University Partnerships for Nanotechnology Workforce Development

# K-12 Resources in Nanotechnology

January 31, 2014

Send Questions and Message Here

File Edit View Tools Window Help

AUDIO & VIDEO

NetWorks Admin

Talk

POLLS

PARTICIPANTS

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mike mac

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- Your chat permission has been enabled. ( 12:33 PM ) -

Not here!

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NACK Building College-University Partnerships for Nanotechnology Workforce Development

# K-12 Resources in Nanotechnology

January 31, 2014


NACK NETWORK
Building College-University Partnerships for Nanotechnology Workforce Development

# K-12 Resources in Nanotechnology

January 31, 2014

**Recording begins**

# Brought to you by:

Brought to You By:

The NACK Network established at the Pennsylvania State College of Engineering, and funded in part by a grant from the National Science Foundation (DUE 1205105).

Hosted by MATEC NetWorks ***www.matecnetworks.org***

NNIN
National Nanotechnology Infrastructure Network
The National Resource for **Nanoscale Science and Technology**

EQUIPMENT
PROCESSES
EXPERTISE

# Nanoscale Science and Engineering (NSE) Resources for K-12

Joyce Allen-NNIN Assistant Education Coordinator

NACK Webinar January 31, 2014

NNIN Nanoscale Science, Engineering & Technology

NSF

# Presenter

## Joyce Palmer Allen

Assistant Educational Coordinator for the National Nanotechnology Infrastructure Network (NNIN) and works at the Institute of Electronics and Nanotechnology (IEN) at Georgia Institute of Technology. Her job includes planning, developing, and implementing educational outreach programs in nanotechnology and representing the NNIN Education and Outreach office at local and national conferences and meetings. She also helps to oversee programs such as the NNIN Research Experience for Teachers and Research Experience for Undergrads at Georgia Tech.

Host: Michael Lesiecki

# Objectives



- Reasons K-12 students need to be exposed to nanoscale science and engineering (NSE) information.
- Big Ideas of NSE and their connections to science standards.
- Resources for introducing students to NSE.
- Resources for connecting NSE to curriculum.
- Examples using NSE resources.

# Who is Joining Us?



**Poll Question:**

What grade level do you teach?

A. Elementary

B. Middle school

C. High School

D. 2-yr or 4-yr

If you do not teach, do you provide outreach to K-12? *Type your answers in the chat box.*

# Poll Question



**Poll Question:** How familiar are you with resources for NSE?

A. I'm very familiar and use websites like the NNIN regularly
B. I'm pretty familiar – I've heard of the NNIN
C. I have NO idea where to find NSE resources – HELP!

**Open for discussion:** What do you hope to gain from participating in this webinar?

# Why expose students to NSE?

# Why should your students be exposed to NSE?



**By 2018:**

- U.S. Bureau of Labor Statistics estimates **8,654,000** U.S. STEM jobs
- **17%** growth in STEM jobs vs. **9.8%** for non-STEM.

Nanoscience and nanotechnology are **growing industries!**

**By 2018:**

- Expected to be a **$2 trillion** "industry"
- Expected to be **5%** of Gross Domestic Product

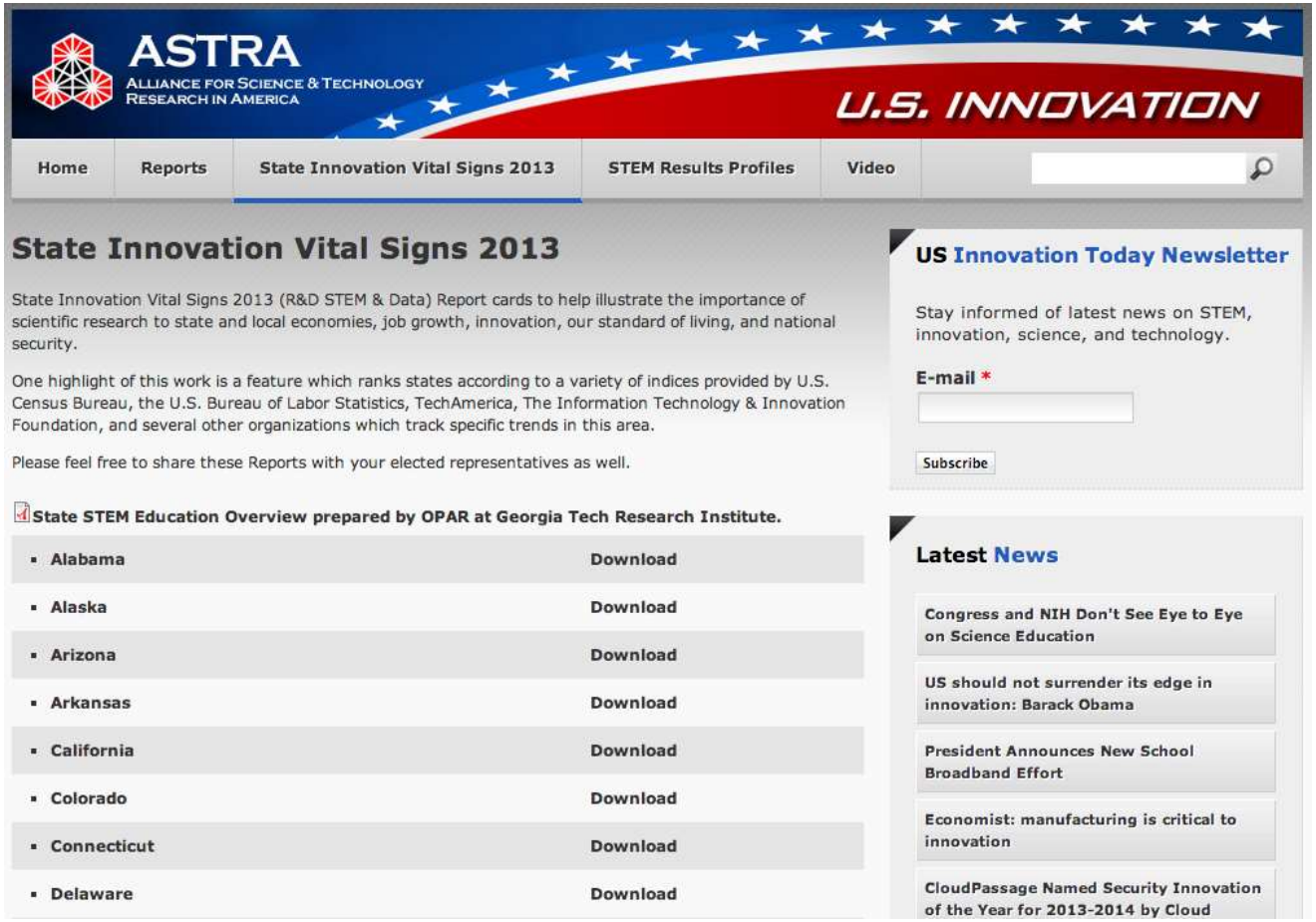
**By 2020:**

- NSF estimates that nanotechnology will employ 6 million workers in the manufacture of nanomaterial-based products.

**Sources**
(www.aboutastra.org)
(US Dept. of Commerce Report)
CEN.ACS.ORG

# Information about STEM






Source: http://www.usinnovation.org/state-innovation-vital-signs

# 211,000 Georgia STEM Jobs to fill for 2018

- Georgia kids and parents need to know about the potential for rewarding and high paying careers in STEM.

- Overall U.S. demand for scientist and engineers is expected to increase at four times the rate for other occupations.

**FAMILIARITY WITH NANOTECHNOLOGY BY REGION AND GENDER**

"How much have you heard about nanotechnology?"

| | Total | Region | | | |
|---|---|---|---|---|---|
| | | East | Midwest | South | West |
| | % | % | % | % | % |
| **HAVE HEARD AT LEAST A LITTLE (NET)** | **38** | **38** | **36** | **38** | **41** |
| A lot | 5 | 5 | 5 | 6 | 5 |
| Some | 12 | 14 | 11 | 12 | 14 |
| A little | 21 | 20 | 20 | 21 | 22 |
| Know the term, but that is all | 26 | 29 | 20 | 25 | 28 |
| Nothing at all | 36 | 33 | 44 | 36 | 31 |

Source:
http://www.harrisinteractive.com/NewsRoom/HarrisPolls/tabid/447/mid/1508/articleId/1073/ctl/ReadCustom%20Default/Default.aspx

# Additional Harris Poll Results



**TABLE 3B**

**NANOTECHNOLOGY RISKS VS. BENEFITS BY AGE**

"Based on what you know, how would you describe the relative risks and benefits of nanotechnology?"

Base: Have heard at least a little about nanotechnology

| | Total | Age | | | | |
|---|---|---|---|---|---|---|
| | | 18-29 | 30-39 | 40-49 | 50-64 | 65+ |
| | % | % | % | % | % | % |
| Risks outweigh the benefits | 6 | 8 | 9 | 9 | 2 | 1 |
| Risks and benefits are about equal | 27 | 24 | 29 | 29 | 29 | 20 |
| Benefits outweigh the risks | 37 | 32 | 34 | 36 | 36 | 58 |
| Not at all sure | 30 | 35 | 28 | 26 | 32 | 22 |

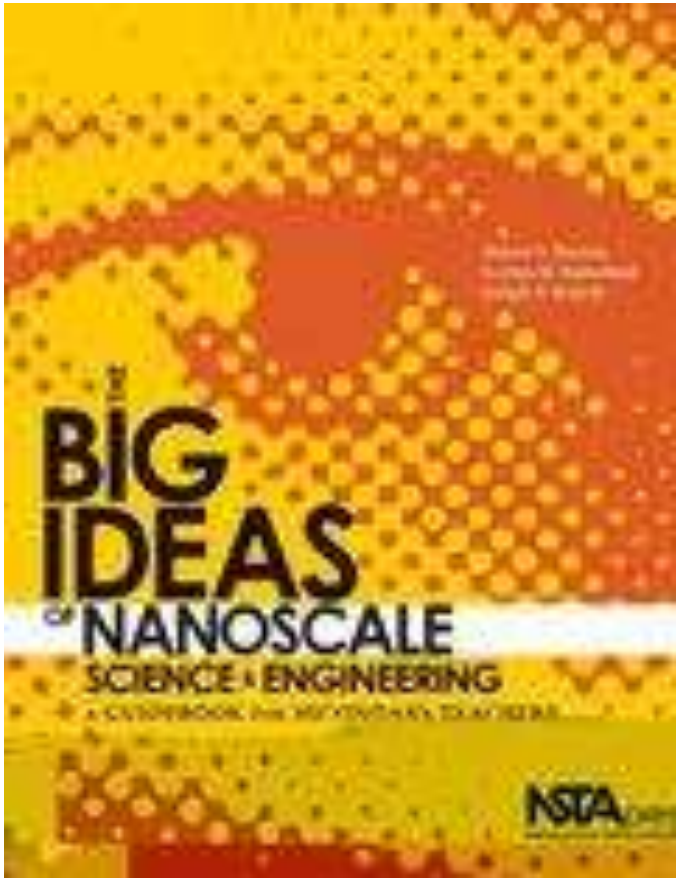
Note: Percentages may not add to 100% due to rounding.

# What should our students know about NSE?



## Big Ideas of Nanoscale Science and Engineering

Stevens et al, 2009



# Big Ideas of Nanoscale Science



- **Size and Scale**
- **Structure of Matter**
- **Size Dependent Properties**
- **Forces & Interactions**
- **Self Assembly**
- **Quantum**
- **Tools & Instrumentation**
- **Models & Simulations**
- **Science &Technology**

Source: *The Big Ideas of Nanoscale Science and Engineering: Guidebook for Secondary Teachers (*2009). Steven, Sutherland, and Kraicik

# Connection of Big Ideas to Science Standards



NSE concepts are easy to integrate into your classroom and align to Next Generation Science Standards or your state science standards.

# Connection of Big Ideas to K-5 Next Generation Science Standards



## Size and Scale

- Number and Operations in Base Ten
- Area and Volume
- **1-LS1** From Molecules to Organisms: Structures and Processes

## Forces and Interactions

- **K-PS2** Motion and Stability: Forces and Interactions
- **3-PS2-3** Ask questions to determine cause and effect relationships of electric or magnetic interaction between two objects not in contact with each other

## Structure of Matter

**5-PS1-1** Develop a model to describe that matter is made of particles too small to

be seen.

## Models and Simulations

**K-ESS3-1** Use a model….

**K-2-ETS1-2** Develop a simple sketch, drawing, or physical model…

**3-LS1-1** Develop models….

# Connection of Big Ideas to 6-8 Next Generation Science Standards



### Structure of Matter

**MS-PS1-1** Describe the atomic composition of simple molecules and extended structures.

**MS-LS1-2** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

### Size Dependent Properties

**MS-PS1-4** Predict and describe changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

**MS-PS2-2** Change in an object's motion depends on the sum of the forces on the object and the mass of the object.

### Tools and Instrumentation

**MS-PS1-6** Undertake a design project to construct, test, and modify a device.....

**MS-PS3-3** Apply scientific principles to design, construct, and test a device….

### Science and Technology

**MS-PS4-3** Integrate qualitative scientific and technical information to support the claim that digitized signals….

**MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

# Connection of Big Ideas to 9-12 Next Generation Science Standards



### Self-Assembly

**HS-PS1-3** The structure and interaction of matter at the bulk scale are determined by electrical forces within and between atoms.

**HS-L-S1-6** Evidence for how carbon, hydrogen, and oxygen form sugar molecules and how they combine with other elements to form amino acids and/or other large carbon-based molecules.

### Size Dependent Properties

**HS-PS1-4** …compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

**HS-PS1-5** …the effects of changing the temperature or concentration of the reacting particles on the rate oat which a reaction occurs.

### Forces and Interactions

**HS-PS2-4** …..predict the gravitational and electrostatic forces between objects.

**HS-LS1-3** ….provide evidence that feedback mechanisms maintain homeostasis.

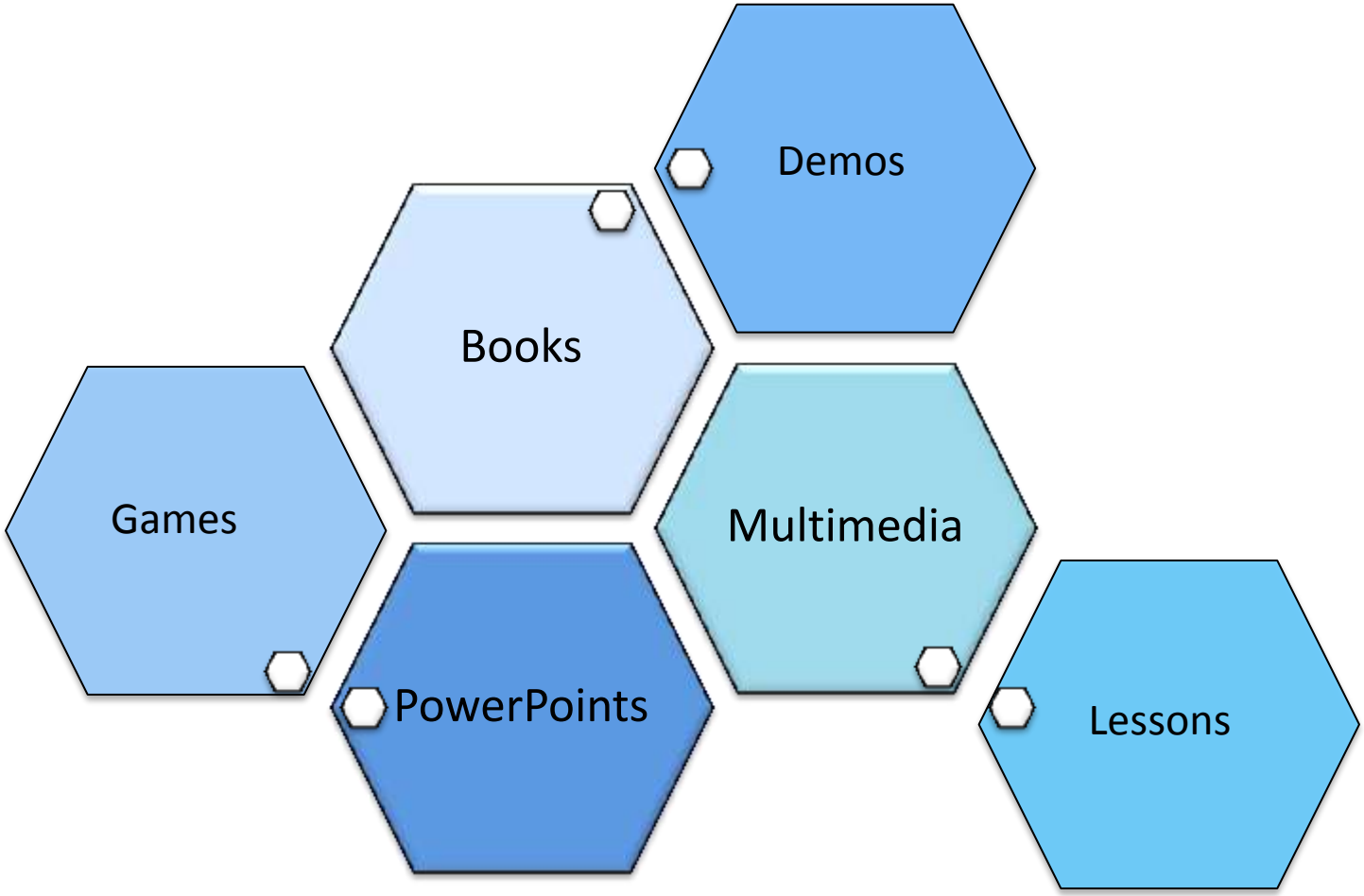
### Size and Scale

**HS-LS1-2**…illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

**HS-LS2-1**… use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

# Resources for Introducing NSE





# Lesson: Using Media to Explore Social and Ethical Issues in Nanoscience and Nanotechnologies

The National Resource for **Nanoscale Science and Technology**

**Topic** Select All

- ☐ Biology ☐ Chemistry ☐ Environmental Science
- ☐ General Science ☐ Physical science ☐ Physics
- ☐ Science and Society ☐ Tools and Technology

**Level** Select All

- ☐ Elementary ☐ Middle School
- ☐ High School ☐ Adult

Search Articles

This lesson introduces students to social and ethical issues related to nanotechnology. The lesson demonstrates possible social issues through case studeies using popular films, books, and news stories. The lesson is intented to stimulate discussion about social and ethical issues related to nanotechnology as well as, in a broader context, the interaction of science and technology with society.

## Files:

- Teacher prepartion Guide
- Student Guide
- Next Generation Science Standards for this lesson


**Subject**: General Science, Science and Society
**Audience**: High School

Source: www.nnin.org

# Nanotechnology: Small Science, Big Deal!




Source: www.nisenet.org

# Size Matters: Introduction to Nanoscience

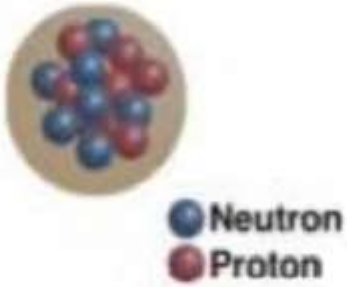


## Cards for Number Line Activity: Objects

(Printing on card stock paper is recommended; then cut to separate.)

1. thickness of a penny

2. nucleus of an oxygen atom




3. diameter of a red blood cell

4. height of a typical 5-year-old child

5. width of a proteinase enzyme

6. length of a dust mite

Source: www.nanosense.sri

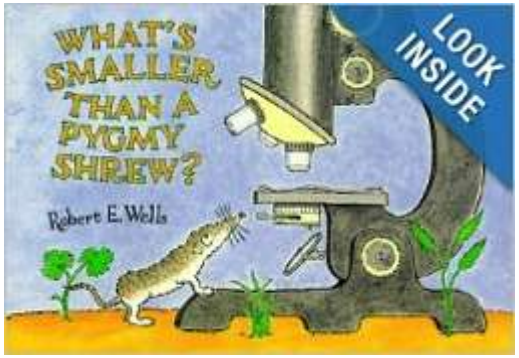
# Size Sorting Activity

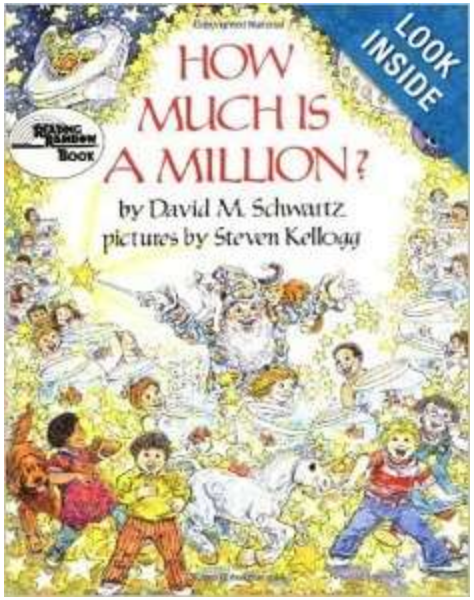


# Introduction Through Books

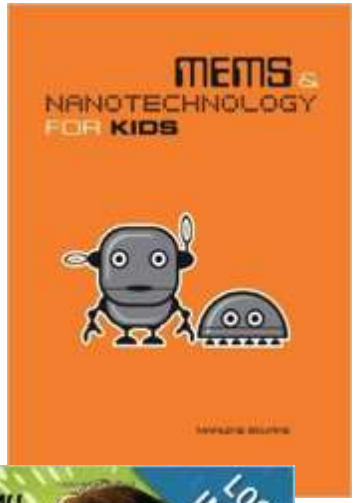


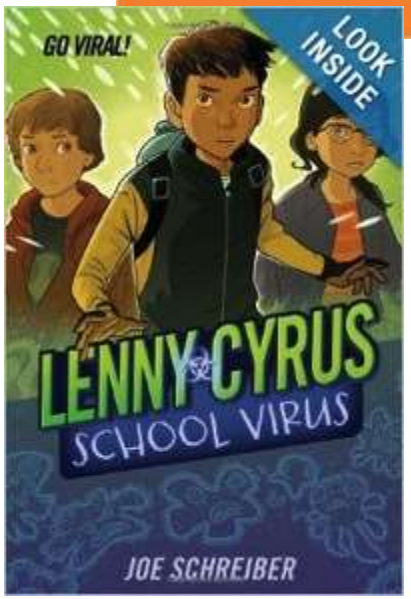
**K-5**



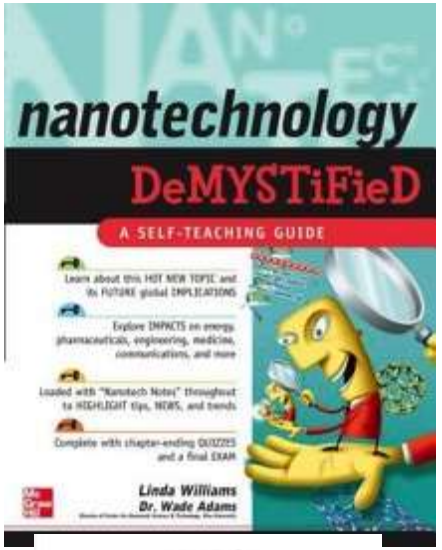




**6-8**



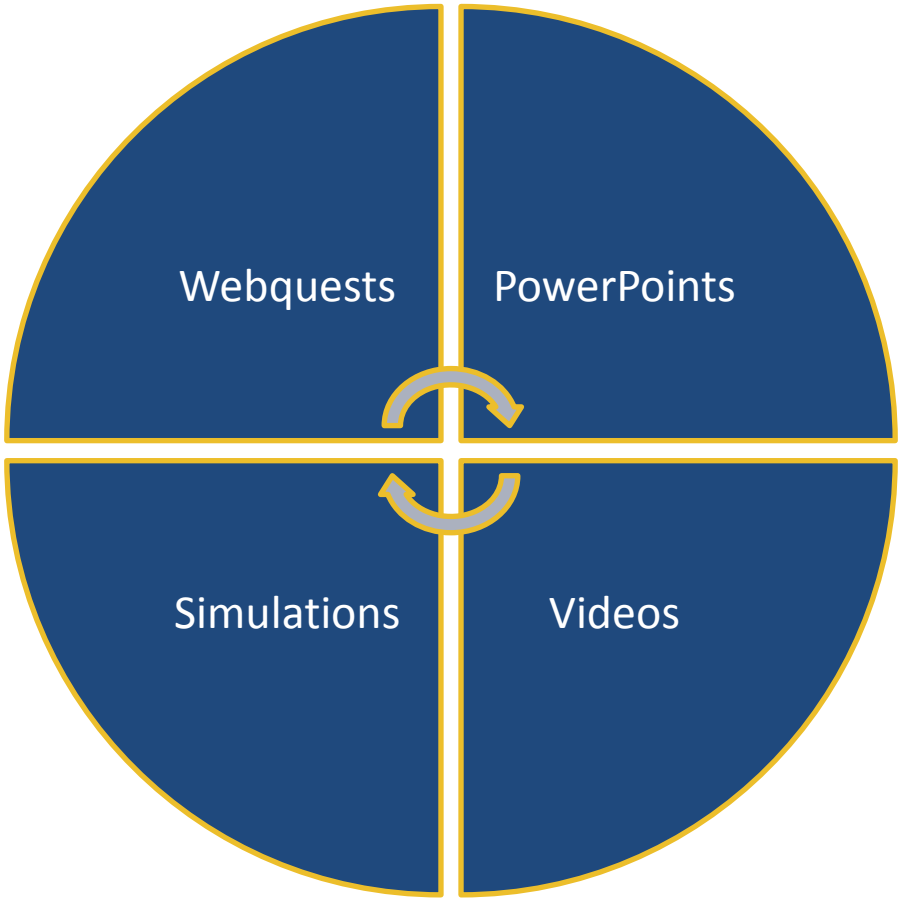




**9-12**



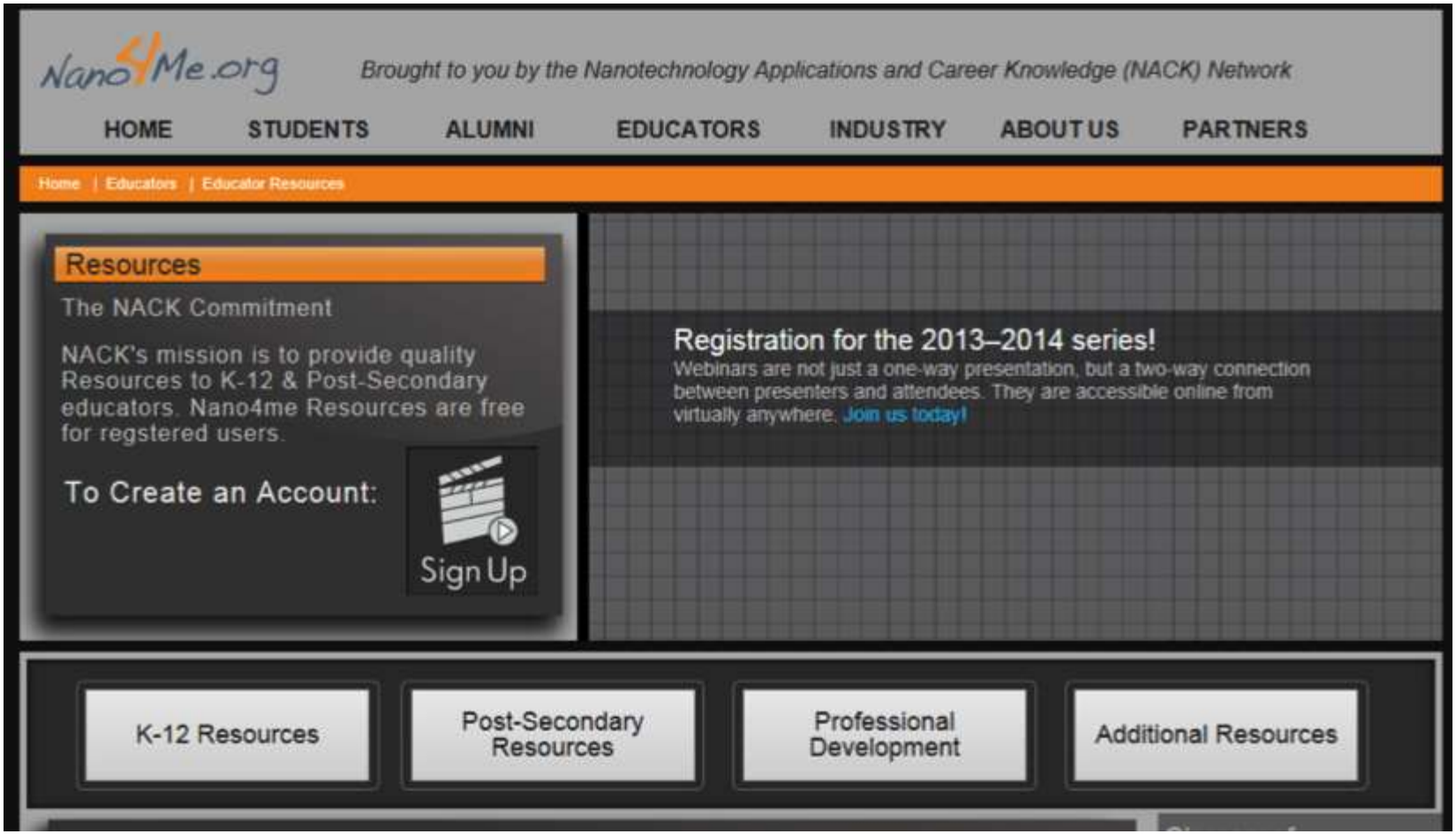

# Introduction Through Multimedia





# Introduction through PowerPoints






Source: nano4me.org/educator-resources

**multiple modules** and **corresponding lab** packages. All modules and labs can be rearranged to create new courses. Suitable for two-year degree programs, for certificate programs, and for freshman-sophomore use in four-year degree programs.

E SC 211 | E SC 212 | E SC 213 | E SC 214 | E SC 215 | E SC 216

**Multimedia:** A collection of interactive multimedia in nanotechnology. These resources are suitable for a variety of levels and subject areas.

**Remote Access:** Video learning modules and example lab experiments suitable for post-secondary and secondary classrooms. ***Request time*** on our characterization equipment and bring cutting-edge technology into your classroom today.

**K-12 Resources**

**Introductory Level Modules:** A series of thought-provoking nanotechnology PowerPoint presentations filled with in-depth material surveying where nanotechnology came from, why it is so unique, how it is practiced, and what it can do.

**Introductory Level Activities:** Interactive nano-enabled products used to expand the imaginations of K-12 students with current applications benefiting from nanotechnology.

**High School Level Nanotech Academy Activities:** A collection of informal activities created for a 1-3 day nanotechnology camp available to those interested in creating similar events or to supplement the classroom experience.

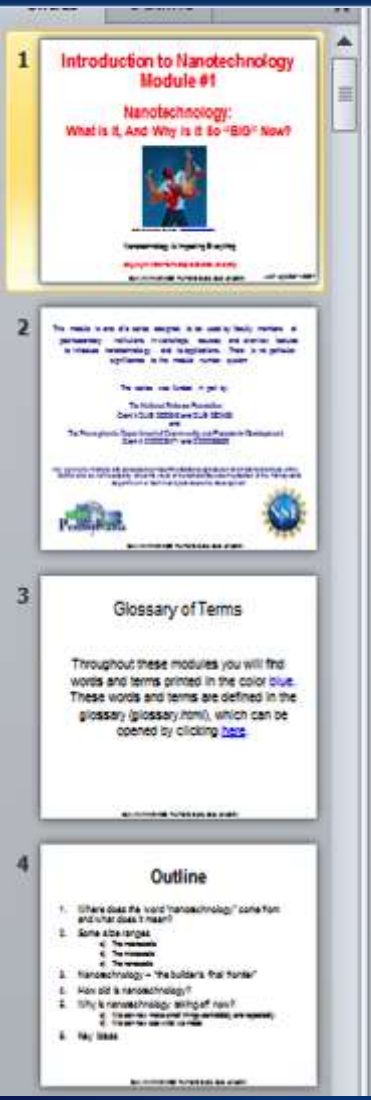
**High School Level Experiments:** A collection of experiments and activities that introduce nanotechnology concepts and applications to many levels; includes, but is not limited to, nanoparticle synthesis for bacterial inhibition, micro- and nanofluidic device fabrication with common materials, micro- and nanoencapsulation, and nanowire sensor applications.

**Multimedia:** A collection of interactive multimedia in nanotechnology. These resources are suitable for a variety of levels and subject areas.

**Remote Access:** Video learning modules and example lab experiments suitable for post-secondary and secondary classrooms. ***Request time*** on our characterization equipment and bring cutting-edge technology into your classroom today.

# Example of PowerPoint From Module






## Introduction to Nanotechnology Module #1

## Nanotechnology:
## What Is It, And Why Is It So "BIG" Now?

© patton brothers illustration (www.pattonbros.com)

Nanotechnology is Impacting Everything



 Last Updated: 1/6/2011

# Introduction through Webquest




Source: www.ice.chem.wisc.edu/Small%20Science/From_Small_Science_Comes_Big_Decisions/Introduction.html

# Task



You are a nanotechnology researcher with an agency whose projects are funded totally by the NNI. When you got to work this morning you found out that your group is earmarked for extreme funding cuts! You and the other research groups are being given the opportunity to present your case to the National Nanotechnology Budget Review Committee to defend your current projects and funding. How you present your case can have a great impact on where these research dollars are spent and, thus, the future of nanotechnology in our country, the scientific community, and the world.

# Explores areas of NSE



| Energy | Military | Environmental Impacts | Transportation | Healthcare |
|---|---|---|---|---|
| • Utilization<br>• Biofuels<br>• Production | • Homeland Security<br>• National Defense | • Improvements<br>• Environmental impact of manufactured nanoparticles | • Fabrication<br>• Fuels<br>• Mechanics | • Preventive Medicine<br>• Prosthetics<br>• Treatment |
| **Agriculture and Food Technology** | **Manufacturing** | **Education and Basic Research** | **Information and Electronic Technology** | **Aerospace** |
| • Food and Agriculture<br>• Bioengineering | • Cosmetics<br>• Clothing<br>• Construction Materials<br>• Electronics | • Workforce Training<br>• Curriculum<br>• Public Education<br>• Graduate Research | • Electronics<br>• Cell Phones<br>• I-pods<br>• Computers | • Spacecrafts & Suits<br>• Health Monitoring<br>• Energy<br>• Food<br>• Electronics |

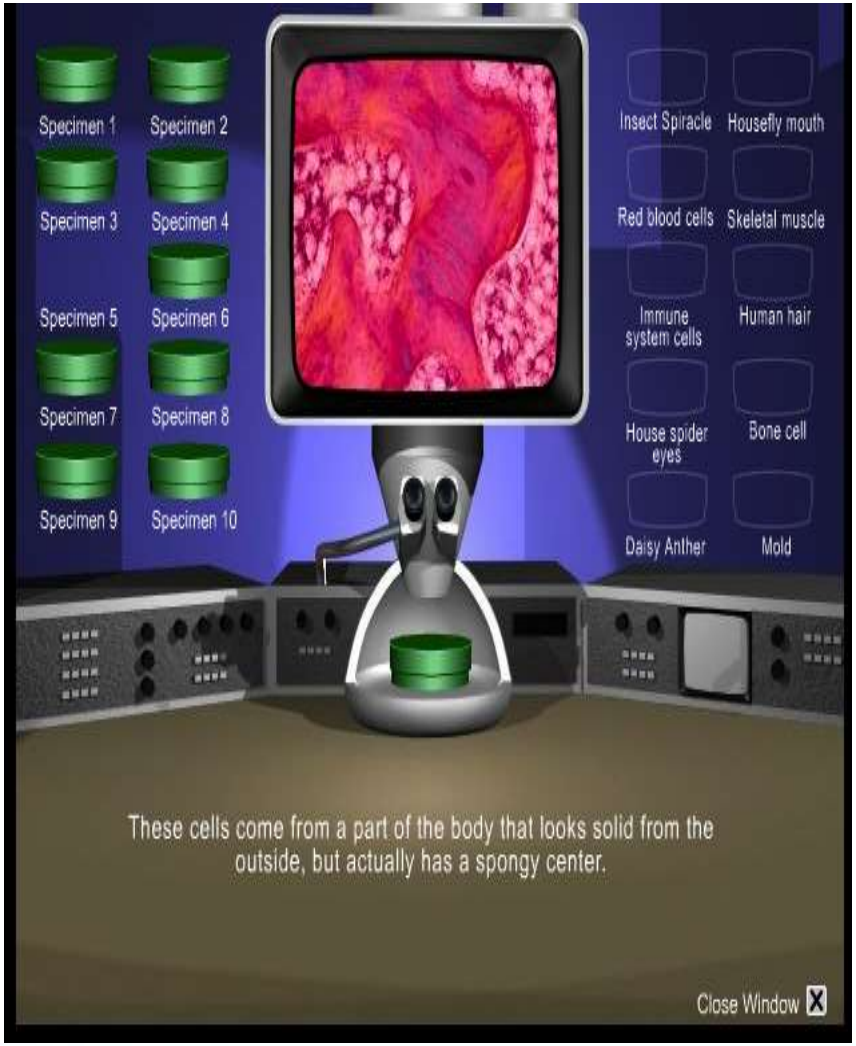
# Introduction through Simulations

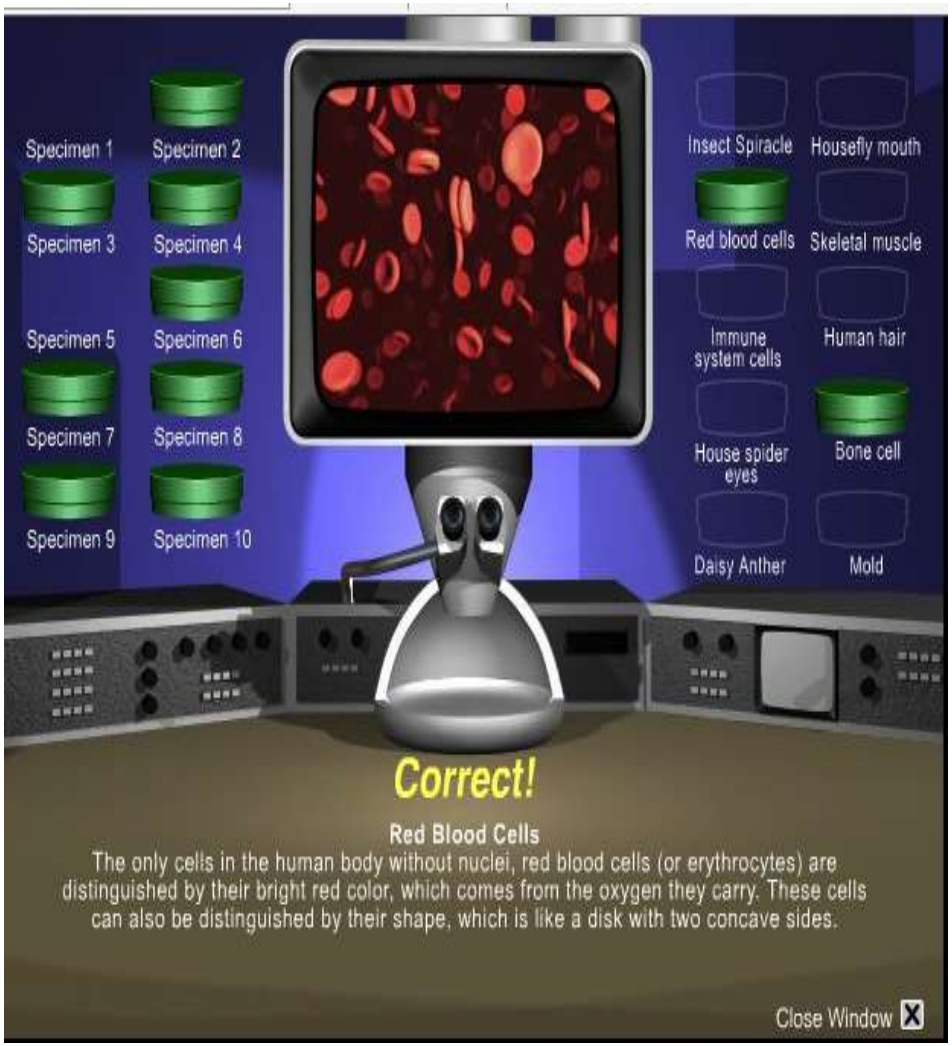



http://school.discoveryeducation.com/lessonplans/interact/vemwindow.html

# The Way it Works

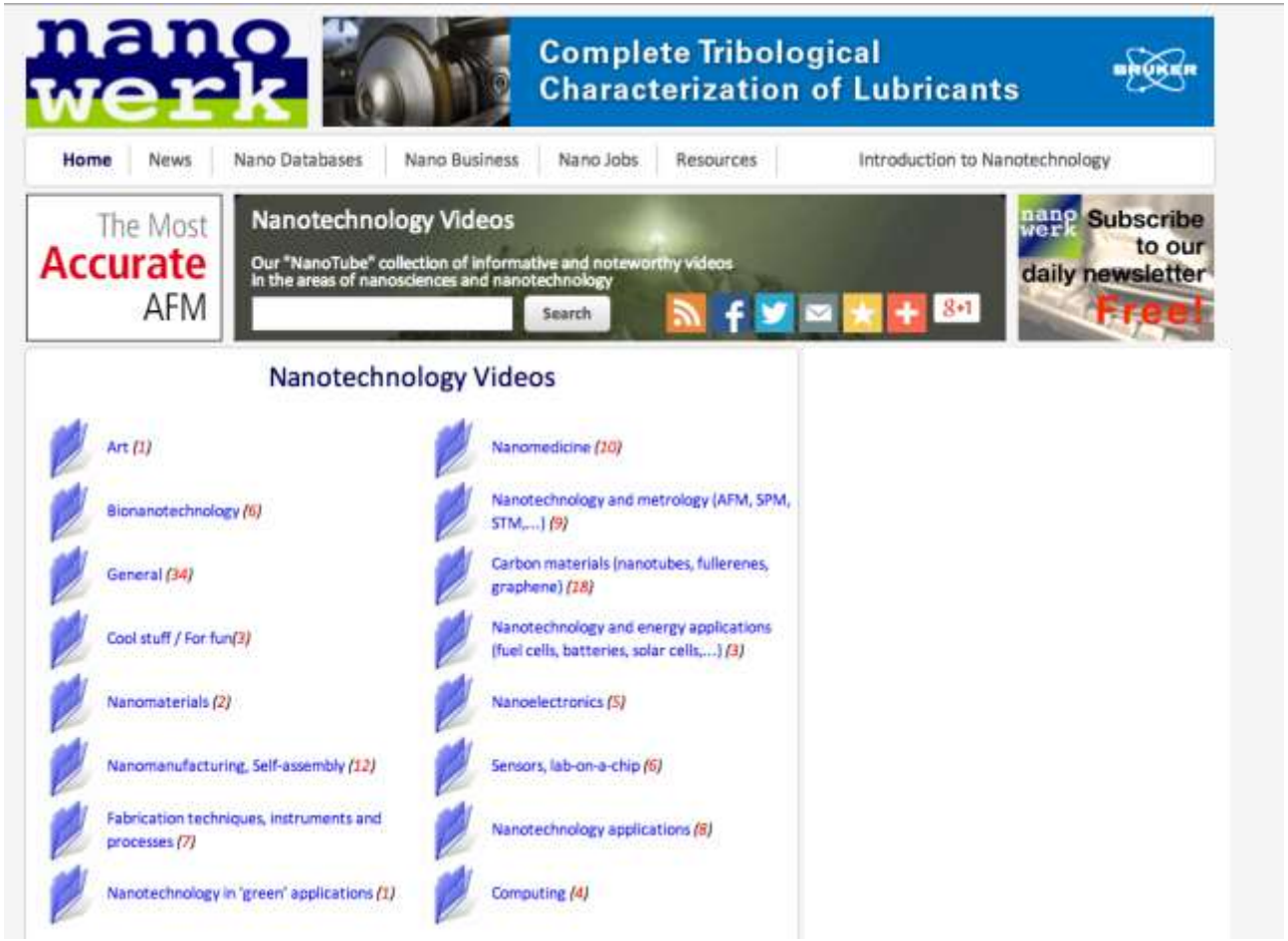




# Introduction through Videos






http://www.nanowerk.com/nanotechnology/videos/videos.php

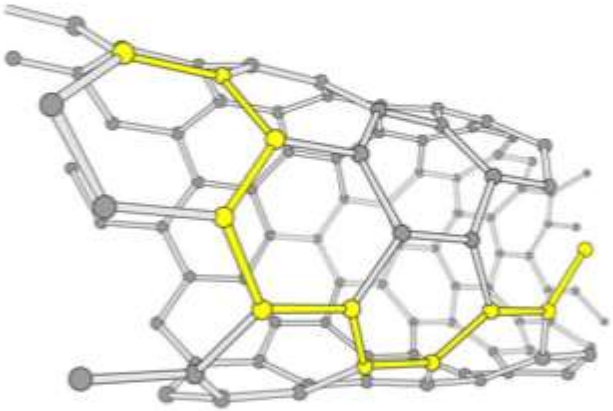
# Introduction through Demos



Source: www.nnin.org

National Nanotechnology Infrastructure Network

Outreach Demonstration Guide



NNIN

Georgia Tech Nanotechnology Research Center

This work was supported by NSF award ECS 0335765

Source: www.nnin.org

**1. Magic Sand Demo – Exploring Hydrophobic Properties**

The NNIN lesson *Exploring Magic Sand* will give you the background information for the full lesson (http://www.nnin.org/nnin_k12teachers.html). It also has resources to buy the materials but you can Google "magic sand" and find other sources plus YouTube videos.

**Materials:**

1. container of magic sand (small vials or bottles) plus a larger container with magic sand (we use the one pound container it is shipped in)
2. container of regular sand (small vials or bottles) plus a larger container of regular sand
3. 2-3 inch cardboard pieces to make sand demos (see picture above)
4. rubber cement
5. small petri dishes or small clear cups (2-3 depending on demo used) each filled ½ with water
6. water in squirt bottle or use beaker/cup with water and eye dropper
7. funnel and fast flow filter paper (or coffee filters)
8. beaker/cup to catch liquid from funnel
9. clear beaker or cup
10. water and stirring rod
11. small drop bottle of surfactant (if doing this part of demo) – dish soap or vegetable oil (you may add food color to this so it is easier to see)
12. paper towels
13. plastic table cloth (optional)
14. hand held scope (optional) (Radio Shack Illuminated Microscope Model MM-100 Catalog # 63-1313)

**To do a demo:**

Prepare demo pieces in advance of event:

1. Cut circles or squares from cardboard (minimum size 2") – such as from a shipping box. We use a die cut machine to cut circles or squares.
2. Spread out a sheet of paper to work over.
3. Spread rubber cement over cardboard piece and sprinkle with magic sand (press as necessary to stick). Shake off excess sand and reuse or return to container.

# Introduction through Games



**Main Menu**

HOME
ABOUT
PLAY
GET INVOLVED


## NanoMission :: Learning Nanotechnology through Games

## Welcome to NanoMission!

NanoMission(TM) is a cutting edge gaming experience which educates players about basic concepts in nanoscience through real world practical applications from microelectronics to drug delivery.

## Objective

Whilst most young people are familiar with nanotechnology as a fantastic futuristic technology involving miniature robots, very few have a realistic understanding of nanotechnology, realise its impact on the world around them, or are genuinely stimulated about its possibilities. Coupled with declining numbers of physics, chemistry and engineering students, this is a major cause for concern.

Our aim is to inspire youngsters about the world of nanotechnology, potentially opening their eyes to choosing it as a career. Aimed at the gaming generations, NanoMission(TM) is an engaging learning experience which educates players about basic concepts in nanoscience through real world practical applications from microelectronics to drug delivery.

Through sponsorship, we aim to make the PC version of the game, including a 'teachers' version which contains lesson plans and online support, **available free** to schools and colleges throughout the world.

## NanoMission Modules

Source: Nanomission.org

# Trading Cards



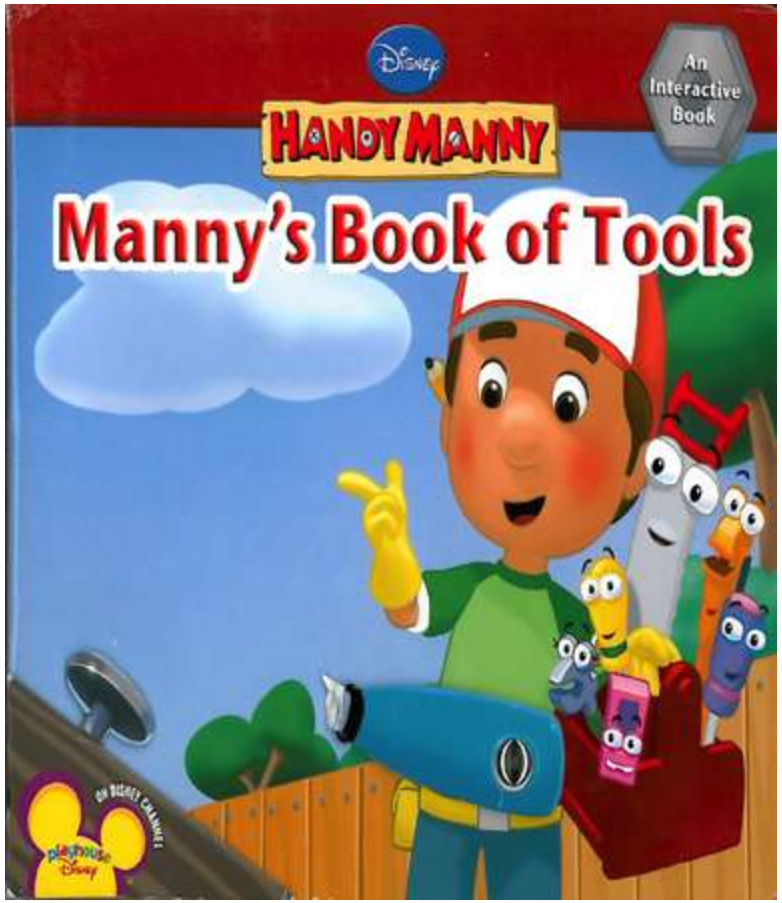

Source: www.cohesion.rice.edu/naturalsciences/nanokids/resources.cfm

# Question Break

# K-5 Resources Connecting NSE to Curriculum

# Lesson: Right Tool for the Job






- The **purpose** of this lesson is to encourage students to think about how the use of tools helps them to gather information about the world around them.
- **Activities** have students look at tools that repair, tools that measure, and tools that help us see.
- This lesson supports **learning about the nanoscale** because objects are too small to be seen and the information we gather depends on the tools that we use.

Source: nnin.org

# Right Tool for the Job Learning Center



# Example of Lesson Being Used with K and 2nd Grade Students



**Tools That Help Us See Center**

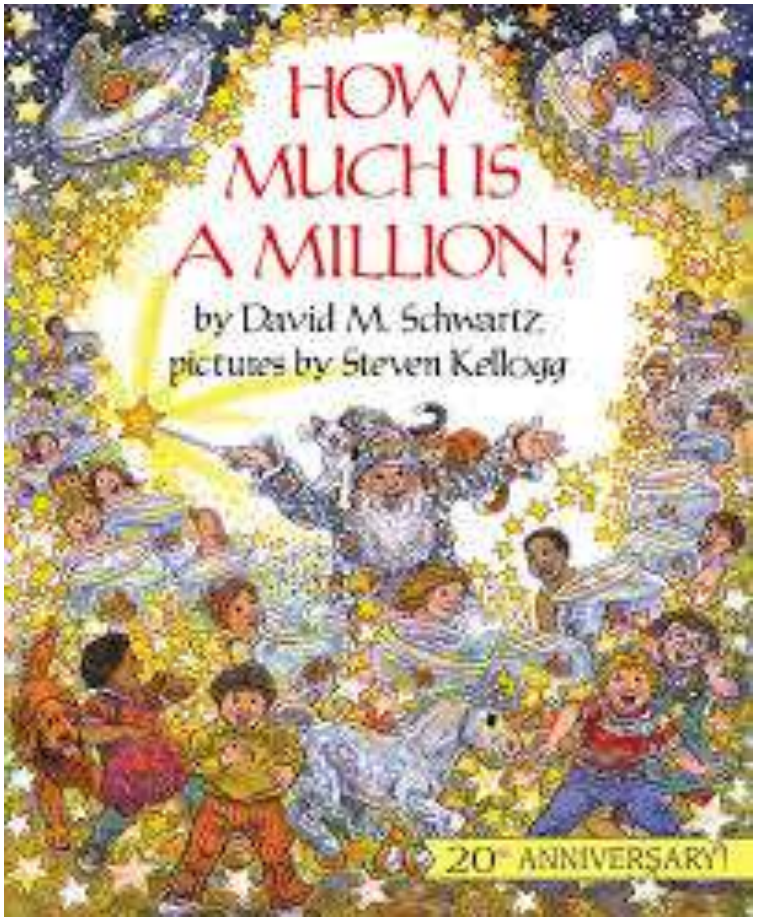
**Tools That Help Us Build Center**

**Tools That Help Us Measure Center**

**Tool Sorting Cards**

# Lesson: Sometimes We Need Large Numbers to Describe Small Things



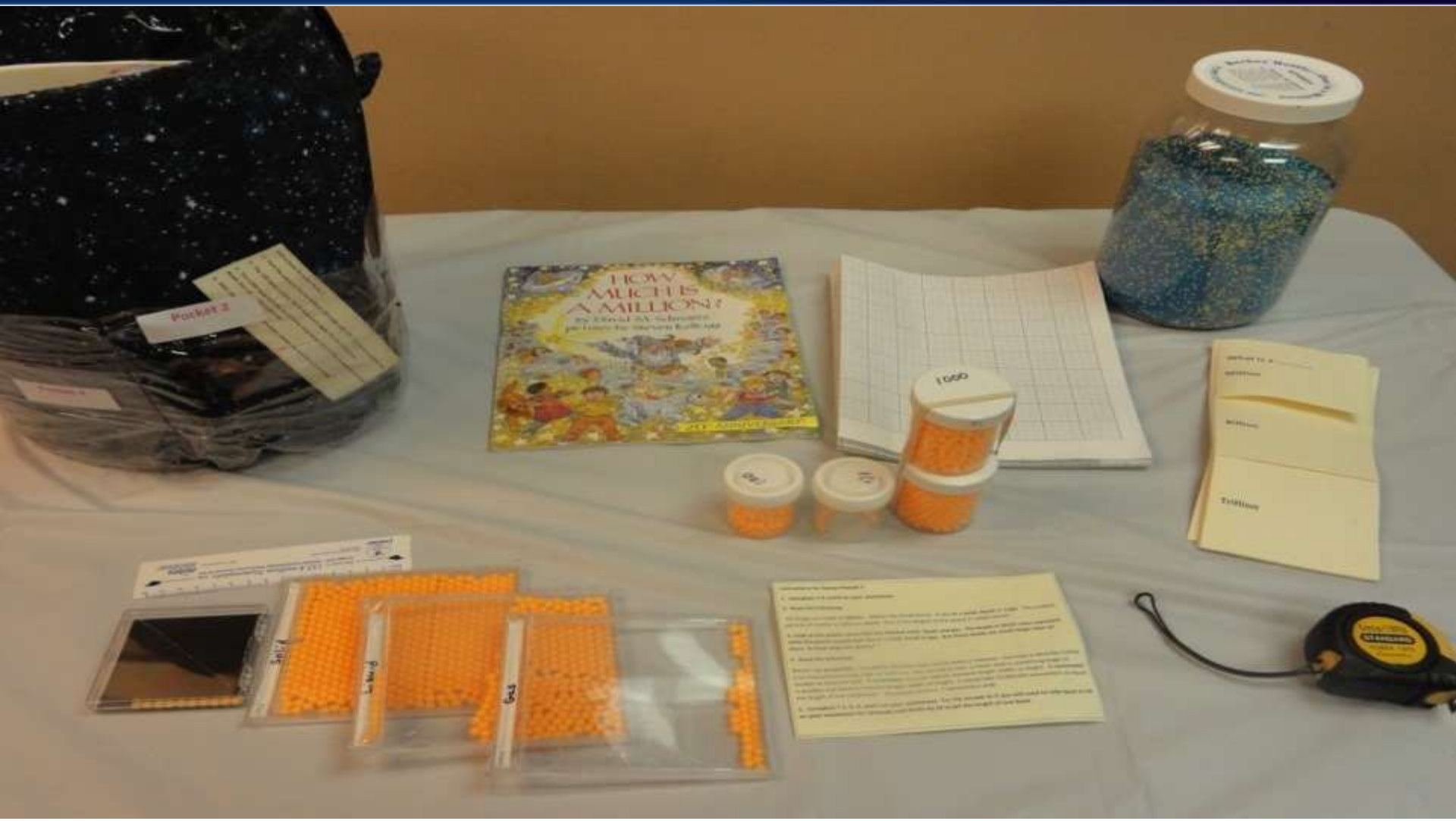



Source: nnin.org

- The **purpose** of this lesson is to help students visualize how small a nanometer is by relating the size to the numbers-millions, billions and trillions and then relating those numbers to how small particles of matter are.
- **Activities** include having students experience how much a million is by using a Becker Bottle and then relating that to the size of particles (atoms) that make up matter.
- This lesson supports **learning about nanoscale science** because for students to understand what one billionth is they first must have an understanding of a billion.

# Materials in Learning Centers

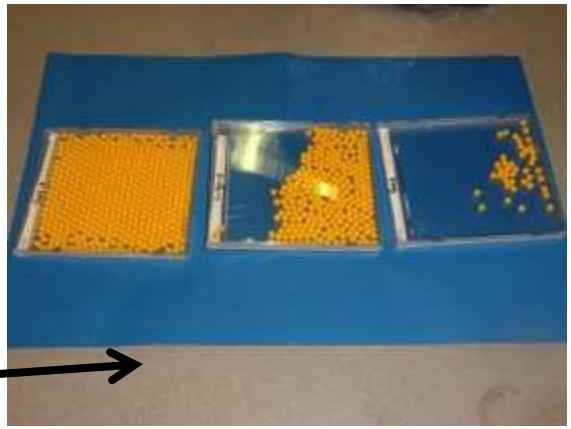




# Activities in Lesson



1. What would a million or billion of something look like?
2. What would one out of a million or billion look like?
3. What particles make up matter and what would they look like?
4. How many of these particles could fit side by side across a centimeter?



Calculate how many cesium atoms (particles) would fit across the length of a centimeter. Show your work and circle your answer.

1 centimeter = 10,000,000 nanometers

1 cesium atom = .7 nanometers average diameter

# 6-12 Resources Connecting NSE to Curriculum

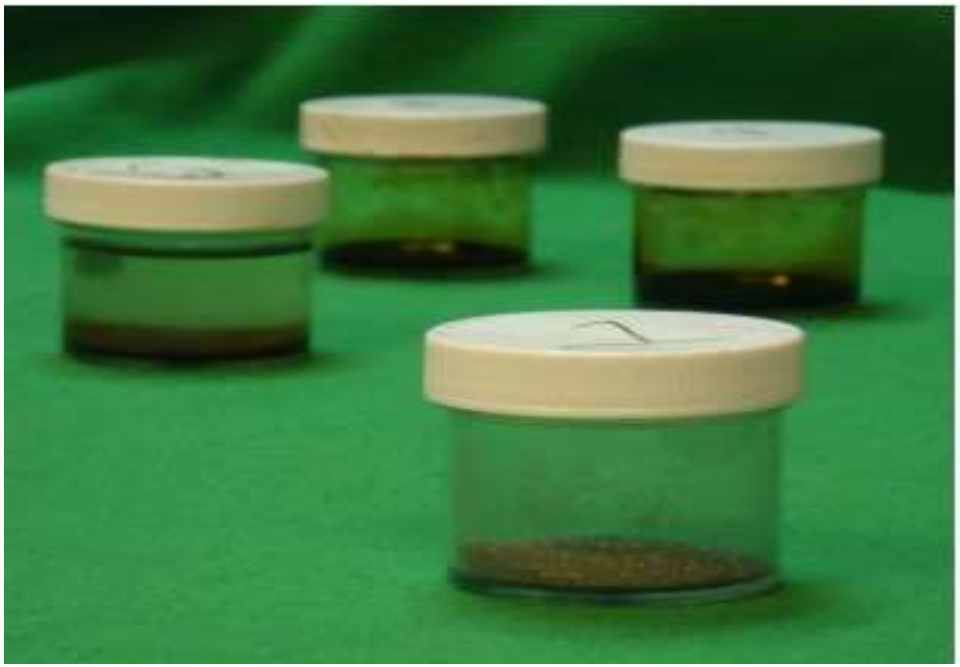
# Lesson: Magnetism and Nanotechnology



1. The **purpose** of this lesson is to take what students know about magnetism and relate that information to the colloidal mixture called ferrofluid.
2. **Activities** include a review of magnetism, and the testing of four containers with a rare earth magnet.
3. This lesson **supports learning about nanoscale science** because students will compare differences in how macro and nano sized magnetic particles behave .

# Ferrofluid Lesson





www.youtube.com/watch?v=PvtUt02zVAs

# Lesson Clean Energy

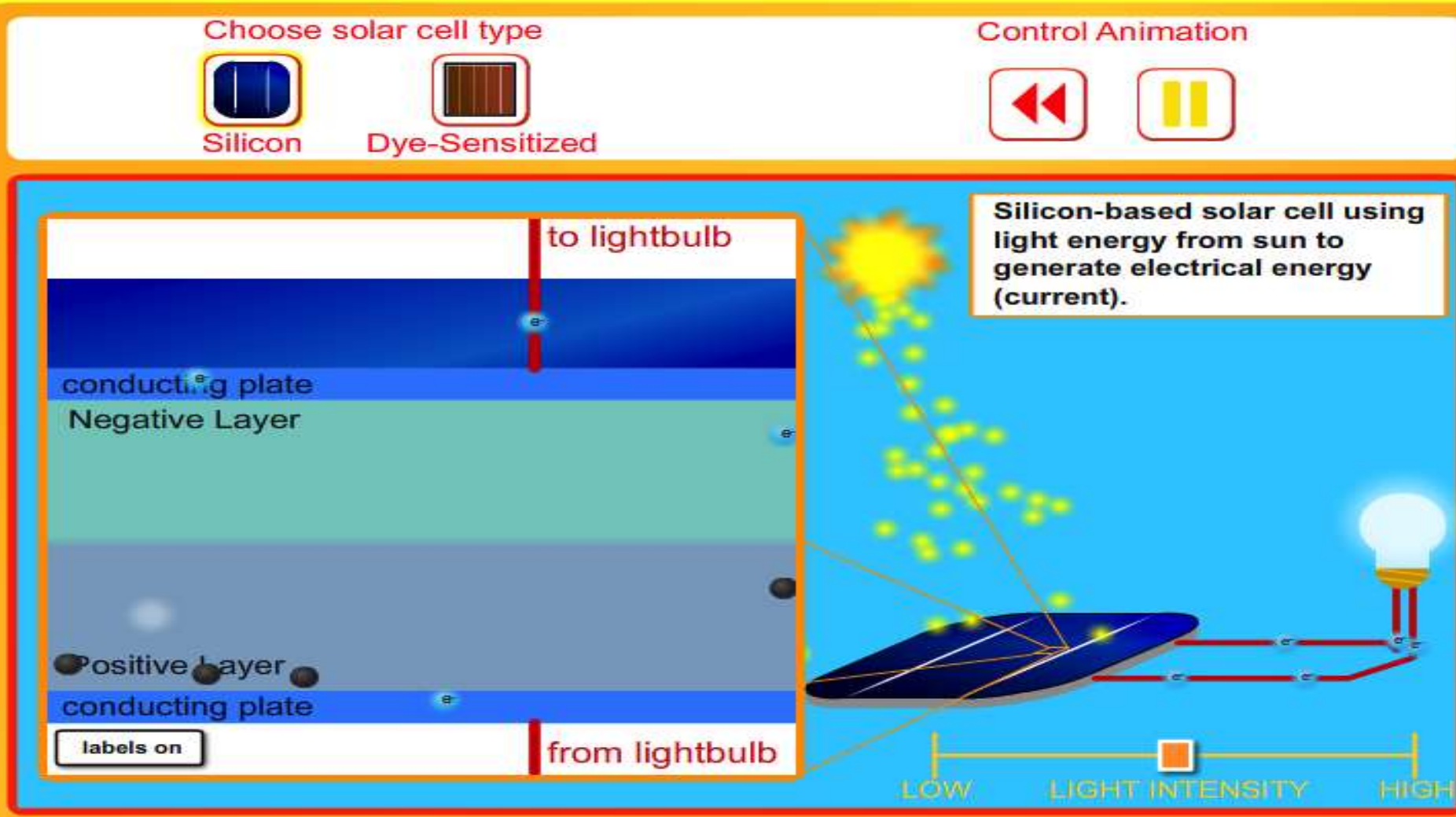


Source: nanosense.sri

1. The **purpose** of this lesson is to introduce students to clean energy alternatives and how nano science may provide important breakthroughs in solar energy technology through low cost, novel energy conversion mechanisms.
2. **Activities** include an introductory PowerPoint which provides a discussion of the top 10 global problems of the next 50 years, and a comparison of silicon-based and nanocrystallline solar cells .
3. This lesson **supports learning about nanoscale science** by having students compare nanotechnology-influenced solar cells with traditional solar cells.

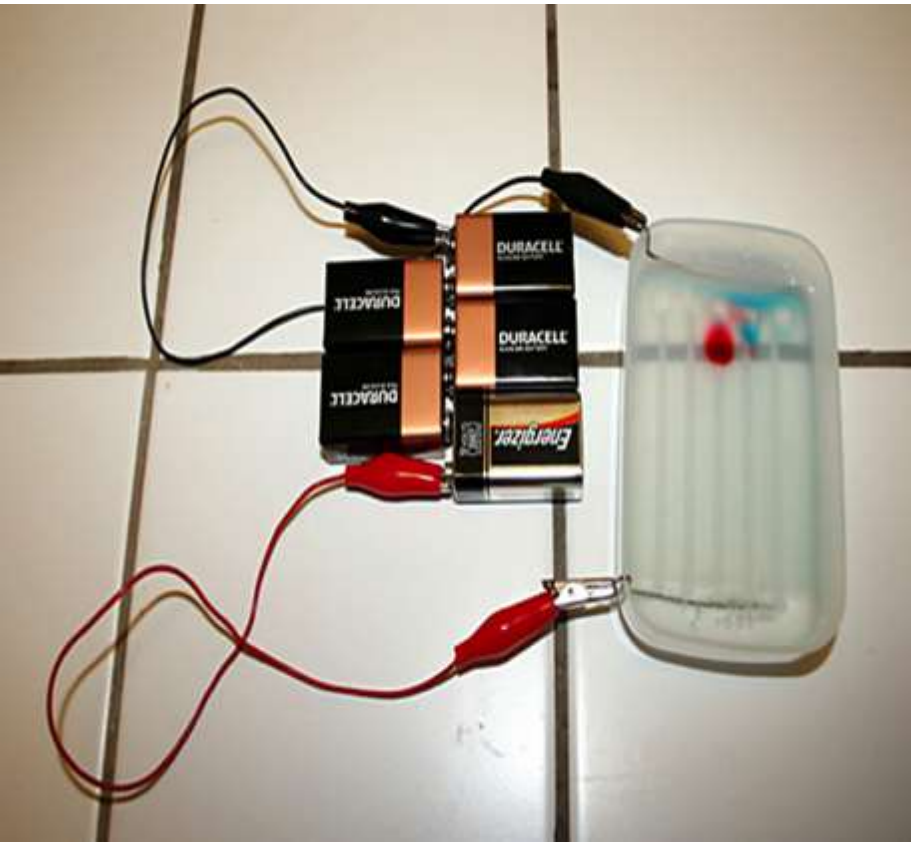
# Simulation of Solar Cells





# Lesson: Forensic Science: Building Your Own Tool for Identifying DNA



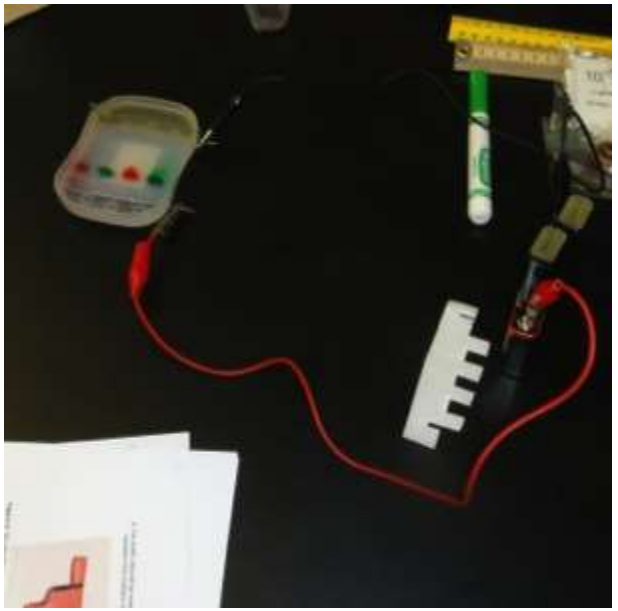



Source: www.sciencebuddies.org/science-fair-projects/project_ideas/BioChem_p028.shtml

1. The **purpose** of this lesson is to model the separation of DNA in a gel electrophoresis chamber by using a soap box and different colors of food coloring dye.
2. **Activities** include making the soapbox device and using it to separate food coloring dye.
3. This lesson **supports learning about nanoscale science** by having students learn about characteristic of nanostructures such as DNA.

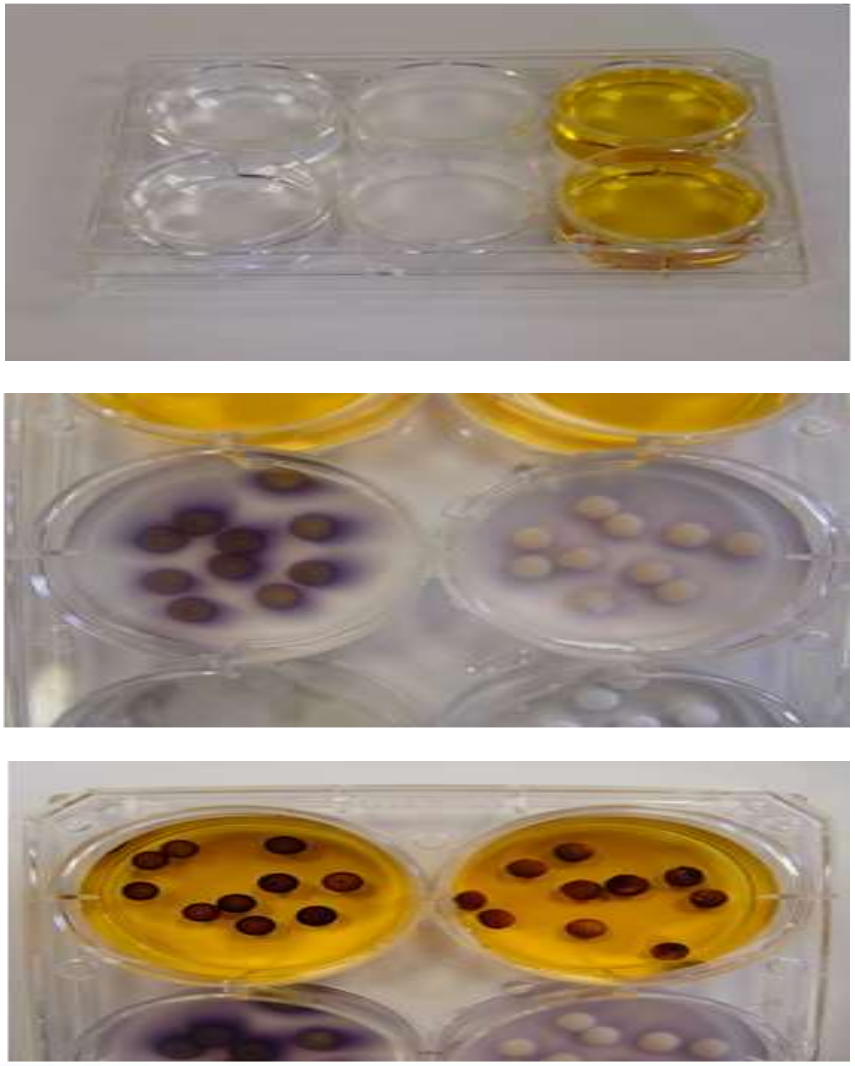
# Lesson Being Conducted by Teachers



# 9-12 Lesson: Connecting Acids and Bases with Encapsulation and Chemistry with Nanotechnology

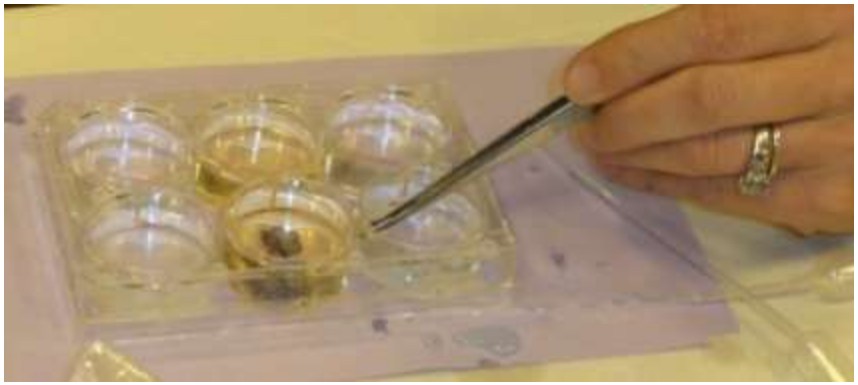




1. The **purpose** of this lesson is to help students develop a theory of acids and bases, differences in weak and strong acids, learn about encapsulation, the importance of scale to technological challenges and how they connect to research in drug delivery.
2. **Activities** are included in Focus, Explore, Reflect, Apply and Extension sections. An alternative version of the Apply section relates to biology.
3. This lesson **supports learning in nanoscale science** because it relates encapsulation to current research in using nanoscale structures for disease detection and drug delivery.

# Lesson Being Conducted by Teachers





# Lesson: Move A Wall



Source: nano-cemms.illinois.edu/materials/move_a_wall_full

1. The **purpose** of this lesson is for students to use geometric and trigonometric concepts to calculate the distance a solid wall can be moved.
2. **Activities** include setting up lab, measuring distances, and calculating how many nanometers the wall moves.
3. This lesson **supports learning in nanoscale science** because the distance the wall moves must be calculated in nanometers. This method is a model of how an image from an Atomic Force Microscope is formed.

# Step by Step Instructions on Setting up Lab



Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems

*Experimental Setup*

*Video Tutorial Found at: https://nano-cemms.illinois.edu/materials/move_a_wall_full*

1. Locate a solid wall (brick, cinderblock, etc.) that is directly across from another wall at least 20 feet away.
2. Place the table near the solid wall, approximately six inches from the wall. Add weight to top of table.
3. Cut a square of carpet tape that is between 1.5 and 2 cm per side.
4. Center and press the sticky side of the tape on the end of the long metal rod. Remove the paper backing of the tape and push the sides of the tape down around the rod.
5. Rest the rod on the table so that one of its ends is approximately 1 inch from the wall and that it is about one inch from the edge of the table.

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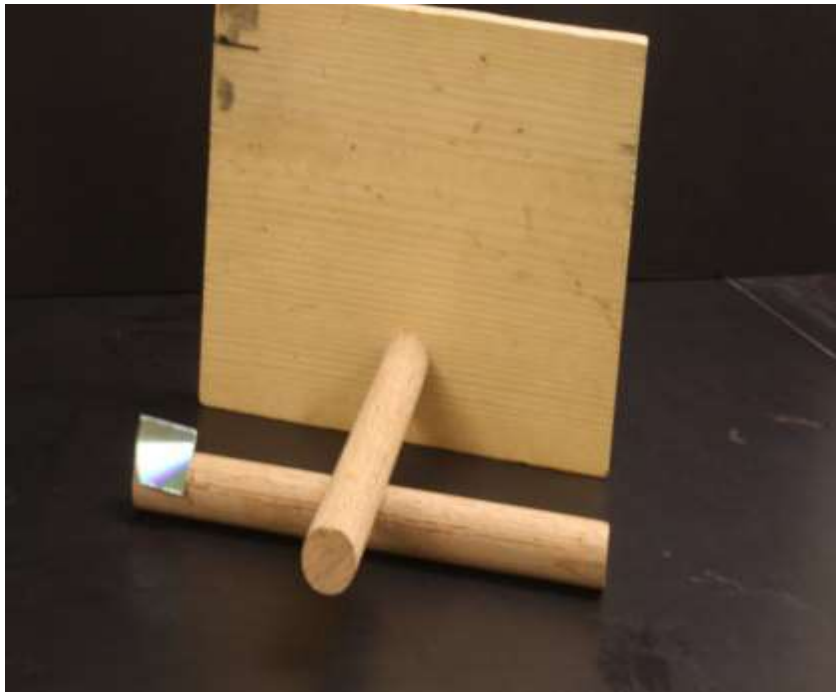
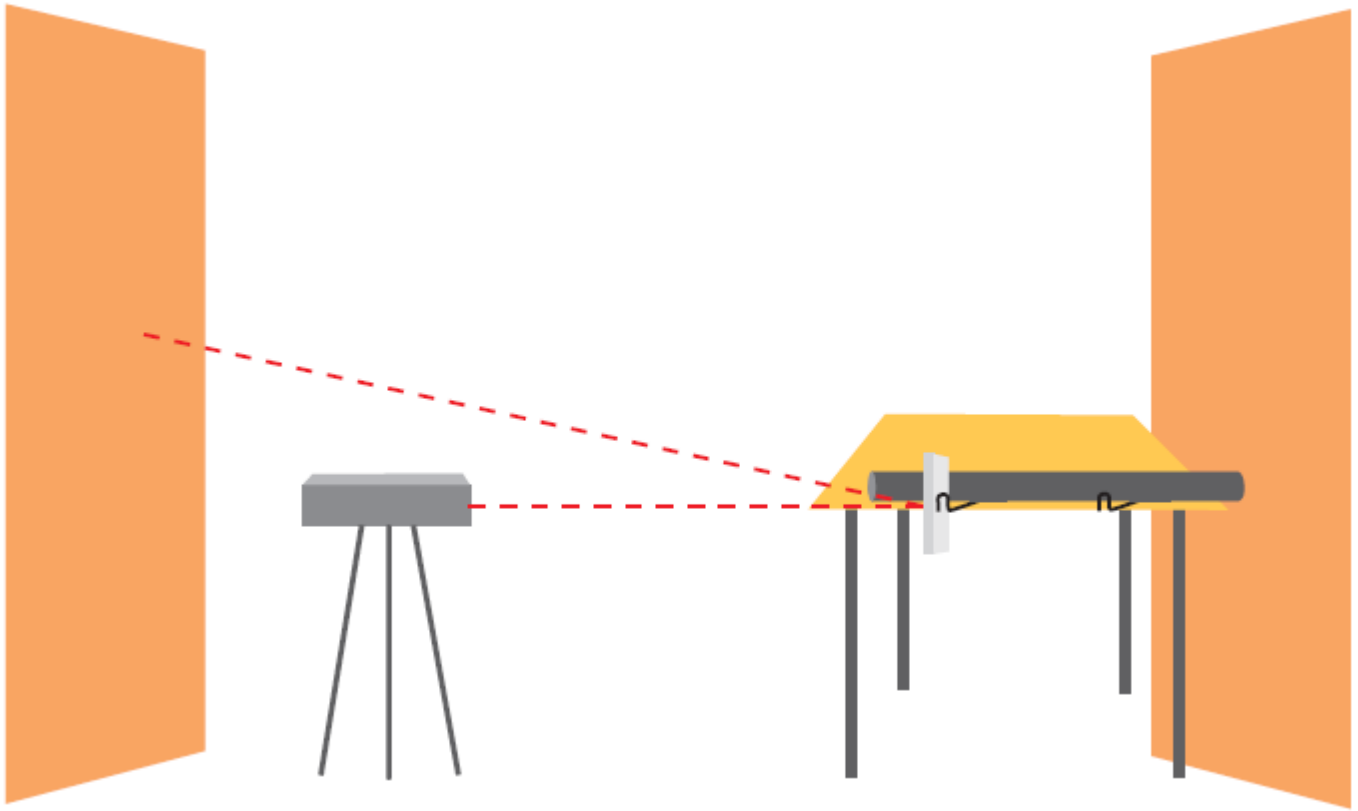


# How the lesson Works





# Lesson Being Conducted by Teachers



# Lesson: Mixtures and Nanotechnology



1. The **purpose** of this lesson is for students to develop or review their knowledge of characteristics of mixtures and how mixtures relate to nanoscale.
2. **Activities** include looking at containers of mixtures and then sorting mixture cards based on mixture characteristics.
3. This lesson **supports learning in nanoscale science** because colloidal mixtures are made up of particles between one and 100 nanometers.

# How the Lesson Works



Lesson has five parts where students develop a knowledge of the vocabulary and characteristics of mixtures.

**Part C:**

1. Gather up cards from the Heterogeneous Mixture group. Do not disturb the cards in the other group. You will need them later. Separate the cards you picked up into two groups, colloids and other heterogeneous mixtures.

| Colloids | Other Heterogeneous Mixture |
|---|---|
| | |

2. Using markers and a sheet of chart paper, list your classification groups and tape to wall.
3. After discussion with other groups make any changes in your groups that you feel are needed.
4. What characteristic did you use to separate the colloids from the other heterogeneous mixtures? _____
5. Write a definition for colloids. _____

**Part D:**

1. Complete the following chart by placing the terms below in the square where they belong: Beaten egg white, Blood, Butter, Cheese, Cloud, Colored Gems, Dust in Air, Floating soap, fog, Gelatin, Marshmallows, Milk, Smoke, Spray Deodorant, Whipped Cream

Title of Chart: _____

| Dispersed Particles | Dispersing Medium | | |
|---|---|---|---|
| | Solid | Liquid | Gas |
| Solid | | | |
| Liquid | | | |
| Gas | | | |

2. After placing all terms on the chart decide on a title for the chart.
3. Discuss with your group which substances above would the following terms go with: sol, emulsion, foam, aerosol

**Concluding Activity**

Summarize the information that you learned today on this sheet incorporating the diagram below. Be sure to use terms correctly.

# Concluding Activity



## How can you tell the difference between a suspension, colloid and solution?

**Classification of some matter is based on particle size.**

# Students and Teachers Conducting Lesson



# Lesson: 3D Printing




1. The **purpose** of this lesson is for students to develop an understanding of the relationships between science and engineering.
2. **Activities** include a presentation on microstereo lithography, students designing computer images to create a three dimensional objects and then using a photoreactive polymer to create a three dimensional object from their image.
3. This lesson **supports learning of nanoscale science** because micro-stereolithography allows for the creation of 3D micro-sized and nano-sized objects.

Source: nano-cemms.illinois.edu/materials/3d_printing_full

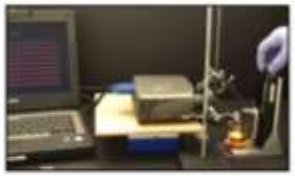
# How the Lesson Works



## Instructor Information for 3-D Printing Lab Activity

***Overview:***

In this lab, students will make a three dimensional object of their own design. A photoreactive mixture of chemicals will polymerize when exposed to ultraviolet light, leaving nearby polymer unreacted. Using PowerPoint and a data projector, one can create different shapes by shining the light of the data projector into a beaker of the photoreactive polymer. PowerPoint allows black and white cross sections to be designed in a user friendly interface. Adding an ultraviolet absorber will prevent the light from penetrating into the polymer more than a fraction of a millimeter. By continually lowering the previous layer of hardened polymer into the beaker a three dimensional object can be made one cross-sectional layer at a time.



3-D Printing Set-Up, at focusing frame

While making layers of object, finished layers are viewable from the side

The image is projected into the beaker of polymer

Rinse finished object with distilled water

3-D object is shown with a quarter

Polyethylene Glycol Dicrylate

b. Mix all three components in 100 mL amber bottle. Add stirbar, put on stir plate gently mixing, allow to mix for a minimum of three days to allow all chemicals to dissolve

**2. Set up the printer**

a. Staging device moves on a threaded rod. Be sure threaded rod is moved to the top to allow full range of movement when printing.

b. Stage has a locking mechanism, unlock stage to pull it up or down. Place beaker on stage

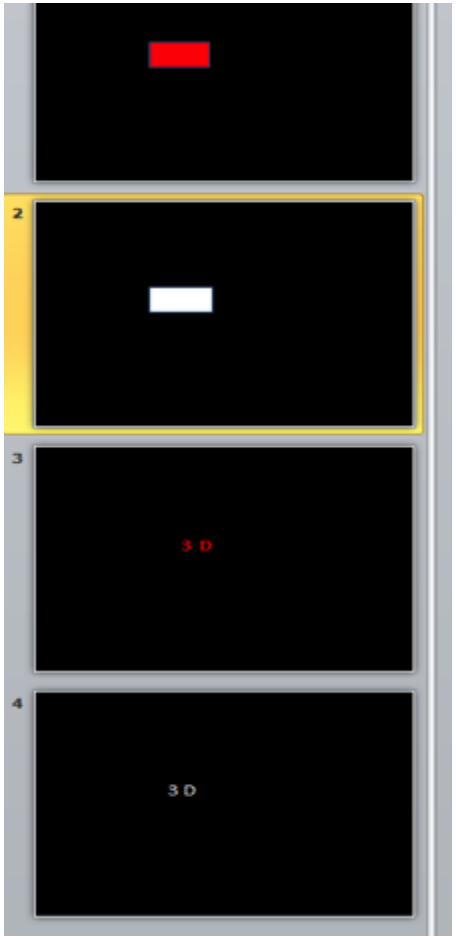
c. Place projector, magnifying glass, mirror, and stage.

# Example PowerPoint for Image



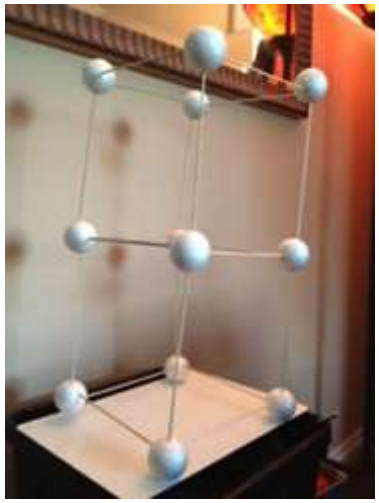
# Image Created by Teachers at a Workshop

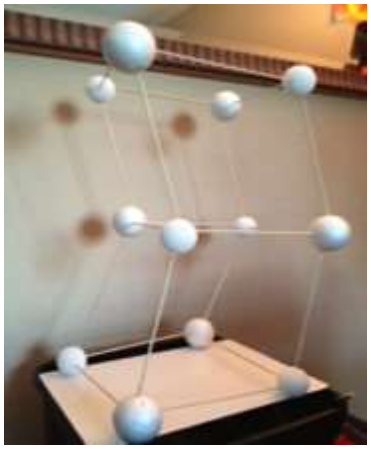





# Lesson: Phase Change







Source: www.nnin.org

1. The **purpose** of this lesson is to help students understand the nanoscale effect of various energy inputs on the crystal lattice of a smart material, Nitinol, and invites students to become nanotechnology inventors.
2. **Activities** include students using the smart material, Nitinol to learn about energy of phase change. They are then challenged to invent a use for Nitinol.
3. This lesson **supports learning of nanoscale science** because students are given an opportunity to design a device using a nano material.

# How the Lesson Works



Students will compare the differences between alloys and polymers that are Smart Memory Materials (SMM) and are not. They will determine the temperature at which transition change occurs.

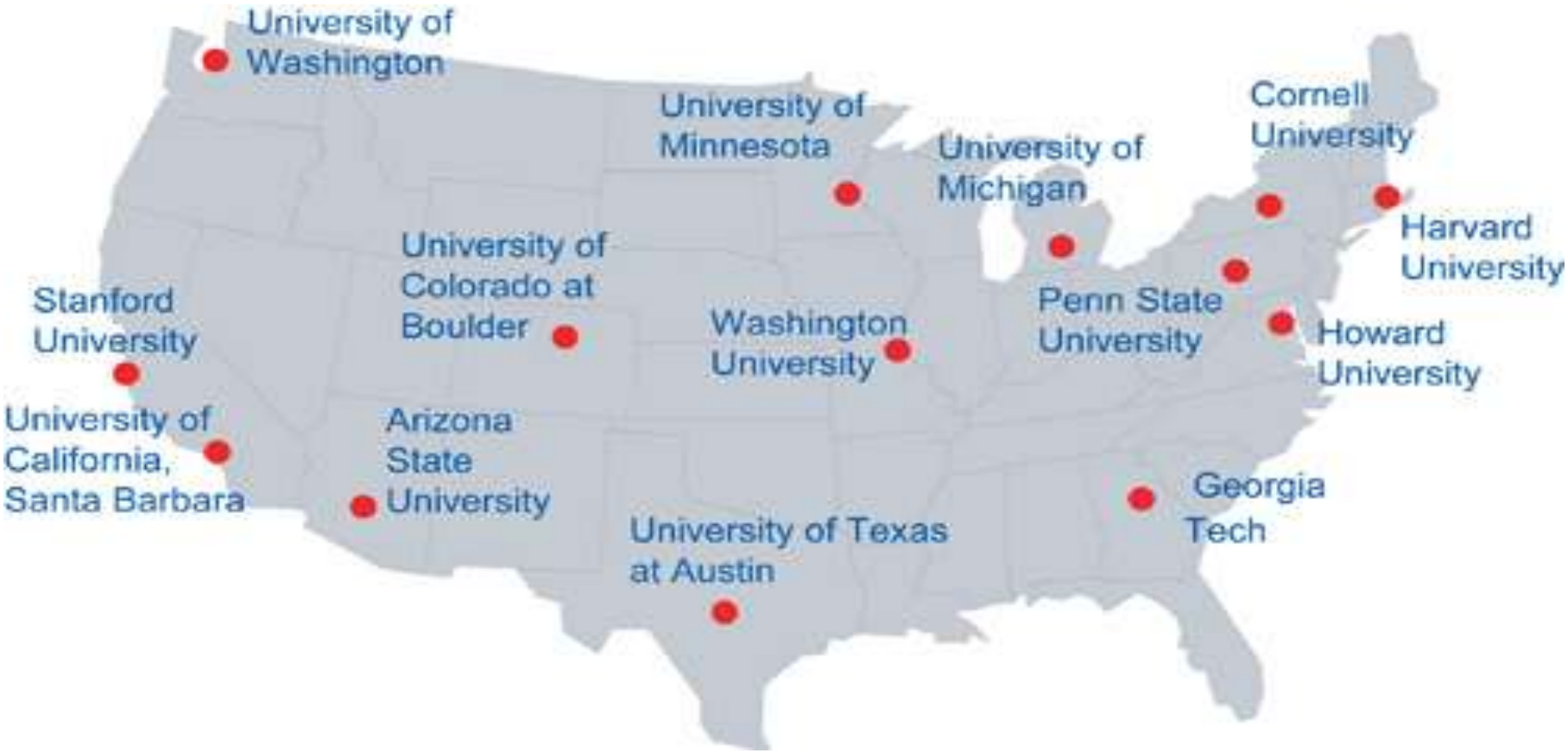
If the 0.21 g Nitinol metal sample was originally at room temperature, 21.0°C, and the
specific heat capacity of Nitinol is 0.46 J/g°C, how much energy must be absorbed by the
metal before it can change phase? Show all work below

*q = heat energy m = mass*
*c = specific heat ΔT = change in temperature*
*q = (0.21 g)x(0.46 J/g·°C)[(50.0 °C - 21.0 °C)]*
*q = (0.21 g)x(0.46 J/g·°C)x(29.0 °C)*
*q = 2.8 J*

# National Nanotechnology Infrastructure Network (NNIN)

The National Resource for **Nanoscale Science and Technology**

www.nnin.org



# NACK




## Nano4me.org

Find out how the NACK Network can help you develop your nanotechnology or nanotechnology manufacturing course or program.

# Where to Find Resource List



**Book Resources**

Internet and Multi-media Resources

# Conclusions



1. National and state data indicate a need for students to be exposed to information about nanoscale.
2. The Big Ideas of Nanoscale Science and Engineering reflect that NSE concepts are already in the K-12 curriculum.
3. Free resources are available for teachers to introduce NSE to their students and to include in the state curriculum they are required to teach.

# Questions?

Please type all questions into the Chat Box

# How Can We Better Serve You?

Whether you are joining us live or watching the recorded version of this webinar, please take 1 minute to provide your feedback and suggestions.

http://questionpro.com/t/ABkVkZQFNi

# Webinar Recordings

To access this recording, slides, and handout visit

nano4me.org/webinars.php

# Certificate of Participation

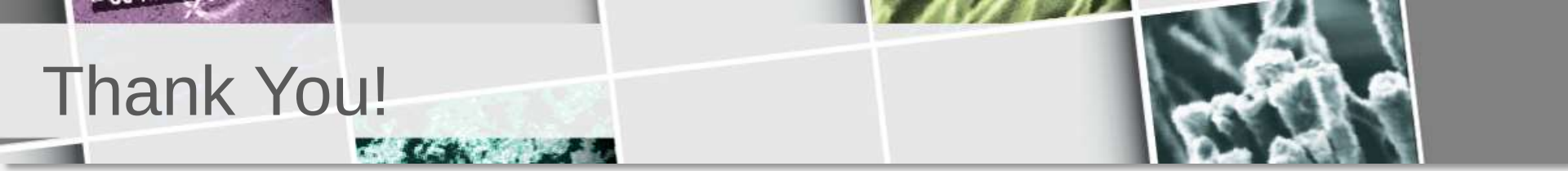
If you attended the live version of this 1.5 hour webinar and would like a certificate of participation, please email:

sbarger@engr.psu.edu

# 2014 Events Calendar

| | |
|---|---|
| **March 28:**<br>*Webinar* | RET Experience: Activities for the HS Classroom |
| **April 7-10:**<br>*Workshop* | Nanotechnology Course Resources Workshop 1: Safety, Processing, and Materials |
| **April 25:**<br>*Webinar* | Industry Partners for Your Nano Program |
| **May 13 - 15:**<br>*Workshop* | Hands-On Introduction to Nanotechnology for Educators |

**Want more events? Visit [www.nano4me.org/webinars](www.nano4me.org/webinars) for more details about these and other upcoming workshops and webinars in 2014.**



# Thank You!

Thank you for attending the
NACK Network webinar

**K-12 Resources in Nanotechnology**