

NSTA Symposium: NanoScale Science: Activities for Grades 6-12 Friday, December 7, 2007

1:30 PM – 1:55 PM

Welcome, Introductions, Goals for the Symposium

Al Byers, Assistant Executive Director of Government Partnerships and e-Learning, NSTA

Flavio Mendez, Symposia and Web Seminars Director, NSTA

- About NSTA Symposia
- Agenda/Goals
- Forms/Logistics/Introductions

Dr. M. Gail Jones, Lead Author, NanoScale Science: Activities for Grades 6-12, Professor of Science Education, North Carolina State University

Dr. Michael Falvo, Co-Author, NanoScale Science: Activities for Grades 6-12, Research Associate Professor, University of North Carolina

Amy R. Taylor, Co-Author, NanoScale Science: Activities for Grades 6-12, Research Assistant, North Carolina State University

1:55 PM – 2:05 PM

Overview presentation

Gail Jones and Amy Taylor

2:05 PM – 3:10 PM

Introduction to Nanoscale Science

Michael Falvo and Gail Jones

Learning Outcomes:

After participating in the presentation/activity,

- Participants will define nanotechnology.
- Participants will describe how science is different at the nanoscale.
- Participants will describe how an atomic force microscope works.

3:10 PM – 3:25 PM

Break

3:25 PM – 3:55 PM

Investigating Viruses and Bucky Balls

Amy Taylor

Learning Outcomes:

After participating in the presentation/activity,

- Participants will describe virus geometry.
- Participants will give an example of a nanomachine.
- Participants will describe the geometry of common nanostructures.

3:55 PM – 5:35 PM

Exploring the Lotus Effect and Applications

Gail Jones, Michael Falvo, and Amy Taylor

Learning Outcomes:

After participating in the activity,

- Participants will describe the lotus effect.
- Participants will give examples of manufactured materials that utilize the lotus effect.
- Participants will apply science process skills to investigations of the lotus effect.

5:35 PM – 5:40 PM

Nanoscale Science and the Curriculum

Amy Taylor

Learning Outcomes:

After participating in the presentation,

- Participants will describe where nanoscale science fits in the curriculum.
- Participants will describe where nanoscale science is developmentally appropriate.

5:40 PM – 6:00 PM

Final Words

- Post-assessment form
- Evaluation form/Survey/Credit info
- NSTA Web Seminars
- Raffle of door prizes

**National Science Education Standards Addressed:
Content Standards, 9-12**

**Content Standard B:
Physical Science**

As a result of their activities in grades 9-12, all students should develop an understanding of

- Structure of Atoms
 - Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atom together.
 - The nuclear forces that hold the nucleus of an atom together, at nuclear distances, are usually stronger than the electric forces that would make it fly apart. Nuclear reactions convert a fraction of the mass of interacting particles into energy, and they can release much greater amounts of energy than atomic interactions. Fission is the splitting of a large nucleus into smaller pieces. Fusion is the joining of two nuclei at extremely high temperature and pressure, and is the process responsible for the energy of the sun and other stars.
- Structure and Properties of Matter
 - The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

- Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.
- Motions and Forces
 - Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F = ma$, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.
 - Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.
 - The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, inversely proportional to the square of the distance between them.
 - Between any two charged particles, electric force is vastly greater than the gravitational force. Most observable forces such as those exerted by a coiled spring or friction may be traced to electric forces acting between atoms and molecules.
 - Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.
- Conservation of Energy and Increase in Disorder
 - All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.
 - Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.
 - Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction, radiation, or convection and the warming of our surroundings when we burn fuels.
- Interactions of Energy and Matter
 - Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.
 - Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.

Content Standard C:**Life Science****As a result of their activities in grades 9-12, all students should develop understanding of**

- The Cell
 - Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules which form a variety of specialized structures

that carry out such cell functions as energy production, transport of molecules, waste disposal, synthesis of new molecules, and the storage of genetic material.

- Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by a large set of protein catalysts, called enzymes. The breakdown of some of the food molecules enables the cell to store energy in specific chemicals that are used to carry out the many functions of the cell.
- Cells store and use information to guide their functions. The genetic information stored in DNA is used to direct the synthesis of the thousands of proteins that each cell requires.
- **Molecular Basis of Heredity**
 - In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular "letters") and replicated (by a templating mechanism). Each DNA molecule in a cell forms a single chromosome.
- **Matter, Energy, and Organization in Living Systems**
 - All matter tends toward more disorganized states. Living systems require a continuous input of energy to maintain their chemical and physical organizations. With death, and the cessation of energy input, living systems rapidly disintegrate.
 - The energy for life primarily derives from the sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. These molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars, and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes.

Content Standard D:

Earth and Space Science

As a result of their activities in grades 9-12, all students should develop an understanding of

- **Geochemical Cycles**
 - The earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on earth moves among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles.
 - Movement of matter between reservoirs is driven by the earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.

Content Standard E:

Science and Technology

As a result of their activities in grades 9-12, all students should develop

- **Abilities of Technological Design**
 - **IDENTIFY A PROBLEM OR DESIGN AN OPPORTUNITY.** Students should be able to identify new problems or needs and to change and improve current technological designs.

- **PROPOSE DESIGNS AND CHOOSE BETWEEN ALTERNATIVE SOLUTIONS.** Students should demonstrate thoughtful planning for a piece of technology or technique. Students should be introduced to the roles of models and simulations in these processes.
- **IMPLEMENT A PROPOSED SOLUTION.** A variety of skills can be needed in proposing a solution depending on the type of technology that is involved. The construction of artifacts can require the skills of cutting, shaping, treating, and joining common materials--such as wood, metal, plastics, and textiles. Solutions can also be implemented using computer software.
- **EVALUATE THE SOLUTION AND ITS CONSEQUENCES.** Students should test any solution against the needs and criteria it was designed to meet. At this stage, new criteria not originally considered may be reviewed.
- **COMMUNICATE THE PROBLEM, PROCESS, AND SOLUTION.** Students should present their results to students, teachers, and others in a variety of ways, such as orally, in writing, and in other forms--including models, diagrams, and demonstrations.
- Understandings about Science and Technology
 - Scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations. Many scientific investigations require the contributions of individuals from different disciplines, including engineering. New disciplines of science, such as geophysics and biochemistry often emerge at the interface of two older disciplines.
 - Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.
 - Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.
 - Science and technology are pursued for different purposes. Scientific inquiry is driven by the desire to understand the natural world, and technological design is driven by the need to meet human needs and solve human problems. Technology, by its nature, has a more direct effect on society than science because its purpose is to solve human problems, help humans adapt, and fulfill human aspirations. Technological solutions may create new problems. Science, by its nature, answers questions that may or may not directly influence humans. Sometimes scientific advances challenge people's beliefs and practical explanations concerning various aspects of the world.

National Science Education Standards Addressed: Content Standards, 5-8

Content Standard F:

Science in Personal and Social Perspectives

As a result of activities in grades 5-8, all students should develop understanding of

- Personal Health
 - Natural environments may contain substances (for example, radon and lead) that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.
- Risks and Benefits

- Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences. The results are used to determine the options for reducing or eliminating risks.
- Students should understand the risks associated with natural hazards (fires, floods, tornadoes, hurricanes, earthquakes, and volcanic eruptions), with chemical hazards (pollutants in air, water, soil, and food), with biological hazards (pollen, viruses, bacterial, and parasites), social hazards (occupational safety and transportation), and with personal hazards (smoking, dieting, and drinking).
- Individuals can use a systematic approach to thinking critically about risks and benefits. Examples include applying probability estimates to risks and comparing them to estimated personal and social benefits.
- Important personal and social decisions are made based on perceptions of benefits and risks.

Standards for School Mathematics Addressed:

Measurement Standard for Grades 9–12

In grades 9–12 all students should—

- make decisions about units and scales that are appropriate for problem situations involving measurement.
- analyze precision, accuracy, and approximate error in measurement situations;
- understand and use formulas for the area, surface area, and volume of geometric figures, including cones, spheres, and cylinders;
- apply informal concepts of successive approximation, upper and lower bounds, and limit in measurement situations;
- use unit analysis to check measurement computations.

Problem Solving Standard for Grades 9–12

Instructional programs from prekindergarten through grade 12 should enable all students to—

- build new mathematical knowledge through problem solving;
- solve problems that arise in mathematics and in other contexts;
- apply and adapt a variety of appropriate strategies to solve problems;
- monitor and reflect on the process of mathematical problem solving.