Major Global Challenges

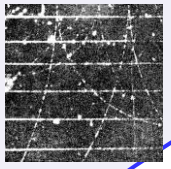
In the next 30 years…

- **Oil production will peak**
  - Need “green energy” development
- **Climate change**
  - Need advanced environmental protection systems
- **Increase in population density**
  - Global health protection issues (food, water, disease control, etc.)

Nanoscale Materials and the related nano-technology will play a key role in global energy, environment, health and security needs!

Nanotechnology is an enabling technology for all industrial sectors.

Economic impact = trillions of dollars!



Biology

Mathematics

Chemistry

Physics

Engineering

Atomic Scale

Sub-Atomic Scale

1nm

Nano Scale

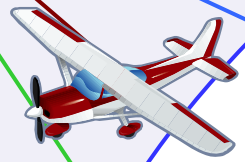
100 nm

Microscopic Scale

Macro Scale

Infrastructure

Health



Communications

Transportation

Energy/ Environment

Where will our future workers and leaders come from?

Nano/Materials-Literacy is needed in all sectors of society

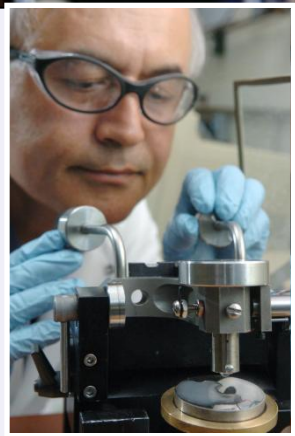
Nano/Mat-literate citizens to support and manage the use of nanotechology

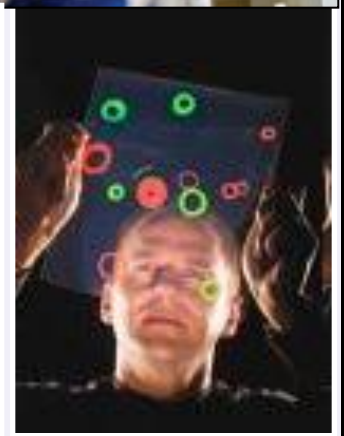
Future consumers and voters!

Nano/Mat-iterate policy makers to enact supportive laws and policies

Legal infrastructure!

Nano/Mat-literate workers: researchers, technicians, engineers...





and **lawyers, marketers, entrepreneurs, etc.**

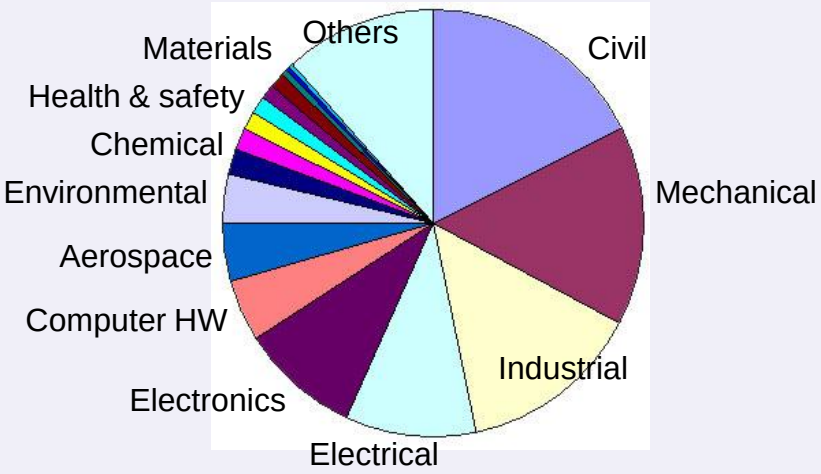
High Demand for Engineers to keep a Growing Economy

Sept 8, 2011

- Over 3m. job opportunities going unfilled in the U.S., highest level in 3 years
- Over 25 m. Americans unemployed, underemployed or only marginally attached to the workforce

- Demand for hi-tech engineers will continue to grow:
  - Half of 1,572,100 engineers (786,050) will retire over the next 8 years (Jacobson, NSPE, 2008)
  - U.S. produced 69,446 B.S. Engineers in 2008 (NSF)

Types of engineer in service (2008)



Qualification

- 2-yr and 4-yr degree
- Engineering requires years of experience before taking on major responsibility

With the expansion of nanotechnology, where will NEW engineers come from?

US Challenges in STEM Education & World Competitiveness Issues

Science Rankings 2006 PISA OECD Countries (30 Total)		
Country	Score	Rank
United States	489	21/30

Math Rankings 2006 PISA OECD Countries (30 Total)		
Country	Score	Rank
United States	474	25/30

- The US currently graduates about 8,000 PhDs per year in engineering, and nearly 70% of them are non-US citizens.
- 40-50% of engineering students at state universities drop out after their second year.
- Pre-college Engineering education is not readily available.
- *How will students learn how to design, build, and do?*
- *How can we prepare them to succeed in nanotechnology?*

Industry Lab

Engineering Pipeline

High School Lab

School om

Education is a Long-term Investment and changes take time to implement

+ 5-10 years

Graduate/Postdoc

Advanced Career Training

- Researchers
- Technology experts
- R&D specialists

+ 10-15 years

Undergraduate

In-depth Nano/Mat literacy

- Further study in nano?
- Highly skilled technicians for nano-manufacturing
- Study other fields such as law or business?

+ 15-20 years

Pre-college

Basic Nano/Mat literacy

- Future nano workers?
- Key nano concepts to enhance STEM
- Critical thinking
- Creative problem solving

The New Science Framework (NRC, 2010)

- Unlike the former National Science Education Standards (NRC, 1996), engineering is strongly emphasized in the new Science Framework (NRC, 2010).
- Engineering is integral to the study of science, and both are deeply intertwined.
- The work of scientists and engineers is a creative endeavor. Both engage in teamwork.
- The study of science alone misrepresents science and marginalizes the importance of engineering.
- Both science and engineering use an iterative cycle of development, testing and refinement, whether of ideas or designs.

The Materials World Modules Program delivers 21st century skill set (NRC core goals)

- Modules are developed in partnership teachers & professors
- Supplementary rather than replacement curriculum
- Taking the latest research into the classrooms to enhance learning
- Inquiry and design (engineering), I-STEM approach to learning
- Strengthen student communication and team-work skills
- Use modern learning technology (simulation, animation, games)
- Professional development for teachers and mentorship for students; teacher summer research programs
- Cyber-MWM community

MWM Modules relevant to Global Challenges

Modules Pertaining to Environment, Food, Water

- Environmental Catalysis
- Food Packaging Materials
- Polymers
- Concrete

Modules Pertaining to Energy

- Solar Cells
- Manipulation of Light in the Nanoworld
- Nanopatterning
- Intro to the Nanoscale

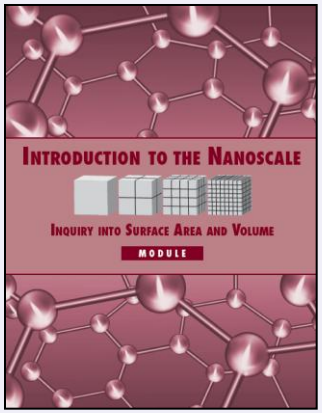
Modules Pertaining to Security

- Smart Sensors
- Nanotechnology
- Ceramics
- Composites

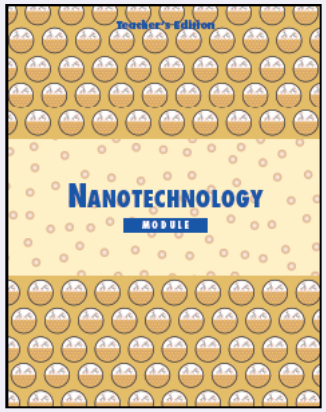
Modules Pertaining to Health&Medicine

- Drug Delivery at Nanoscale
- Biosensors
- Biodegradable Materials
- Sports Materials

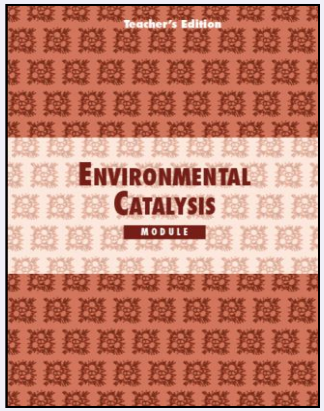
Materials World Modules in nano for middle, high school, and first year college students



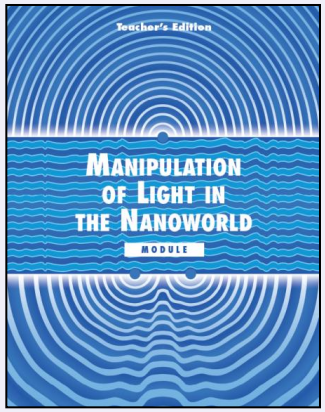
Introduction to the Nanoscale



Nanotechnology

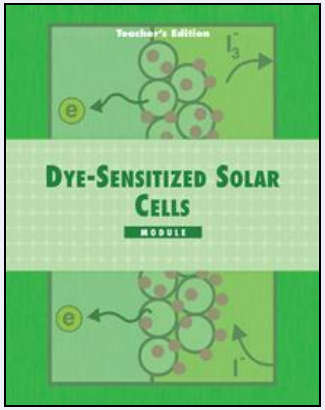


Environmental Catalysis

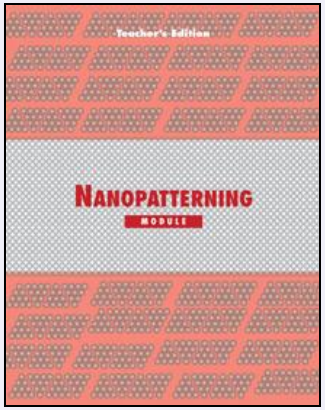


Manipulation of Light in the NanoWorld

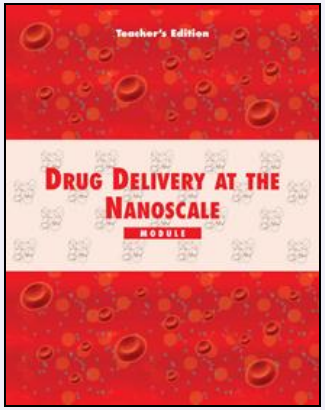
Sports – measuring COR



Dye-Sensitized Solar Cells



Nanopatterning

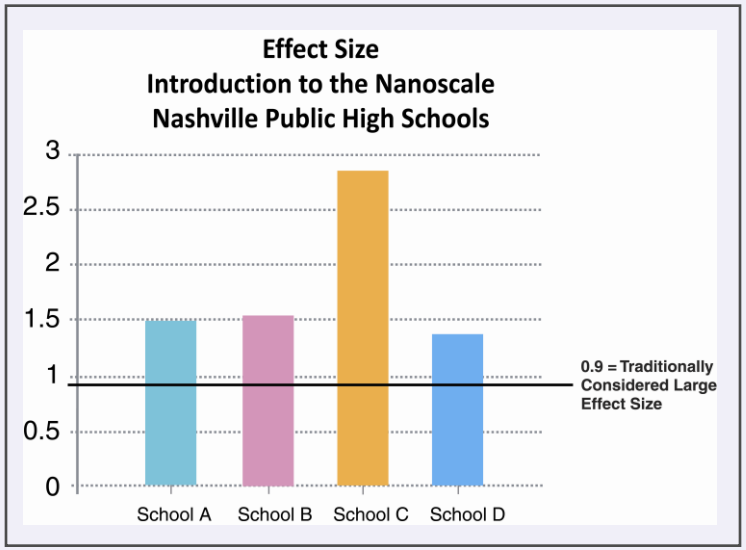


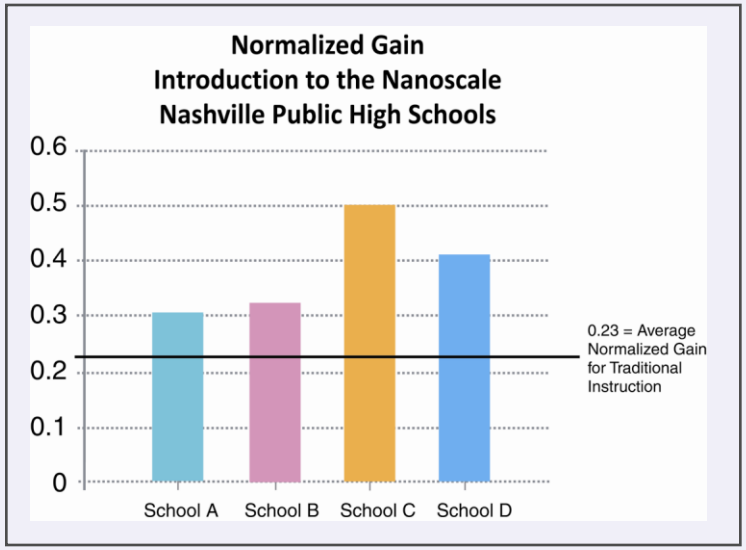
Drug Delivery at The Nanoscale

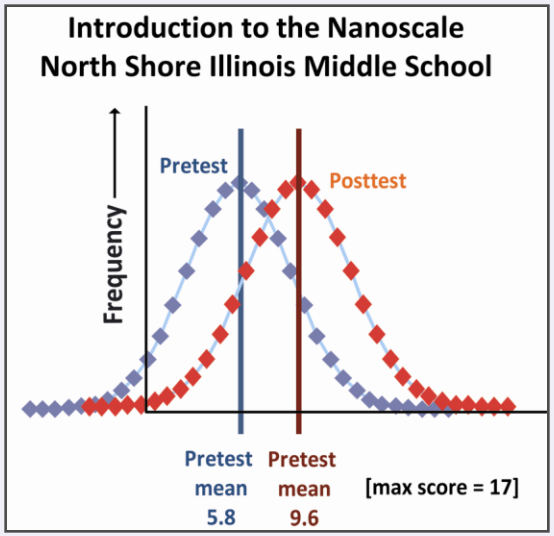
Designing a sun alert patch

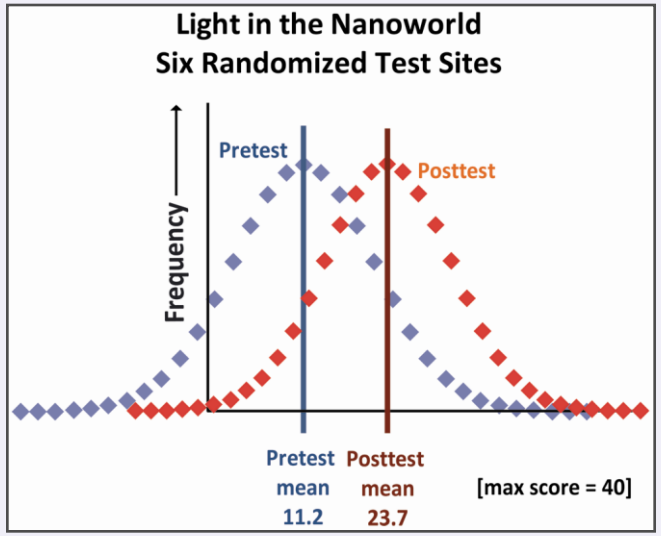
In the dark - Biosensors

Field tests of selected nano-modules









One approach (Regional Action)

- Local industry and classrooms need to benefit from the latest research discoveries from universities and government labs
- Schools need to benefit from regional industrial support and work opportunities
- Regional industry need to benefit from schools and universities for human resources
- Local government need to help coordinate and support rapid progress and economical development of the region.