

Nanoscience Learning Goals Workshop 2006

- NSF-funded joint SRI/NCLT workshop held June 2006 at SRI International



- 39 participants, leading scientists and science educators in nanoscale science and engineering, learning science, science education and informal education
- Participants identified and clarified the big ideas in NSE appropriate for grades 7-12^[1]

Nanoscience Learning Goals

Workshop	NCLT Faculty Workshop
Particulate nature of matter	Size & scale
Size & scale	Size & scale
	Surface-to-volume ratio
Dominant forces	Surface-dominated behaviors
Self-assembly	Self-assembly
	Quantum mechanics
Tools	Tools/instrumentation/characterization
Properties of matter	Size-dependent properties
Modeling	Models and simulations
Technology and society	Societal impact/public education

NCLT Faculty Workshop 2006

- August 2006 at Cal Poly State University, San Luis Obispo
- Participants identified big ideas and learning goals in NSE at the undergraduate level (grades 13-16)
- Strong overlap with SRI/NCLT workshop findings



Boeing/SRI Study 2006/2007

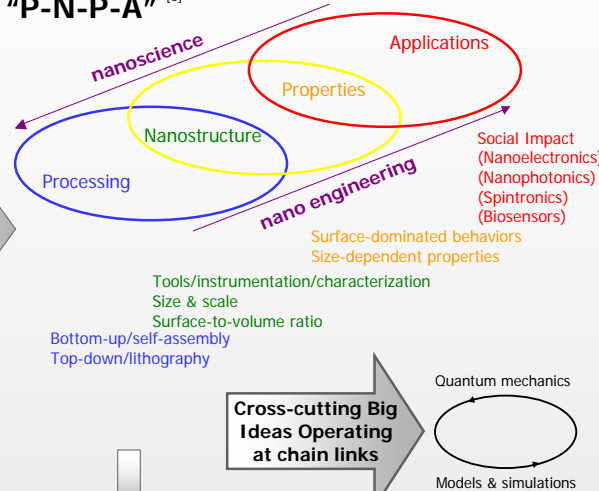
- Objective: to identify learning outcomes relevant to post-secondary education and compare them with industry needs as specified by Boeing and analysis of industry
- Study conducted through survey of industry needs, analysis of university-level courses, and interviews with university faculty
- Strong overlap with the other studies^[2]

Required nanotechnology competencies

Required nanotechnology competencies	P-N-P-A
Nanofabrication	Processing
Characterization/modeling of nanostructure	Nanostructure
Surface chemistry and engineering	Properties
MEMS, sensors, micro/nano devices	Applications

Big Ideas and Learning Goals in NSE

"P-N-P-A"^[3]



Evaluation of NSE Degree Programs Posted on the NCLT Portal

A program was rated for: strength at a given PNPA node (i.e., more than one Big Idea present at that node) based upon the course title/description and for overall balance across the PNPA continuum.

Conclusions:

- Few degree programs are balanced re: P-N-P-A
- Programs are often discipline-specific, i.e., they lack interdisciplinary exposure
- Student access to advanced instrumentation is variable
- Students are not being routinely exposed to societal issues (e.g., safety, ethics)

Recommendations:

- Require coursework across the P-N-P-A continuum
- Require coursework outside the home department
- Require hands-on labs with state-of-the-art equipment
- Incorporate societal aspects in coursework, or provide stand-alone courses

Prototype of an Undergraduate Certificate Program at Northwestern University*

- Require a minimum of 4 semester courses (6 quarter courses)
- Students must take at least one course from each of the P-N-P-A areas
- At least 2 of these should be outside the home department
- At least one course should have a significant component of societal issues (e.g., safety, ethics) as evidenced by the course outline

Processing Courses

- Physics 358: Nanolithography
- Chem 250-1: Nanoscale Patterning
- EECS 388: Nanotechnology
- MechE 382: Experiments in Nanoscience and Engineering

Properties Courses

- BME 344: Biological Performance of Materials
- EECS 381: Electronic Properties of Materials
- MSE 351-1,2: Introductory Physics of Materials
- MSE 370: Biomaterials
- MSE 376: Nanomaterials
- MechE 319: Nanomechanics and Nanotribology
- MechE 320: Nanomechanical Properties of Surfaces

Nanostructure Courses

- BME 344: Biological Performance of Materials
- EECS 381: Electronic Properties of Materials
- MSE 351-1,2: Introductory Physics of Materials
- MSE 370: Biomaterials
- MSE 376: Nanomaterials
- MechE 319: Nanomechanics and Nanotribology
- MechE 320: Nanomechanical Properties of Surfaces

Applications Courses

- BME 317: Biochemical Sensors
- BME 343: Biomaterials and Medical Devices
- ChemE 372: Bionanotechnology
- EECS 384: Solid-State Electronic Devices
- MechE 381: Introduction to MEMS
- MechE 385: Nanotechnology
- MechE 389: Molecular Machines in Biology

* This is only a prototype certificate program, and has not been approved

A Lesson and a Challenge

- The most important finding of this work is the necessity of balance across the P-N-P-A continuum with regard to nano-education at the undergraduate level.
- The greatest challenge is how to expose undergraduate students in traditional programs to the interdisciplinary milieu of nanoscience/nanotechnology.

References:

- S. Stevens, L. Sutherland, P. Schank, and J. Krajcik, The Big Ideas of Nanoscience: draft report, 20 February, 2007 (<http://www.nico.org/projects/nano/index.html>)
- R. Cormia, S. Stevens, V. Dang, D. Drane, N. Sabelli, J. Krajcik, and M. Richey, Nanoscience: A Vehicle for a Goals-Oriented Science Education, draft report, 2007 (<http://ctl.sri.com/projects/displayProject.jsp?nick=nanoscience>)
- S. Wansom, T. O. Mason, M. C. Hersam, D. Drane, G. Light, R. Cormia, S. Stevens, G. Bodnar, "A Rubric for Post-Secondary Degree Program in Nanoscience and Nanotechnology", Int. J. Engng Ed., Vol. 25, No. 3, pp. 615-627, 2009