

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

Nanoscience Learning Goals Workshop

NCLT Faculty Workshop

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

S. Stevens, L. Sutherland, P. Schank, and J. Krajcik, "The Big Ideas of Nanoscience" (preliminary report)

NCLT Faculty Workshop 2006

August 2006 at Cal Poly State University, San Luis Obispo

32 faculty participants from 17 schools (8 participants from community colleges, 24 from universities)



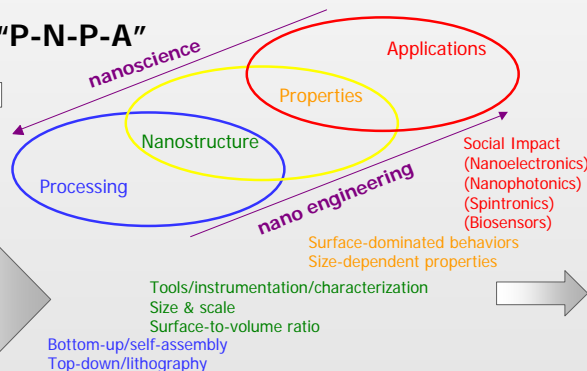
across the country and Puerto Rico

Participants identified big ideas and learning goals in NSE at the undergraduate level (grades 13-16)

Strong overlap with SRI/NCLT workshop findings

Big Ideas and Learning Goals in NSE

"P-N-P-A"



Evaluation of NSE Degree Programs Posted on the NCLT Portal

NSE Program Type	Processing	Nano-structure	Properties	Applications	Summary Rating
University	Strong	Strong	Strong	Weak	Partially Balanced
University	Strong	Strong	Strong	Strong	Balanced
University	Weak	Weak	Strong	Weak	Imbalanced
University	Weak	Weak	Strong	Strong	Imbalanced
University	Weak	Strong	Absent	Weak	Imbalanced
University	Strong	Strong	Strong	Strong	Balanced
University	Weak	Strong	Strong	Strong	Partially Balanced
Community College	Strong	Strong	Strong	Strong	Balanced
Community College	Strong	Weak	Absent	Strong	Imbalanced
Community College	Strong	Weak	Absent	Strong	Imbalanced

A program was rated as: "strong" at a given P-N-P-A node if more than one big idea was represented at that node in course titles/descriptions. Otherwise, that node was rated "weak" (a single big idea represented) or "absent" (no indication of course coverage at that node).

Summary rating based on the following criteria: "Balanced": all four nodes present with "strong" ratings, "partially balanced": all four nodes present, at least 3 of which are "strong", and "imbalanced": two or more "weak" nodes, or one or more nodes missing altogether.

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

Required nanotechnology competencies

- Nanofabrication
- Characterization/modeling of nanostructure
- Surface chemistry and engineering
- MEMS, sensors, micro/nano devices

P-N-P-A

- Processing
- Nanostructure
- Properties
- Applications

Findings re: college courses/programs

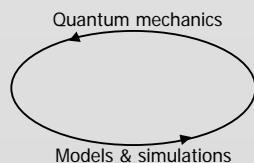
- Mismatch between industry needs and skills of university graduates
- Lack of interdisciplinary preparation
- Lack of course coherence in 4-year institutions
- Disconnect between survey courses and advanced electives
- Training tends to be theoretical rather than practical

A. Rosenquist, S. Stevens, R. Cormia, V. Dang, D. Drane, N. Sabelli, and J. Krajcik, "Nanoscience: A Vehicle for a Goals-Oriented Science Education" (preliminary report)

Major observations

- Tools/instrumentation/characterization frequently mentioned, both in big ideas and learning goals.
- Quantum mechanics was thought essential for teaching NSE at the undergraduate level.
- More attention was given to nanostructure vs. properties relationship than to processing and applications, which deserve greater attention.
- Societal impact was rarely mentioned in science courses.
- Biology and the life sciences are essential to nanotechnology. (Note: Many engineering schools do not require biology at the undergraduate level)

Two cross-cutting big ideas enable NSE at the chain links of the above diagram



Conclusion

- Few existing NSE degree programs are programmatically balanced across the P-N-P-A continuum
- P-N-P-A balance requires interdisciplinarity, few existing programs are flexible enough to allow for such exposure
- The "Nanostructure" node is especially important for NSE education; there is a wide variability in providing student access to advanced instrumentation among existing programs
- The big idea of "societal impact" (public safety, ethics, etc.) is largely underrepresented in existing degree programs
- This study argues that the P-N-P-A rubric be used as a tool for program and course construction and evaluation in NSE higher education