

DAY 2

Session IV: NCLT, NIMD, and NISE projects

Framing questions:

- ◆ Finding a place for nano in the secondary curriculum: what have we learned?
- ◆ Preparing teachers for pilot and field-testing: what are we doing? What might we do better?
- ◆ What research projects are currently underway? What research questions are emerging?
- ◆ Collaboration among formal and informal efforts: how can they support one another?

The session began with each project summarizing current efforts. McREL's NanoLeap project in collaboration with Stanford University researchers is developing a multimedia guide for secondary physical science and chemistry teachers. It will incorporate text, activities, and simulations and provide web-based teacher support. The project is currently engaged in professional development of leader teachers who will participate in development and pilot testing.

SRI's NanoSense project shared the first volume of their curriculum series entitled *Size Matters: Introduction to Nanoscience*. It includes both teacher and student materials, reference readings, PowerPoint presentations, worksheets, and assessments. Noting that teachers must believe they have sufficient understanding to field students' questions before presenting a new topic, the developers start the volume with a segment *For Anyone Planning to Teach Nanoscience... Read This First!* It alerts teachers to challenges and opportunities associated with teaching nanoscience, and it encourages teachers to examine with students how to approach phenomena we don't yet understand. Early evaluation results indicate that transfer from a professional development session to an effective classroom lesson is challenging, even for master teachers.

The NCLT, housed at Northwestern University, offers a monthly web cast to share ideas among nano researchers and educators. The Center is forming interdisciplinary research teams that will study the extent to which new tools and technologies promote students' understanding of nanoscale phenomena.

NISE is a newly-funded network of major science museums in Boston, Minneapolis, and San Francisco. Ultimately 100 additional museums across the country will join the network. It will promote all forms of public engagement related to NSEE including exhibits, media programs, public forums, and professional development.

The conversation about the role of nano content in school science quickly turned to a discussion of obstacles:

- ◆ Guidelines for a coherent progression of nano concepts must be developed.
- ◆ Learning goals for students of different ages have not been articulated.
- ◆ The science standards do not encompass topics such as nanoscience.
- ◆ Tools and technologies to help students visualize and understand phenomena at the nanoscale are not available.

The classroom materials described in the workshop all begin with the concept of size and scale, but there is little research available on students' comprehension of this topic. Some questioned this starting point. There was overwhelming support for establishing a research based learning sequence to guide future materials development and education outreach efforts.

Teacher professional development is a challenge for all of the instructional materials projects. A small number of teachers have participated in existing programs. Few teachers have adequate content knowledge for learning or teaching nano, or for the roles they would normally play in materials development: consulting as experts in pedagogy and the needs of students from diverse backgrounds; conducting pilot and field tests; and leading professional development for peers as resources become available for dissemination. Participants suggested strategies that have been successful in other content areas: lesson study, engaging teams of teachers, rather than individuals, securing administrative support, internships with researchers, professional development in cross disciplinary teams, and mentoring.

Participants identified several system-related issues that inhibit change in school science:

- ◆ While research supports the need for 2-3 week focused instructional units to achieve content understanding, teachers are asking for 1-day lessons to insert in existing curricula.
- ◆ Neither teachers nor curricula are prepared to incorporate interdisciplinary topics.
- ◆ Middle school courses have greater content flexibility and fewer time constraints, but students and their teachers have limited prior knowledge on which to base instructional units.
- ◆ Secondary science curricula, already overburdened with content, do not welcome additional topics, particularly those not clearly linked to standards and high stakes assessments.
- ◆ Pre-service programs are not preparing teachers for interdisciplinary content.

Members of the informal community emphasized that museum-based and other informal programs, not constrained to align with specific disciplines or audience ages, have greater flexibility than classroom programs. Museums can introduce nanoscale topics in the context of engineering or technology, fields that accommodate interdisciplinary approaches. Participants supported stronger links between formal and informal programs, specifically in sharing instructional resources, linking schools to museums that would provide access to costly visualization tools and technologies, and collaborating in teacher professional development that addresses both content and engagement.

Session V. NSEC, NCN, NNIN, and MRSEC projects

Framing Questions:

- ◆ What design principles guide the development of education outreach materials?
- ◆ Professional Development programs: What works? With whom? How do we measure success?
- ◆ Student programs: What works? With whom? How do we measure success?
- ◆ Fostering collaboration among the nanoscience and education communities: how can they support one another?

The discussion began with questions about what students know about nano. Although few studies are available, there was consensus that students acquire impressions from television, but much of their background is misinformation.

Workforce development is a major concern of the education outreach programs, along with meeting the needs of adult audiences. When students at NSEC-sponsored summer camp were asked what they knew about nano, most responded, “Nothing.” Following a 3-day program, students report interest and excitement. The hope is that they will pursue science-oriented careers. While there was some discussion of the value of nanotechnology to teach basic science concepts, most were concerned about guidelines for building public understanding of specific topics in nanoscience and engineering. Participants wanted to know more about successes at other Centers and questioned whether the NCLT and NISE had the capacity to serve as a clearinghouse for these efforts.

The discussion of professional development focused not on teachers, but on the needs of legislators, the business community, lawyers, journalists, and other non-technical audiences. As in previous sessions, participants emphasized the need to respond to fear and misinformation generated by science fiction novels, such as Crichton’s *Prey*. Interestingly, one participant talked about using the novel to generate interest and pose questions that would be answered with accurate information.

Some Centers offer workshops in nanotechnology for media people. Industries are contacting the Centers for more education programs. Some Universities are engaging nanoscience and engineering graduate students to lead tours and outreach sessions for business people and for students from other university departments. A big challenge is communicating key ideas in jargon-free, non-technical language.

The discussion of student programs brought forth concerns about reaching diverse, currently underserved audiences and providing them with information about career opportunities. Some suggested collaborating with community organizations that have programs reaching underserved youth. Specific examples of youth programs were described: Howard University has a charter middle school that focuses on science; University of California-Santa Barbara provides Chip Camps for local Spanish-speaking students; and Princeton University’s Materials Academy hosts students from the Trenton Public Schools. There were also descriptions of programs targeting young women with featured presentations by female researchers and doctors. Project leaders were urged to invest in professional evaluations to study the impact of these programs and guide future efforts.

There was optimism about increased collaboration across the nanoscience and education communities now that the NNIN (National Nanotechnology Infrastructure Network) and the NISE (Nanoscale Informal Science Education) Network are in place and intend to share resources with each other and with regional partners. The museums bring expertise in how to make effective presentations to the public. The research centers provide essential content expertise. It was suggested that the NCLT serve as a clearinghouse for resources for formal education and that all NSEE resources be centrally housed and disseminated on-line.

Conclusions and Next Steps

A cross-section of NSEE professionals representing the NSECs, MRSECs, and formal and informal projects funded through ESIE attended the workshop and provided their perspectives on current needs and challenges. There was general agreement that nano scale phenomena offered many “hooks” to engage learners of all ages in science and that ultimate success would depend on finding a balance between generating engagement and promoting understanding.

Workshop participants supported the following conclusions:

- ◆ Establish a clearinghouse for sharing information and resources.
- ◆ Take advantage of informal venues to promote awareness and broaden participation.

- ◆ Foster partnerships to share expertise across scientific and education communities, both formal and informal.
- ◆ Develop a research-based sequence of learning goals to guide resource development.
- ◆ Expand professional development efforts for teachers and other professionals.
- ◆ Plan future meetings for exchange of ideas across the NSEE community.

Networking across the projects began at the start of the workshop. By the final session, resources, particularly teacher materials and presentation outlines, had been shared, and several participants agreed to make presentations for other projects. In January 2006, the Division of Elementary, Secondary, and Informal Education (ESIE) funded a conference for experts in nano science, learning sciences, and instructional materials development to collaborate with teachers in the development of a learning trajectory to guide NSEE efforts. It will be disseminated to the science and education research communities through a series of research articles and to teachers through a monograph published by the National Science Foundation.