APS physics
Forum on Education
American Physical Society

Summer 2006 Newsletter

Ernie Malamud, Editor

IN THIS ISSUE

Articles
Message from the Chair by Peggy McMahan 2
JLab's Outreach Programs submitted by Douglas W. Higinbotham 4
The Laboratory Science Teacher Professional Development Program by Todd Clark and Jennifer Coughlin 4
Online Physics Education Resources from the American Museum of Natural History by Robert V. Steiner 9
Improving Science Teaching in California by Dick Farnsworth and Stanley F. Hitomi 12
Engaging Faculty Scientists in K-12 Education Collaborations by Elizabeth Stage 15
The San Diego Science Alliance: Fostering Community Wide Industrial and Academic Outreach by Patricia Winter, Nancy Taylor, Christopher M. Smith and Rick Olson 18
Education in Nuclear Science by Peggy McMahan and Joseph Cerny 20
Nanosense: Introducing High School Students to Nanoscale Science by Patricia Schank and Alyssa Wise 22
The Bose In Harmony With Education program by Jason Brisbois 25
The General Atomics Fusion Education Outreach Program by Rick Lee 27

Teacher Preparation Section
A Note from the Teacher Preparation Section Editor by Chance Hoellwarth 30
The Learning Assistant Model for Teacher Education in Science and Technology by Valerie Otero 31
Undergraduate Learning Assistants at the University of Arkansas by Gay Stewart 36
Creating and Sustaining a Teaching and Learning Professional Community at Seattle Pacific University by Lane Seeley and Stamatis Vokos 38

Browsing the Journals by Thomas D. Rossing 42
FEd Executive Committee 44

AAPT Summer Meeting in Syracuse, NY

Please join us at the joint FEd/DNP/AAPT plenary session.

Session AM: Plenary I - Nuclear Physics in the 21st Century, the Legacy of Hans Bethe
Monday, July 24 10:15am-11:45am
AM01 10:15 Hendrik Schatz (MSU) - Frontiers in Nuclear Astrophysics
AM02 10:45 Timothy Hallman (BNL) - Making Quark-Gluon Soup at the Relativistic Heavy Ion Collider
AM03 11:15 Elizabeth Beise (NSF and U. Md) - News and Views of the Proton

There will be a reception sponsored by the FEd following the session.

2007 APS Meetings

The FEd will sponsor invited paper sessions at the March, 2007 meeting in Dallas,TX, and the April, 2007 meeting in Jacksonville, FL. We seek your suggestions for session topics and speakers. Volunteers to organize sessions are encouraged. Please send your suggestions to David Haase (david_haase@ncsu.edu) before August 15.

NanoSense:

Introducing High School Students to Nanoscale Science

Patricia Schank and Alyssa Wise

NanoSense (nanosense.org) is one of a few innovative programs addressing the question of how to teach nanoscale science at the high school level. Working closely with scientists and educators, we are creating, classroom testing, and disseminating curriculum units to help high school students understand science concepts that account for nanoscale phenomena and integrate these concepts with core scientific ideas in traditional curricula. As part of our participatory approach, we have also hosted two national workshops to bring together leading experts and practitioners in nanoscience and science education to identify and elaborate core concepts and learning goals for nanoscience education (see http://nanosense.org/workshops.html).

Using the design features shown in the Table as our framework, we have developed and tested two units:

- *Size Matters* (5 lessons) focuses on concepts of size and scale, unusual properties of the nanoscale, tools of the nanosciences, and example applications.
- *Clear Sunscreen* (6 lessons) focuses on interactions of light and matter; in particular, why zinc oxide nanoparticles block UV light but are transparent to visible light.

Each unit includes lesson plans, essential questions to drive learning, active learning experiences (labs, visualizations), student and teacher readings, slide presentations for class discussion, worksheets, quizzes, and performance assessments. Units in development focus on how nanoscience could advance energy production (*Clean Energy*) and water treatment (*Fine Filters*).

Table. Key design features and their use in NanoSense units.

Key Design Feature	Example from NanoSense Units
Situate the units in one discipline (chemistry) to facilitate adoption in the existing high school structure.	Lessons build on knowledge of atomic models, ionic and covalent bonding, emission of light by gases, etc. (*Clear Sunscreen*)
Center the units around exciting applications as a "hook" for students.	Science fiction story illustrates how nanotechnology could affect their lives in the future. (*Size Matters*)
Guide the units with essential questions.	Why can some sunscreens block harmful UV light but let visible light through? (*Clear Sunscreen*)
Elaborate core science concepts and view them through a new lens.	"Unique Properties" labs illustrate surface area to volume ratio effects (e.g., catalysis). (*Size Matters*)
Make explicit ties to biology, physics, material science, and engineering.	Slides and performance assessment explore nanoscience applications in several disciplines. (*Size Matters*)
Include visualizations of molecular entities and interactions generated and manipulated by students.	Students generate animations of scattering of visible light by nano- and large-size particles of zinc oxide. (*Clear Sunscreen*)
Highlight important features of the nature of science (inquiry process, use of models, etc.).	The "Black Box" activity considers the limitations and challenges in using probes to "see." (*Size Matters*)

Based on our experiences designing and testing NanoSense units, we have identified three main challenges and implications for developing nanoscience curricula.

Challenge 1: Defining the Curriculum. Agreeing on a few central concepts through discussion and debate is an important first step in making sure that curricula meet the needs of the many stakeholders involved. Another issue is how to organize the curriculum: should it be topically based around applications, organized by underlying themes, or structured around content topics within traditional scientific disciplines? Our work suggests that organizing units around content topics helps students connect their prior knowledge to the new information. A third issue is finding reliable and verifiable information in a rapidly evolving area. For exam-

(Continued on page 23)

(Continued from page 22)

ple, in the literature we found numerous terminology differences and explanations that contradicted each other on various fronts regarding whether zinc oxide blocks UV radiation by absorbing or scattering the radiation. There are few common frameworks for understanding emerging science—particularly ones that are understandable at a high school level.

Challenge 2: Situating the Science. We are targeting our materials for high school chemistry, but knowledge of physics and biology are quite helpful for both teachers and students in understanding nanoscience and its applications. This raises the question of whether nanoscience is best taught toward the end of the general high school science sequence. Team teaching approaches could also be effective, but coordinating such efforts adds another layer of complication. Another approach is to leverage student knowledge of other disciplines, which could also reduce some of the burden on the teacher. A final issue is how to help teachers determine where the curriculum fits with what they currently teach. We have found it useful to provide teachers with alignment charts of where the curriculum addresses core science topics. Providing teachers with multiple ways to use the materials and a "drill-down" structure for progressively greater depth of understanding enables adjustment for different levels of students.

Challenge 3: Preparing Teachers. A final challenge is developing teacher support materials for an area in which the content reaches outside teachers' expertise. Lack of familiarity with the content made it difficult for our teachers to stimulate discussion by asking follow-up questions and to identify and address student misconceptions. Developers must create materials that provide deep explanations, provide strong guidance for discussion topics and questions, and identify and highlight potential misconceptions. The novelty of the content, combined with the newness of the field, raises pedagogical demands that some teachers may not be prepared to deal with. Teachers are not able to know all the answers to students' (and their own) questions, and many questions go beyond our current understanding as a scientific community. To help teachers engage these challenges, we have recast them as opportunities to model the scientific process and provide concrete strategies for how to do so (see Figure). In this way, we aim to have teachers and students experience science in action as an empowering and energizing experience rather than as an exercise in frustration.

Figure. Excerpt from teacher's guide addressing pedagogical challenges of teaching nanoscience.

	The Challenge…		Provides the Opportunity to…
1	Traditional chemistry and physics concepts may not be applicable at the nanoscale level	➡	Address the use of models and concepts as scientific tools for describing and predicting chemical behavior: • Identify simplifying assumptions of the model and situations for intended use • Discuss the advantages and limitations of using conceptual models in science and of specific models • Integrate new concepts with previous understandings • Note that industry may be able to manipulate properties without necessarily being able to fully explain why

Despite these challenges, it is possible to introduce emerging science at the high school level. Cutting-edge science topics can engage students, reinforce core science concepts, and give students a better idea of how the traditional disciplines tie together. NanoSense units are available at nanosense.org, and we invite you to use them and send us feedback to improve the materials.

Acknowledgement

NanoSense is supported by NSF Grant No. ESI-0426319. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

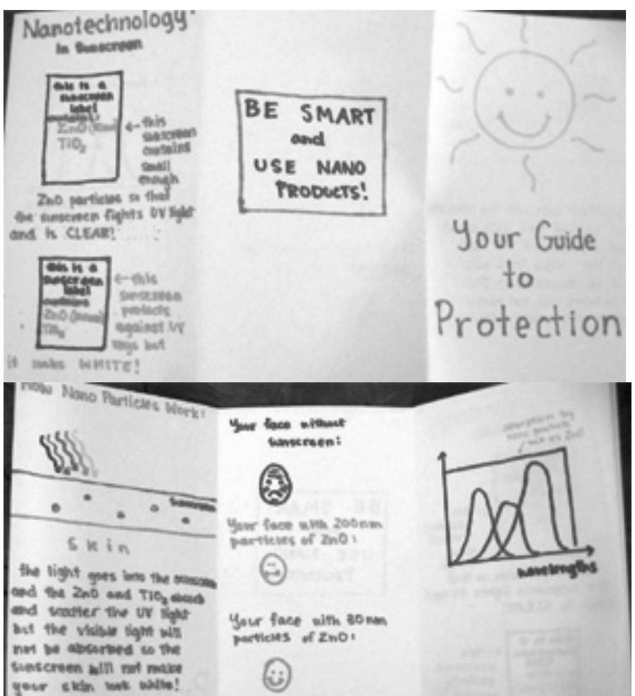
Patricia Schank (patricia.schank@sri.com) is a research computer scientist at SRI International and principal investigator of the NanoSense project.

Alyssa Wise (afwise@indiana.edu) is a doctoral student in the Learning Sciences program at Indiana University's School of Education.

(Continued on page 24)

(Continued from page 23)

Students testing the UV blocking ability of a sunscreen.



Students create pamphlets to tell consumers about sunscreens with nanoparticulate ingredients.

Using ChemSense to animate the scattering of visible light by different sunscreens.