The Global Nanoscale Science and Engineering Education Workshop

Report Appendix

Appendix 1: Participant List

Name – Affiliation

Vance R. Ablott - Triangle Coalition for Science and Technology Education
Ethan Eliot Allen - University of Washington
Carol Lynn Alpert - Museum of Science, Boston
Brian H. Augustine - James Madison University
Carol Barry - University of Massachusetts
Laura M. Bartolo - Kent State University
Larry Bell - Museum of Science, Boston
Kristin Black - Center on Polymer Interfaces and Macromolecular Assemblies
Richard Dean Braatz - University of Illinois/Urbana-Champaign
Kristy M. Brumfield - Louisiana State University
Amy Brunner - Penn State Univeristy
Lynn A. Bryan - Purdue University
Nathaniel Charles Cady - College of Nanoscale Science & Engineering, University at Albany
Michael A Carpenter - University at Albany, College of Nanoscale Science and Engineering
Robert P.H. Chang - Northwestern University
Zhen Chen - University of Missouri
Kevin James Conley - Forsyth Technical Community College
Julia H. Cothron - MathScience Innovation Center
John L. D'Agati - University at Albany, College of Nanoscale Science and Engineering
Michael A. De Miranda - Colorado State University
Julie Dillemuth - Center for Nanotechnology in Society, University of California Santa Barbara
Denise Drane - Searle Center for Teaching Excellence
Kate Duckworth - Exploratorium
Sarah Whiting Dugan - Northwestern University
Kimberly Ann Duncan - University of Wisconsin-Madison Materials Research Science and Engineering Center
Matthew Edwards - Alabama A&M University
Robert K. Ehrmann - Penn State Center for Nanotechnology Education & Utilization
Heather M. Evans - National Nanotechnology Coordination Office
Alexander R. Fiorentino - Museum of Science, Boston
Luis E. Fuentes-Cobas - Centro de InvestigaciÃ³n en Materiales Avanzados
Hamid Ghandehari – University of Utah
Nicholas J. Giordano - Purdue University
Margaret F. Glass - Association of Science-Technology Centers
Manuel Gomez - Institute of Functional Nanomaterials, University of Puerto Rico
Andrew Greenberg - University of Wisconsin/Madison
Eric Anthony Hagedorn - UTEP
Andrea J. Harmer - Lehigh University
Dyneisha Herbert-Felder - The MayaTech Corporation
April Ann Hill - Penn State University Center for Nanoscale Science
Seng-tiong Ho - Northwestern University
Mary Frances Hobbs - MathScience Innovation Center
James Hone - Columbia University

Matthew Hsu - Northwestern University
Mohammad A. Islam - American University of Sharjah
Tadashi Itoh - Division of Frontier Materials Science, Graduate School of Engineering Science, Osaka University
Nebojsa Ilija Jaksic - Colorado State University - Pueblo
Marilyn Dale Johnson - Oregon Museum of Science and Industry
Sinead Anne Kennedy - Catalan Institute of Nanotechnology
George E. Kiriakidis - University of Crete and IESL/FORTH, Greece
Lisa C. Klein - Rutgers University
Susan M. Kowalski - BSCS (Biological Sciences Curriculum Study)
Joseph Krajcik - University of Michigan
Polly A. Kroha - Nano-CEMMS, University of Illinois at Urbana-Champaign
Harold Walter Kroto - The Florida State University
Margaret Henrietta Kroto - None - freelance
Abdou Lachgar - Wake Forest University
Frances Patricia Lawrenz - University of Minnesota
LeRoy Lee - Wisconsin Science Network
Shelley Lee - Wisconsin Department of Public Instruction
Gregory J. Light - Northwestern University
Hanjo Lim - Department of Electrical & Computer Engineering, Ajou University
Heh-Nan Lin - National Tsing Hua University
Philip H. Lippel - National Nanotechnology CoordinationOffice
Brenda Alejandra Lopez Silva - University of Illinois at Chicago
Sebastian Lourdudoss - Royal Institute of Technology
Eric D. Marshall - New York Hall of Science
Paul J. Martin - Science Museum of Minnesota
Tom Mason - Northwestern University
Krish Mathur - U.S. Department of Education
Richard J. Matyi - College of Nanoscale Science and Engineering, University at Albany
Jean-Marie B. Mayas - The MayaTech Corporation
Ana-Rita Mayol - Institute of Functional Nanomaterials, University of Puerto Rico
David N. McIlroy - University of Idaho
Zuleika Medina Torres - Penn State
Thomas G. Moher - University of Illinois/Chicago
Maria Elena Montero Cabrera - Centro de Investigacion en Materiales Avanzados (Advanced Materials Research Center)
Juana Moreno - Louisiana State University
Christine Morrow - University of Colorado/Boulder
James S. Murday - University of Southern California
Ron A. Naaman - Weizmann Institute
Carolyn Aitken Nichol - Rice University
Murray Grant Norton - Washington State University
Julie Ann Nucci - Center for Nanoscale Systems, CNS Institute for Physics Teachers
Teri Wang Odom - Northwestern University
Rae Ostman - Sciencenter
Megan O'Sullivan - MRI at Northwestern University
Deb H. Ovenden - The SPECTRUM Group
Rene M. Overney - University of Washington

Kim Pacheco - University of Northern Colorado
Su-Seng Pang - Louisiana State University
Nathalie Marie Panissal - University of Toulouse
Jim Pellegrino - University of Illinois/Chicago
Monica J. Plisch - American Physical Society
Karen Pollard - Science Museum of Minnesota
Liangti Qu - University of Dayton
Lisa Regalla - Twin Cities Public Television
Christine Reich - Museum of Science, Boston
John Ristvey - Mid-Continent Research for Education and Learning
Jill Kirsten Robinson - Indiana University
Elory A. Rozner - Museum of Science and Industry
Linda S. Schadler - Rensselaer Polytechnic Institute
Martin G. Schubert - cc-NanoChem e. V. - Competence Center Chemical Nanotechnology for New Materials
Lyle H. Schwartz - U. Maryland
Shadi Shahedipour-Sandvik - UAlbany-State University of New York
Jennifer M. Shanahan - Materials Research Institute, Northwestern University
Vesselin N. Shanov - University of Cincinnati
Bartlett Michael Sheinberg - Houston Community College District
Eileen C. Sheu - University of Chicago Materials Research Center
Fuh-Sheng Frank Shieu - National Chung Hsing University
Jeffrey Ray Simpson - Towson University
Tina Stanford - SRI International
Aldrin E. Sweeney - University of Central Florida
Zi Kang Tang - Hong Kong University of Science and Technology
Kasif Teker - Frostburg State University
Thomas R. Tretter - University of Louisville
Christophe Jean - francois VIEU - INSA Toulouse
Emily Weiss - Northwestern University
Mary Anne White - Dalhousie University
Otto Carl Wilson - Catholic University of America
Melinda Sue Wong - Northwestern University
John X.J. Zhang - The University of Texas at Austin
Guoping Zhang - Indiana State University

Appendix 2: Webcast Participant List

As of 11-19-08

Name – Affiliation

Charles Adagbon - Royal Institute of Tech Stockholm, Sweden
Daniel Akins - City College of New York
Alkim Akyurtlu - University of Massachusetts Lowell

Bill Allen - North Seattle Community College
Joseph Andrade - Utah Science Center
John K. Baker - General Dynamics Land Systems
Loveeta Baker - Caption Colorado
Deborah Bassett - University of Washington
Bill Bayley - Purdue University
Shohreh Behrouzi - Temple University
Kimberly Bentley - Girls Incorporated
Barbara Berlucchi - Hingham High School
D. Jeffrey Beyer - Albany High School
Suprotim Bose - on24
Mala Braslavsky - Ohio University
Wayne Brumfield - The University of Louisiana at Monroe
Carolina Bueno - PUC Campinas
Holly Burnside - Drexel University
Mario Cabodi - Boston University
Laura Cabrera - CAPPE
Mack Carter - Center for Nanotechnology
Skonchai Chanunan - Srinakharinwirot University
Kabir Chopra - UCLA
Youngsoo Chung - Drexel University
Jennifer Cleary - Heldrich Center for Workforce Development, Rutgers University
Whitney Cobb - McREL
Seth Cohen - OSTP
Judy Counlty - McREL
Thomas Deits - Lansing Community College
Alberto Delgado - University of Illinois - UC
Roy Diaz - Intellectual Ventures
Kari Diggins - Caption Colorado
Mostafa Dokhanian - Alabama A&M University
Kevin Doura - Lehigh University
Manu Dube - Yeditepe University
Travis Earles - White House OSTP
Phil Engen - University of Minnesota
Dustin Felix - York Community High School
Barbara Flagg - Multimedia Research
Kevin Freedman - Drexel University
Sergio Freire - Univ. of the Sciences in Philadelphia
Seth Frye - UW Milwaukee
Holly Gannon - Schaumburg High School
Matt Garland - ON24
Curtis Giddings - MATES
Susan Greenberg - University of New Hampshire
Louis Harnisch - Argonne National Lab - Ed Programs
Hisham Hegab - Louisiana Tech University
Zhongping Huang - Widener University
Kelly Hutchinson - Purdue University
John Ireland - NanoInk

Yuko Izzo - Northwestern University
John Jaszczak - Michigan Tech University
Andrew Johnson - University of Illinois at Chicago
Venkata KanakaRrao - VNR VJIET
Savas Kaya - Ohio University
Cynthia Kessel - Washington Middle School
Stephen Krause - Arizona State University
Susana Lai-Yuen - University of South Florida
Carmen Lilley - University of Illinois at Chicago
Xinyu Liu - Ames Lab of U.S.DOE
Peng Liu - MRI
Brenda Lopez - UIC
Florence Lopez - Caption Colorado
Geok-Chooi Lou - Northwestern University
Morten Lundsgaard - University of Michigan
Felice Macera - Penn
Negar Mansourian-Hadavi - Northwestern University
Pamela Martin - University of Illinois at Urbana-Champaign
Jeremiah Mbindyo - Millersville University
Zena McFadden - Stoughton High School
Andrew McGhie - Univ. of Pennsylvania
James McGonigle - Nano/Bio Interface Center/ UPenn
Helen McNally - Purdue University
David Mills - Louisiana Tech University
Mim Nakarmi - Brooklyn College
Roger Narayan - University of North Carolina at Chapel Hill
Crystal Ngutter - NIH
Susana Olague - GOH, LLC
Megan O'Sullivan - MRI
Vivian Ota Wang - NNCO
Salvatore Pace - Ben Franklin Technology Partners
Eun Jung Park - Northwestern University
Ann Pearson - Insight School of Wisconsin
Liangti Qu - University of Dayton
B.L. Ramakrishna - Arizona State University
Umberto Ravaioli - University of Illinois UC
Jill Robinson - Indiana University
Donna Robinson - Caption Colorado/ Captioner
Edwin Saunders - VerizonBusiness
Derek Schlieps - University of Washington
David Shaw - SUNY, Buffalo
Jonathan Shu - Cornell University
Jonathan Silver - George Washington University
Daniel Steinberg - Princeton University
Todd Stewart - Guardians of Honor
Tianxiang Su - University of Pennsylvania
Su Swarat - Northwestern University
Shannon Swilley - Princeton University

David Ucko - NSF
Nathan Unterman - Glenbrook North High School
Marge Urbonas - Lockport East
Vahid Vahdat - University of Pennsylvania
Ryan Vallance - The George Washington University
Debra Vogt - McPherson Middle School
Yan Wang - University of Central Florida
Kristen Woods - Boston University
Brandon Wright - Northwestern University
D. Wu - USP
John Q. Xiao - University of Delaware
Terry Xu - UNC Charlotte
Jianwei Zhang - University at Albany, SUNY
Guoping Zhang - Indiana State University
Wenzhe Zhou - Cornell University

Appendix 3: Program

Workshop Agenda
Key Bridge Marriott, Arlington, VA

Wednesday, November 12, 2008

4:00 PM - 7:00 PM	Attendee Registration (Early Arrivals)
4:00 PM - 7:00 PM	Poster Registration (Early Arrivals)

Thursday, November 13, 2008

7:30 AM - 8:30 AM	Morning Refreshments (Meeting starts at 8:00 am)
7:30 AM - 10:00 AM	Poster & Attendee Registration
8:00 AM - 8:55 AM	Opening General Session
	Welcome & Meeting Overview *Dave Ucko, Education and Human Resources Directorate, National Science Foundation*
	Overview of Nanoscale Science & Engineering Effort *Mike Roco, Senior Advisor for Nanotechnology, Directorate for Engineering, National Science Foundation*
	Vision on Global NSEE *R.P.H. Chang, Northwestern University*
8:55 AM - 9:00 AM	**Logistics Overview:** Guardians of Honor, LLC

9:00 AM - 9:45 AM	**Plenary Presentation:** Harry Kroto (Nobel Laureate, 1996), Florida State University and University of Sussex
9:45 AM -10:45 AM	**Poster Session I: Perspectives on Cutting-edge Nano Research & Concepts** & Break
10:45 AM - 11:45AM	**Panel I: Cutting-edge Nano Research & Concepts** (Moderator, Robert Westervelt) *Presentations, plus Q & A Session* James Hone, Columbia University (Graphene Research) Teri Odom, Northwestern University (Nanopatterning Research)
11:45 PM - 12:45 PM	Lunch & Networking
12:45 PM - 2:00 PM	**Panel II: International Perspectives on Formal & Informal NSEE Programs** (Moderator, Larry Bell) *Q& A Sessions with the following panelists:* Luis Fuentes, Advanced Materials Research Center, Mexico Tadashi Itoh, Osaka University, Japan Martin Schubert, Competence Center cc-NanoChem e. V., Germany Sebastian Lourdudoss, Royal Institute of Technology, Sweden
2:00 PM – 3:00 PM	**Poster Session II: Nano Education Research/Assessment Practices/Evaluation** & Break
3:00 PM - 4:00 PM	**Panel III: Nano Education Research/Assessment Practices/Evaluation** (Moderator, Greg Light) *Presentations, plus Q & A Session:* Joe Krajcik, University of Michigan (Nano Learning Research) Frances Lawrenz, University of Minnesota (Education Evaluation) Christine Reich, Museum of Science, Boston (NISE Evaluation) Jim Pellegrino, University of Illinois at Chicago (Assessment)
4:00 PM - 5:30 PM	**Breakout Session I: Engagement of Students, Teachers and General Public** – Groups 1-2: Nano Research & Concepts integrate at pre-college level Groups 3-4: Nano Research & Concepts integrate at college level & above Groups 5-6: International Perspectives – pre-college and college Programs and Projects Groups 7-8: Informal Education & General Public Outreach Group 9: Education Research/Assessment Practices/Evaluation – pre-college including general public Group 10: Education Research/Assessment Practices/Evaluation – college level
5:30 PM - 7:00 PM	Reception with Cash Bar Opportunities for Networking & Collaboration

Friday, November 14, 2008

7:30 AM - 8:00 AM	Morning Refreshments
8:00 AM - 9:00 AM	General Session: International Programs in Nanoscience Education (Moderator, Emily Weiss) Keynote Presentations from: *Fuh-Sheng Shieu, National Chung Hsing University, Taiwan* *Christophe Vieu, INSA de Toulouse & Nathalie Panissal, University of Toulouse, France*
9:00 – 9:45 AM	Report Back Session from Breakout Session I (Moderator, R.P.H. Chang)
9:45 – 10:00 AM	Break
10:00 - 11:00 AM	**Poster Session III: Best Practices in Curriculum/Course Development/Outreach to General Public**
11:00 AM - 12:00 PM	**Panel IV: Best Practices in Curriculum/Course Development/Outreach to General Public** (Moderator, Robert Semper) *Presentations, plus Q & A Session* Linda Schadler, Rensselaer Polytechnic Institute (High School Curriculum) John Ristvey, Mid-Content Research for Education and Learning (High & Middle School) Micheal DeMiranda, Colorado State University (College) Lynn Bryan, Purdue University (Teachers & Professional Development Models) Paul Martin, Science Museum of Minnesota (Community Outreach (Nano Days) NISE)
12:00 PM – 1:00 PM	Lunch & Networking
1:00 PM – 2:00 PM	**Poster Session IV: Networking & Collaborations – NNI Networks**
2:00 PM -3:15 PM	**Breakout Session II: Best Practices Curriculum/Course Development/Outreach to General Public** & Break Groups 1-2: Informal Education & Community Outreach Groups 3-4: Professional Development Groups 5-6: Pre-College Curriculum Groups 7-8: College Curriculum Groups 9-10: Networking & Collaborations
3:15 PM - 4:00 PM	Report Back from Session II & Summary of Workshop (Moderator, R.P.H. Chang)

Appendix 4: Abstracts for Posters

Presenter: Ethan Allen, University of Washington
Poster Title: Center for Nanotechnology

The Center for Nanotechnology (CNT) at the University of Washington promotes the learning of nanoscale science and technology among diverse populations. More than 40 students have now graduated from the first nanotechnology Ph.D. program in the nation and are active participants in the academic, governmental, and commercial nanoscale science and technologuy workforces. As a member of NNIN, the CNT contributes educational modules and materials to an ever-growing library of resources on the NNIN web site.

Presenter: Ethan Allen, University of Washington
Poster Title: Genetically Engineered Materials Science and Engineering Center (GEMSEC)

The Genetically Engineered Materials Science and Engineering Center (GEMSEC) at the University of Washington offers educational opportunities to a broad spectrum of learners. Programs for middle and high school students, as well as for the general public, are complemented by other actitivities for teachers, undergraduates, and graduate students. Engagement of GEMSEC researchers in all of these activities provides a wealth of learning opportunities for students of many levels, and promotes clear and accessible communication of science among GEMSEC investigators.

Presenter: Carol Lynn Alpert, Museum of Science, Boston
Poster Title: The Nanomedicine Explorer: A Unique Multimedia Resource

The Nanomedicine Explorer is a unique bilingual (English/Spanish) multimedia resource that is available both as a museum-style interactive kiosk and as a virtual web exhibit. This first edition of the Explorer focuses on cancer nanomedicine and showcases a diverse group of researchers telling stories of their own quests for improving cancer detection and treatment through the application of nanotechnology. The program also features easy-to-follow animations exploring basic concepts, interactive games, a polling activity, and includes (in the web version) options for sharing viewer comments. The NCTL is planning to link some of the stories and features to specific curriculum modules for contextual enrichment, and this is an option for other curriculum developers as well. The Nanomedicine Explorer was produced by the Museum of Science, Boston with support from the NCRR SEPA program of the National Institutes of Health, the NSF NISE Network, and the Center for High-rate Nanomanufacturing. Our plans are to continue to update and add new research stories and interactive features, and we are seeking additional production partnerships and funding. Virtual exhibit: www.nanomedicine-explorer.net. Inquiries: nano@mos.org.

Presenter: Carol Lynn Alpert, Museum of Science, Boston
Poster Title: Talking Nano: Nano 101 in a Box

This professionally-produced 6-DVD video set features leading researchers with a knack for communicating cutting-edge concepts with clarity and style. Richly illustrated, these fascinating talks

illuminate basic concepts of nanotechnology, potential applications and future impacts. The talks are suitable for school, public, and professional audiences, and will be useful on a case-by-case basis for middle school through college classrooms. Highlights include Don Eigler, accompanied by his service dog Argon, introducing 'my world of atoms,' and demonstrating live imaging and moving individual atoms, projected on the big screen. Eric Mazur connects our everyday experience of the novelties of reflection and refraction to future advances in optical computing. George Whitesides addresses the spirit of innovation and the ways in which nanotechnology may change the way we live and work. David Rejeski takes a fascinating look at questions of consumer safety, regulation, and public opinion. The bonus disk - The Amazing Nano Brothers Juggling Show - features two very talented guys juggling their way hilariously through basic atomic structure and nanoscale forces, at times from atop 7-foot unicycles. Suitable for children of all ages, including adults. The videos were filmed and produced at the Museum of Science, Boston, in association with the NSF Center for High-rate Nanomanufacturing, the NSF Nanoscale Science and Engineering Center at Harvard, the Wilson Center Project on Emerging Nanotechnologies, and the Nanoscale Informal Science Education Network. Information and copies available at www.talkingnano.net.

Presenter: Brian Augustine, James Madison University
Poster Title: Top Down Nanoscience Curriculum Development Throughout the Undergraduate Chemistry Curriculum at James Madison University

We describe a model used for seeding nanoscience topics throughout the undergraduate chemistry curriculum at James Madison University (JMU). An overview of the changes to the chemistry curriculum as a result of this program will be presented. Lecture topics in general, inorganic, organic, materials science and physical chemistry have been added or improved and laboratories for general, organic and physical, have been developed and implemented. A new general physical science course for nonscience majors and an upper-division majors lecture-laboratory course called, 'Science of the Small: An Introduction to the Nanoworld' have been developed and will be broadly described. We will further describe how a new series of vertically integrated laboratory experiments exploring the properties of supramolecular micelles are being used to introduce nanoscience into several different courses. In addition, we will discuss how this project, in particular the Science of the Small course, has helped to catalyze 'top-down' thinking about seeding a range of interdisciplinary topics throughout the undergraduate chemistry curriculum.

Presenter: Laura Bartolo, Kent State University
Poster Title: MatDL: The NSDL Materials Digital Library Pathway

Authors: Laura M. Bartolo, Sharon C. Glotzer; Donald R. Sadoway; James A. Warren; Matthew John M. Krane; Adam C. Powell IV; Krishna Rajan; Diane Geraci; Vinod K. Tewary; Cathy S. Lowe MatDL Pathway (http://matdl.org) assumes stewardship of significant content and services to support the integration of research and education in the materials community. MatDL is a consortium of organizations including: Kent State University, MIT, National Institute of Standards and Technology, University of Michigan, Purdue University, and Iowa State University, and focuses on serving materials undergraduate and graduate students, educators, and researchers. In addition to providing a Repository, MatDL offers the materials community: 1) tools to describe, manage, exchange, archive, and disseminate data among national and international government-funded materials collaborations (teams, centers, and institutes); 2) services and content for virtual labs; 3) workspace for open access development of computational

materials modeling and simulation tools; and 4) workspace for collaborative development of core undergraduate materials teaching resources. MatDL is expanding its collaborations across the materials community through joint efforts with the ChemCollective (CCLI Phase 2) and professional societies such as the international Minerals, Metals & Materials Society (TMS). A primary goal of MatDL is to help integrate research and education. By offering materials educators convenient access to relevant, shared learning resources based on research, both teaching and learning within materials and cognate disciplines are positively impacted.

Presenter: Larry Bell, Museum of Science, Boston
Poster Title: Overview of NISE Net

The NISE Net is building the capacity for research centers and informal science educational institutions to work together to raise public awareness, understanding, and engagement with nanoscale science, engineering, and technology. The focal points of our work are: an online catalog of informal educational products, professional capacity building activities, a network of supportive institutions aimed at building participation, and an annual NanoDays event to serve as a catalyst.

Presenter: Richard Braatz, University of Illinois/Urbana-Champaign
Poster Title: Interactive software and design projects for teaching critical concepts in nanoscale science and technology

Interactive visualizations, simulations, and design projects are developed for teaching critical concepts in nanoscale science and technology to high school and college students. These nanoconcepts are associated with size-dependent properties and size and scale, and are illustrated by the chemical and physical behavior of metal, semiconductor, and polymer nanoparticles. For example, in one project students design mixtures of biodegradable polymer nano- and microspheres to obtain a desired release profile for drug delivery applications. In another project students design nanocomposite phase-change materials for passive heat management. Interactive software span a range of applications including gold nanoparticles for tumor treatment, titanium dioxide nanoparticles for environmental cleanup of organic contaminants in water, and copper nanostructures as components of microelectronic devices. These interactive visualizations, simulations, and design projects illustrate various Nano Concepts defined by the National Center for Learning and Teaching in Nanoscale Science and Engineering.

Presenter: Michael Carpenter, University at Albany, SUNY
Poster Title: The College of Nanoscale Science and Engineering at the University at Albany - Nano High Educational Program

The College of Nanoscale Science and Engineering (CNSE) at the University at Albany, SUNY, in partnership with Albany City School District, has implemented model programs for Nanoscale Science and Engineering education at the High School and Middle School levels. Within these programs students participated in commencement level, discovery-based courses which have been conceived, designed, and implemented at Albany High School (AHS) as part of the `Nano High' partnership with the CNSE. Instructional design and methodologies were embedded in student-centered, hands-on, inquiry based learning around the central theme of research and development at the nanometer scale. Classes were

designed to simulate a scientific research/engineering team culture based on mentorship programs developed at the CNSE. Students participated in real-life, problem solving laboratory experimentation/studies utilizing tools and technology for scientists and engineers at the AHS campus and the cutting-edge nanofabrication and research facilities at the CNSE. Activities at both sites were coherently integrated to connect foundational physical, chemical, and biological concepts with advanced nanoscale science and engineering research and applications to spur student interest and innovation, while simultaneously exposing them to the wide array of professional career choices in emerging `nano' fields. Their studies followed a weekly syllabus of concepts, research themes, and activities that corresponded to desired outcomes and skills. Team-based teaching and learning models, both in the classroom and in the laboratory were used and in doing so emulated today's high-tech workplace. Details on curriculum, laboratories, outcomes and assessments will be provided for both the high school and middle school programs.

Presenter: Kevin Conley, Forsyth Technical Community College
Poster Title: The Two-Year Associate of Applied Science Degree Program in Nanotechnology at Forsyth Technical Community College, Winston-Salem, North Carolina

This poster will tell the story of nanotechnology training from a student's point of view through five stages of execution: (1) Recruitment through outreach to K-12 and local professionals, (2) One year of theory courses, (3) One year of laboratory courses, (4) A Cooperative Education experience in industry, and (5) Job placement. Additionally, the poster will reveal the depth of content provided in six disciplines of education: Biology, Chemistry, and Physics, and the three E's: Engineering, Economics, and Ethics. Special emphasis will be given to our new course in biological atomic-force microscopy. Ours remains the first and only two-year nanotechnology degree program in the American Southeast. Linking our educational goals to industry needs in the region remains our primary challenge - so we welcome your insights and suggestions.

Presenter: Julie Dillemuth, Center for Nanotechnology in Society, University of California Santa Barbara
Poster Title: Traveling Nanotechnologies: An Undergraduate Internship Program in Nanotechnology and Society

In summer 2008, five social science and humanities undergraduates traced the `travels of a nanotechnology' through the Global Value Chain and consumer products' life cycles at the Center for Nanotechnology in Society (CNS) at UCSB. Mentored by Graduate Fellows, one team of interns investigated nanosilver in washing machines, plush toys, and first aid applications, and another team researched solar technology companies in China and Italy. They used a Global Value Chain approach to consider all the inputs and activities that go into creating a product or an industry ' from R & D, design, and raw materials, to production, manufacture, marketing and distribution, including all the people or companies involved. At the end of the program, interns presented their results in a poster and presentation, and created information cards for their product. As a model for undergraduate research on societal implications of nanotechnology, this project was successful in three primary ways: 1) working with commercial products in everyday use or on the cutting edge of technology motivated students, 2) interns were able to be self-directed and make research decisions based on a guiding framework and theoretical foundations, and 3) the project integrated nanoscale science and engineering with societal implications, giving students a 'big picture' around which they could tell the story of their nanomaterial.

CNS-UCSB is a national research and education center for the societal implications of emerging nanotechnologies. Launched in January 2006, CNS-UCSB is one of only two National Science Foundation Nanoscale Science and Engineering Centers devoted to this study.

Presenter: Julie Dillemuth, Center for Nanotechnology in Society, University of California Santa Barbara

Poster Title: Education and Public Engagement in the Center for Nanotechnology and Society, UCSB

The NSF Center for Nanotechnology in Society (CNS) at the University of California, Santa Barbara is a national research and education center for the societal implications of emerging nanotechnologies. CNS brings together faculty from Anthropology, Cultural Studies, Feminist Studies, Environmental Studies, Global and International Studies, History, Political Science, Social Psychology and Sociology to investigate three main research areas: Historical Context of Nanotechnologies, Innovation, Diffusion and Globalization of the NanoEnterprise, and Risk Perception and Social Response to Nanotechnologies. In the CNS Education Program, graduate and undergraduate students take lead roles in Center research and education initiatives. Our Graduate Research Fellowship Program brings together a diverse set of students from social science and science and engineering disciplines. Fellows are an integral part of CNS research groups, are closely mentored by faculty, and benefit from an exceptional interdisciplinary experience: they hone communication and collaboration skills, learn new methods, literature, and academic cultures, and broaden their ideas, understanding, and professional network. In summer, Fellows mentor undergraduate interns from community colleges and UCSB campus, who spend eight weeks doing research alongside CNS scholars. Additional components of CNS Education are curriculum development and public engagement. CNS has created new technology and society courses and enhanced existing courses at UCSB, at the undergraduate and graduate levels, and cosponsored an Educators Workshop for designing courses that integrate nanotechnology and society. Public engagement includes quarterly `NanoMeeter' community forums that bring top researchers into conversation with the public, a podcast series, newsletter and website, as well as informal science education events such as NanoDays.

Presenter: Denise Drane, Searle Center for Teaching Excellence

Poster Title: An instrument to assess attitudes and perceived knowledge about nanotechnology

Realization of the benefits of nanotechnology at a societal level will require both a nano-literate workforce and a population capable of grasping what nanotechnology is and how it can be applied in their everyday lives. In this poster, we present a survey instrument that is being designed to assess undergraduate students' knowledge about nanotechnology and their attitudes towards it. The survey contains 24 items. Each item appears in the form of a statement and respondents indicate the extent of their agreement with the statement on a 5 point Likert scale. Fifteen items assess perceived knowledge about nanotechnology e.g. 'I could explain nanotechnology to a non-technical person.' Nine items assess attitudes towards nanotechnology e.g. 'I am eager to use nanotechnology products'. The instrument has been administered to 337 undergraduates in engineering, materials science and materials science for non-majors classes at Northwestern University and California Polytechnic State University at San Luis Obispo. Factor analysis revealed that knowledge items loaded on 3 factors. There was no clear factor structure for the attitude items however, and these items are currently being revised.

Presenter: Denise Drane, Searle Center for Teaching Excellence
Poster Title: A Teaching Unit on 'Size and Scale' that makes Variations in Conceptual Understanding Salient to Students

Although 'size and scale' is often considered a relatively easy concept in nanoscience, our instructional experience and previous research reveal that students have difficulty understanding this concept, even at the college level. This poster presents results of a study evaluating two teaching interventions designed to enhance students' conceptions of size and scale by making them aware of variations in the ways in which people understand 'size and scale'. Fourteen students in a freshman engineering design course at a Midwestern University in the US participated in the study. The first intervention was designed to help students see 'proportion' as a critical aspect of a scale for objects of widely varying sizes. Activities were also designed to lead students to understand the difference between linear and logarithmic scales. The second intervention was designed to help students recognize alternative conceptions of 'size and scale'. Students examined excerpts from interviews that demonstrated critical distinctions between interviewees' in terms of their conceptions of 'size and scale'. Impact of the intervention was assessed using pre and post unit surveys and a post-unit interview. Two researchers reviewed students' survey responses and their interview transcripts (including diagrams). Responses were coded using a previously developed typology of understandings of 'size and scale'. Students showed better understanding of 'scale' in terms of size continuum on the post survey. Analysis of the interview responses suggested the interventions helped 'push' students from thinking in terms of absolute differences towards thinking in terms of proportions.

Presenter: Sarah Dugan, Northwestern University
Poster Title: Apples to Atoms

"Apples to Atoms" was created by undergraduate engineering students in the Nano-EDC class at Northwestern University. It is a collection of activities focused on important concepts underlying nanoscience, developed for middle school science and math students. Each of the four chapters (Size and Scale, Measurement, Microscopy, and Surface Area to Volume Ratios) contains a series of linked activities and readings which provide context for the concepts developed in the activities. A storyline with student characters runs through the book, asking and answering typical student questions in a series of skits. Suggested assessment items are also included. The chapters are inter-related, but are designed so they may be taught independently or in any order.

Presenter: Sarah Dugan, Northwestern University
Poster Title: Manipulation of Light in the Nanoworld

"Manipulation of Light in the Nanoworld" extends the standard topics of wavelength, diffraction, and interference into the nanoscale by introducing students to the concept of photonic crystals. Hands-on activities present macro and microscale diffraction and interference effects in an engaging way. Computer simulations that parallel some of these hand-on activities allow students to observe the changes in these effects as objects move from the micro to the nanoscale. These concepts are then approached from a materials perspective - with examples such as a butterfly wing and a film of oil, -

introducing students to the idea that the physical properties of materials affect the light incident upon them. Eventually, the students use a computer simulation of a photonic band gap to predict the behavior of photonic crystals (an artificial opal structure) they actually make and test.

Presenter: Sarah Dugan, Northwestern University
Poster Title: Nano-EDC: A project-based introduction to Nano

For the past three years NCLT has sponsored a "Nano" section of the freshmen-level, project-based design course (Engineering Design and Communication) at Northwestern University. During the second semester of EDC, students work in groups of four using the design process (learned during the first quarter) to solve a problem for a real client. In Nano-EDC the clients are middle school teachers and their classrooms and the problem was to develop lessons and activities to teach specific nanoconcepts. Two of the main goals in the development of this class were to improve the students' (both freshman and middle school) understanding of nanoscience and technology and to create engaging, concept-focused lessons and activities for middle schools. Initial evaluation of the course using multiple choice questions given pre- and post- course indicates improvement in freshman students' understanding and knowledge of the chosen nanoconcepts. Various lessons that students have developed are being field-tested and edited with the intent to include them as NCLT curriculum materials.

Presenter: Kimberly Duncan, University of Wisconsin-Madison Materials Research Science and Engineering Center
Poster Title: Training Undergraduates in the Broader Context of the Research Enterprise

The Interdisciplinary Education Group of the UW-MRSEC has collaborated with university faculty and staff and industrial contacts to develop undergraduate-level training materials associated with the context of research. Topics covered include ethics in research, documentation and treatment of research data, publication practices, presentation of results, and the structure of the broader research community. Authors: Katie D. Cadwell, Greta M. Zenner and Wendy C. Crone

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Presenter: Kimberly Duncan, University of Wisconsin-Madison Materials Research Science and Engineering Center
Poster Title: Utilizing Novel Methods to Engage Non-Expert Audiences in Nanotechnology

Diverse audiences require diverse methods of engagement. The UW MRSEC's Interdisciplinary Education Group uses stained glass, nano-themed coloring pages, an art show and even balloons to engage public audiences in nanotechnology. These non-traditional methods highlight the connections between art and science and draw in audiences that don’t typically identify as science enthusiasts. Authors: K.A. Duncan, D. Horoszewski, E. Hood, A. Johnson, K. Luster, D. Meshoulam, R. Nygard, J. Paguirigan, M. Sims, H. Williamson, S. Ng, C. Johnson, G.C. Lisensky, W.C. Crone, and G.M. Zenner

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Presenter: Luis Fuentes-Cobas, Centro de Investigaciones en Materiales Avanzados
Poster Title: The Materials World Modules in Mexico: From Bulk to Nano

Nano-science oriented high-school education in Mexico is following a mixed top-bottom / bottom-top path. 'Top-bottom' means that (besides the application of 'top' pedagogical methodology) nano approach represents a second stage of the MWM project, after successful establishment of bulk-oriented initial modules. 'Bottom-top' refers to the interesting fact that bulk- and nano-oriented science education is diffusing into big cities, starting from a province-generated embryo. The Chihuahua MWM project is described. Emphasis is put on cooperation with Prof. R.P.H. Chang group, Dr. M. Hsu advice, Chihuahua Education Secretariat support, teachers' training and students' scientific motivation. Statistics on students science subjects results demonstrate the usefulness of the Modules as a science education tool. Present attempt to assimilate the international nanoscience 'boom' into the Mexican pre-college educational system is described. The launching platform for this effort is Chihuahua. Opportune actions, coordinated among the Centro de Investigación en Materiales Avanzados (CIMAV), the National Center for Learning and Teaching in Nanoscale Science and Engineering (NCLT) and Mexican science and education authorities are already being developed in the CIMAV Scientific Education Master of Science program. Resources and education experiments associated with the Mexican National Nanotechnology Laboratory at CIMAV are characterized. Authors: L. Fuentes, M. Hsu, M. E. Montero, R. Martínez, A. Pérez, F. Espinosa, A. Zaragoza, S. Maloof, E. Orrantia, M. Gallardo, J. González, M. G. Chacón, R.P.H. Chang

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Presenter: Andrew Greenberg, University of Wisconsin/Madison
Poster Title: The University of Wisconsin-Madison Nanoscale Science and Engineering Center and Discovery Center Museum Partnership: Big Ideas for Teaching Small Science

The University of Wisconsin-Madison NSEC and the Discovery Center Museum in Rockford, IL have developed an equal partnership to teach nanoscale science and engineering to the general public through hands-on exhibits and workshops for the public. Current projects, evaluation, and best practices for building a research center and museum partnership will be presented.

Presenter: Eric Hagedorn, University of Texas at El Paso
Poster Title: 3 Years of Teacher Nanoeducation Professional Development

Formative and summative evaluation of 3 years of two-week summer nanoeducation programs for high and middle school teachers are presented. Connections between formative evaluative findings and programmatic changes are highlighted. Qualitative and quantitative results indicating the success of the programs will be presented.

Presenter: Andrea Harmer, Lehigh University
Poster Title: Engaging middle school students in collaborative, problem-solving using nanotechnology and electron microscopy

Designed to foster learner engagement, this method used an online, problem-based, science inquiry that investigated the Lehigh Gap, Palmerton Superfund Site during five weeks of collaborative classroom sessions. The inquiry prototype was authored in WISE, the Web-Based Science Inquiry Environment (UC, Berkeley). Online materials, readings, and class sessions were augmented with remote access to an electron microscope to analyze Lehigh Gap samples and an introduction to nanoscale science and

nanotechnology through the ImagiNations Web site at Lehigh University. Students contributed artifacts they generated during their research to a university database and presented them to researchers at the university working on the same problem. This approach proved highly engaging and generated design and development guidelines useful to others interested in designing for student engagement and introducing nanoscale science and electron microscopy in middle school science. This study further found that students' engaged in science inquiry both behaviorally and emotionally and on several different levels. The various levels appeared to create two hierarchies of engagement, one based on behavioral criteria and the other based on emotional criteria. For students involved in the collaborative, problem-solving science, which included experts and access to their microscopes, the highest levels of engagement seemed to empower students and create in them a passion towards science. These hierarchies are illustrated with students' direct quotes, which prove that students engaged in this particular design of science inquiry. Students' engagement in the inquiry led to their achievements in understanding nanoscale science, nanotechnology, and electron microscopy and initiated positive attitude changes towards learning science.

Presenter: April Hill, Penn State University Center for Nanoscale Science
Poster Title: Science Camps for Students who are Blind or Visually Impaired

The Pennsylvania State University Center for Nanoscale Science (CNS) has extensive experience in the development and implementation of K-12 summer science camps. CNS is also a partner in the Independent Laboratory Access for the Blind (ILAB) project, which has produced several adaptive tools that allow high-school students with visual impairments to access the chemistry laboratory. Building on these experiences, CNS is currently developing science camp curricula geared toward students who are blind or have low vision. A preliminary assessment was carried out in July 2008 at the Summer Sensations camp at St. Lucy's Day School for Children with Visual Impairments in Philadelphia. The activities presented were adapted from CNS's popular Potions camp (for grades 4-6). The insights gained from this initial field testing are aiding the development of curricula that CNS will present at summer programs being offered by the National Federation of the Blind (NFB) in 2009 and 2010.

Presenter: Seng-tiong Ho, Northwestern University
Poster Title: Lightwave for the Nano World

The paper describes our efforts in developing educational tools and modules for high school and college level students to educate them about the interactions of light with nano structures. We will also discuss the scientific and technological applications of lightwave in the nano world.

Presenter: Matthew Hsu, Northwestern University
Poster Title: Introduction to the Nanoscale: Inquiry into Surface Area and Volume

As an introduction to the nanoworld, a series of inquiry-based curricular activities were developed to (1) give students a feel for just how small the nanoscale is, (2) give student practice in communicating nanoscale quantities and relating them to the familiar macroscale, and (3) illustrate the first and foremost property that increases in importance at the nanoscale, viz., surface area. Through the various hands-on activities students investigate the effects of changing surface area with size/shape of different

forms of sugar, polymers, and building block models. The activities culminate in a card game that further reinforces the foundational knowledge of size, scale, and surface area relationships at the nanoscale.

Presenter: Tadashi Itoh, Division of Frontier Materials Science, Graduate School of Engineering Science, Osaka University
Poster Title: Graduate-level Career-up Programs in Nanoscience and Nanotechnology

For these five years, Osaka University has offered new graduate-level subsidiary pilot programs in nanoscience and nanotecchnology for master, PhD and refresher courses. The concept together with the details of construction of these programs is presented. Not only a set of lectures but also a hands-on-practice partially in cooperation with industries are performed including the subjects of computational nano-materials science, nano-electronics and nano-processing, macro-molecules and nano-bioprocesses, nano-structural and functional analyses, and nano-photonics. More than 1100 students in total have been registered, among which we expect that about 700 students will be given the certificate of completion with 9 to 10 credits. The impression of the students and their supervisors, and the assessment of academic and industrial professionals will be presented together with the perspective of future development of these programs.

Presenter: Nebojsa Jaksic, Colorado State University - Pueblo
Poster Title: Nanotechnology Education at Colorado State University - Pueblo

This poster describes nanotechnology educational efforts at the Colorado State University - Pueblo from 2003 to 2008. The efforts include integration of nanotechnology topics, courses, and projects in undergraduate and graduate engineering curricula. The projects include designs of low-cost scanning tunneling microscopes and production of carbon nanotubes using electric discharge machines. An undergraduate nanotechnology course with the description and an analysis of educational goals is presented. A nanomanufactuing laboratory experiment implemented within a required engineerign course is analyzed.

Presenter: Sinead Kennedy, Catalan Institute of Nanotechnology
Poster Title: Emerging Nanophotonics: The European Network Of Excellence "PhOREMOST"

In 2004, the European funded project PhOREMOST - Nanophotonics to Realise Molecular Scale Technology - was established with the goal to develop a network of excellence (NoE) in the field of nanophotonics. Nanophotonics is a knowledge area emanating from optics and photonics, which harvest new functions and properties of nanostructures and sub-wavelength phenomena. 26 leading research groups from across Europe and 10 associated partners, working in the fields of nanophotonics and molecular photonics, came together to lend their knowledge and expertise to strengthen scientific and technological excellence in nanophotonics. As a consortium they would help to overcome research fragmentation, create a critical mass of resources and spread excellence beyond the boundaries of its partnership. The PhOREMOST NoE is now coming to an end in 2008. So after 4 years what has been the impact for European nanophotonic research? What are the best practices for networking activities and what is the lasting contribution to nanophotonics? We show how PhOREMOST helped to integrate over 300 researchers nanophotonics. How seed-money provided the opportunity for younger scientists to

develop their research via inter-network collaborations, overcoming geographical and cultural barriers. We present examples of dissemination to scientific, industrial as well as public audiences, including an emerging nanophotonics roadmap. Lastly we identify what it takes to achieve a nanotechnology network of excellence. We show the enormous contribution made by scientific personnel to dedicate their research and time to increase the public awareness of nanotechnology and help younger minds develop an interest in nanoscience and technology.

Presenter: George Kiriakidis, University of Crete and IESL/FORTH, Greece
Poster Title: Ultra sensitive nanostructured metal oxide gas sensors

Ultra low detection limits of gas sensors based on In and Zn oxides have great potentials for a number of applications due to their low cost and robust structure. For toxic gas detection in particular sensitivity should be followed by stability and suitability of the sensing element that should preferably be operating in service free and ease of operation conditions. Nanostructured In and Zn oxides grown on robust or flexible substrates operating at room temperature have been fabricated with sputtering and aerosol spray pyrolysis techniques. Optimization of grain structure and surface topology has lead to ultra low detection limits for Ozone (<5 ppb) and NO2 (<50 ppb) which are well below the international standards imposed by the USA (FDA) and EU.

Presenter: Lisa Klein, Rutgers University
Poster Title: Implementing an Undergraduate Interdisciplinary Concentration in Nanomaterials Science and Engineering at Rutgers University

Since 2002, the course 'Introduction to Nanomaterials Science and Engineering' has been offered eight times. This course is designed as an interdisciplinary technical elective for engineering and physical science undergraduates at Rutgers University. Typical enrollment is between 30 and 35 students, largely from biomedical, mechanical, and materials science and engineering. Based on the experience of the course coordinator, we report some strategies for promoting interdisciplinarity, and maintaining a balance of rigor with description.

Presenter: Susan Kowalski, BSCS (Biological Sciences Curriculum Study)
Poster Title: Field Test Results of High School Nanoscience Curriculum

BSCS developed and field tested a Nanoscience unit that will be a module in the third level of BSCS Science: An Inquiry Approach. Students in the courses (N = 400) were in 10th through 12th grade, and had either taken, or were currently enrolled in chemistry. Most students were enrolled in general level courses (not honors, Advanced Placement, etc.). Students identified themselves as White (55%), African American (17.5%), Latino/a (17.8%), Asian (9.5%), and Other (9.6%). In developing the unit, the goal was to help students better understand fundamental science principles by exploring concepts in the engaging context of nanoscience. Because self-assembly is a primary component of many nanoscience applications and allows for teaching a number of generalized science principles, it was chosen as the focus of the unit. The first chapter covers science principles important to the understanding of self-assembly, including intermolecular forces, surface area and volume, and thermodynamics. The second chapter focuses on biological self-assembly and making ethical decisions about the use and

development of nanotechnology. Each chapter was developed using the BSCS 5E Instructional Model. A primary concern in developing the unit was whether students would be able to learn difficult concepts, such as entropy and enthalpy, through the use of the materials. Results of the field test have shown statistically significant ($p<.001$) differences from pretest to posttest with an extremely large effect size ($d = 1.08$). These results suggest that students were able to effectively learn and retain information on topics generally only taught to advanced students.

Presenter: Polly Kroha, Nano-CEMMS at University of Illinois at Urbana-Champaign
Poster Title: The Nano-CEMMS Program for Workforce Development

The Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS) at the University of Illinois endeavors to develop a diverse U.S. workforce of educators, scientists, engineers, and practitioners to advance nanomanufacturing technology in the U.S. and beyond. Nano-CEMMS targets pipeline development through the following programs:
K-12 Students - Hands-on workshops in school classrooms; Summer camp programs for middle and high school students; NanoChallenge, a research program for high school students; Middle school student research collaborations with teachers and Nano-CEMMS faculty
Teachers - 2-week summer institutes for high school mathematics, science and technology teachers with follow-up sessions; Telephone and classroom support throughout the school year; 1-day workshops in Illinois and North Carolina; Hands-on presentations for in-service teacher workshops; Free classroom activity kits
University Students - Undergraduate and graduate level courses; Cross-disciplinary research ethics training; Summer Research Experience for Undergraduates (REU) program; Summer Research Opportunities Program (SROP); Monthly graduate student seminars; Workshops for undergraduate science education majors
Informal Education - Museum exhibits and education programs; Presentations at job fairs, university visitations, technology showcases, scouting events, and community organization meetings.
STEM Education Collaborations - An Illinois Workforce in Nanotechnology Initiative (I-WIN) focuses on changing Illinois learning standards to include STEM education in emerging technologies; Partners includes U.S. Congress representatives, Illinois businesses and industries, the Illinois State Board of Education, the Illinois Department of Commerce and Economic Development, University of Illinois and public school/community college administration and faculty, and many others.
Diversity Programs - Summer camp programs that target diverse pre-college students; Scholarship opportunities; Campus MERGE program for graduate student recruitment; Attendance at student recruitment conferences; Individualized tracking and follow-up
Evaluation - Independent and unbiased external evaluation; Formative guidance on the design and implementation of programs based on findings and recommendations; Summative feedback on the extent individual programs meet their intended program goals; Instruments designed to gather qualitative and quantitative data on subject knowledge, participant engagement, quality improvement, demographics/diversity, and follow-up opportunities.

Presenter: Robert Lam and Karen Liu, Northwestern University
Poster Title: NCLT Nanoscholar Research in Nanomedicine

Nanotechnology holds great promise for the future of medicine. Our work utilizes the principles of nanotechnology to enhance current methods of therapeutics and diagnostics for applications in biology

and medicine. Our summer work with NCLT showcases bionanotechnology and its applications towards detection of botulinum neurotoxin and drug delivery using nanodiamonds.

Presenter: Gregory Light, Northwestern University
Poster Title: Student conceptions of size and scale: mapping understanding in the nanoscience context

The concept of 'Size and Scale' has been widely acknowledged as a foundational idea for students' learning of nanoscale science and technology. However, while recent research have suggested that undergraduate students often have difficulty grasping this concept, little is known about their conceptions (and misconceptions) of 'size and scale' at the undergradtaue level. This poster reports on two related studies aimed at answering this question. The first study explored the ways students understand this key concept through think-aloud interviews, and identified a preliminary typology of student conceptions. Specifically, students' conceptions seemed to vary along three dimensions ' continuity of scale between the macro-, micro-, and nano-worlds; structure of scale - logarithmic scale, linear scale, or a combination of the two; and numerical format of scale - integrated or detached. Three major categories (and 5 types) of conceptions were classified based on variations along these dimensions, and possible reasons for such variations were proposed. Building upon these results, we developed four assessment items that further probe the critical dimensions underlying student conceptions, and administered them to a bigger student population in the second study. Preliminary analysis of students' responses to the items confirmed the three categories of the typology, but extended it to include 9 conception types, providing richer information to help educators better understand how undergraduate students come to grasp (or not grasp) the concept of 'size and scale'.

Presenter: Gregory Light, Northwestern University
Poster Title: Student understanding of surface-area-to-volume ratio and its relationship to property change at the nanoscale

Student understanding of surface-area-to-volume ratio (SA/V), particularly in relation to property change has been identified as core concept in the study of nanoscale science at the undergraduate level (Wansom et. al. in press). However, little is know, about how undergraduates conceive of and try to make sense of SA/V in the nanoscience context. This poster will present the results of several studies unpacking student understanding of this concept. Drawing upon interviews, surveys and concept mapping, the results indicate that SA/V is a potential threshoild concept for understanding key areas of nanoscience and, moreover, that there is significant variation in the way in which students understand or fail to understand SA/V. The most salient variation concerns how students connect SA/V change to property change. Many students failed to consider the role of 'volume' in the relationship between SA/V and property change, and thus were unable to explain the connection between the two beyond the idea of 'surface exposure'. These variations are identified and described. The poster also explores the potential pedagogical reasons for this variation and their associated misunderstanding. The implications for nanoscale education are discussed.

Presenter: Heh-Nan Lin, National Tsing Hua University
Poster Title: Atomic force microscopy nanomachining for the fabrication of metal nanostructures and its use as a platform for nanolithography education

Metal nanostructures are receiving considerable interests in recent years for both fundamental and application reasons. In this work, the fabrication of metal nanostructures by a combination of atomic force microscopy nanomachining on a thin polymer resist, metal coating and lift-off is presented. Nanodots with sizes and nanowires with widths ranging between 50 and 100 nm have been successfully created. In addition, nanoelectrodes can be produced with ease by direct scratching a nanowire. The results exemplify the feasibility and effectiveness of the present technique as an alternative to e-beam lithography. For nanoscale education, the nanomachining technique can be learned within a day for a trainee with a background in atomic force microscopy. The extra instruments needed only include a spin-coater for the preparation of a polymer film and an ion-sputter for metal deposition. Therefore, the atomic force microscopy nanomachining technique can be considered as a convenient platform for educational purpose in nanolithography.

Presenter: Brenda Lopez Silva, University of Illinois at Chicago
Poster Title: DNA Three Ways: Domain content learning and representational affordances in a middle school classroom

This poster summarizes the design rationale and classroom experience surrounding a middle school instructional unit on the nanoscale phenomena of coupling of single strand viral DNA nucleotide chains. The instructional design was motivated by a strategy for integrating new nanoscale content into an existing curricular unit, situating learner activity within a design framework, and using multiple representational affordances of nanoscale phenomena, both as media for the design activities and as objects of student critique. Three representations of DNA were constructed. On printed worksheets, DNA was represented as a rigid, linear chain of nucleotides, with the goal of establishing the overall component structure and base pair nucleotides. A second model employed plastic ‘pop beads,’ color-coded by base type, onto which we attached polarized magnets and Velcro fragments, intended to highlight the differential binding properties of the base pairs and the flexibility of the DNA strands. The final model was a computer graphic simulation in which DNA was depicted as large groups of strands of nucleotides moving in a liquid medium; here the purpose was to highlight the dynamism of DNA and the attractive forces governing self-assembly into paired strands. The computer simulation was implemented as a whole-class resource, projected from an overhead projector to a 6-foot diameter platform on floor of the classroom. Students showed significant pre-post gains both in their understandings of domain concepts and in their ability to articulate affordances and constraints of representations and models.

Presenter: Tom Mason, Northwestern University
Poster Title: A Rubric for Post-Secondary Degree Programs in Nanoscience and Nanotechnology

Based upon a set of "big ideas" identified by recent workshops and a study report, a broad curricular framework has been developed for degree programs in nanoscale science and engineering (NSE). The

framework is built around four essential areas or nodes in NSE that include: Processing (how nano-entities are fabricated), Nanostructure (how the structure of nano-entities can be imaged and characterized), Properties (the resulting size-dependent and surface-related properties of nanostructured materials/devices), and Applications (how nanomaterials and nanodevices can be designed and engineered for the benefit of society), which can be abbreviated as "P-N-P-A." The P-N-P-A rubric provides a tool for program and course construction and evaluation in higher education. An analysis of emerging NSE degree programs in the U.S. suggests that improvements need to be made in the programmatic balance among the P-N-P-A nodes, with particular attention being paid to essential features such as the interdisciplinarity of NSE and its societal impact (ethics, safety, and so on). A significant challenge for achieving programmatic balance is providing students access to advanced instrumentation, which is an essential element for student mastery of the "nanostructure" node. Recommendations and challenges for achieving programmatic balance are discussed.

Presenter: Richard Matyi, College of Nanoscale Science and Engineering, University at Albany
Poster Title: The College of Nanoscale Science and Engineering at the University at Albany: A New Partnership Model for Education in Nanotechnology

The College of Nanoscale Science and Engineering of the University at Albany ‘ State University of New York is the first college in the world dedicated to research, development, education, and deployment in the emerging disciplines of nanoscience, nanoengineering, nanobioscience, and nanoeconomics. CNSE’s Albany NanoTech complex is the most advanced research facility of its kind at any university in the world: a $4.5 billion, 450,000-square-foot complex that houses a fully-integrated, 300mm wafer, computer chip pilot prototyping and demonstration line within 65,000 square feet of Class 1 capable cleanrooms. This facility has attracted more than 2,000 scientists, researchers, engineers, students, and faculty and hosts over 250 corporate partners, including IBM, AMD, ASML, Applied Materials, Tokyo Electron, and International SEMATECH. The CNSE offers a one-of-a-kind academic experience where students and faculty work alongside scientists from industry on fundamental cutting-edge research underlying the real-world problems. One of the principal goals of the CNSE is to address the looming shortage of scientific and engineering personnel in nanoscale science and nanotechnology. In response to this need, CNSE conducts multi-level programs that encourage science awareness in grades K-12 to help ensure the U.S. science and technology workforce of the future. These activities include NanoCareer and NanoCommunity Days, NanoHigh, the Excelsior Scholars Nanoscale Science Summer Institute, the NanoEducation Summit, as well as numerous regional collaborations. CNSE's educational outreach programs inspires students to pursue careers in science and technology, creating the innovative workforce that is critical to our future on a regional, statewide and national scale.

Presenter: Ana-Rita Mayol, Institute of Functional Nanomaterials, University of Puerto Rico
Poster Title: Bringing Upper Undergraduate Courses to the 21st Century: Integrating Nanoscience Concepts and Skills in the Intermediate Physics and Physical Chemistry Laboratories

The current state of the teaching laboratories in advances courses is outdated. The curriculum teaches the core concepts and new applications, yet the laboratories lack modern infrastructure, modern equipment and innovative experiments that promote problem solving skills. The development of new experiments, bringing the most recent results in research in nanoscience and technology, will open a window to motivate students to pursue undergraduate and graduate careers in nanoscience in addition to providing the fundamentals to excel in industrial setting. By replacing outdated experiments in the

established curriculum with experimental activities in nanoscience and technology the Laboratory Courses will be brought into the 21st Century milieu. Moreover, the development of new curricular materials that employ the new approaches and tools will vividly show and explore the fundamentals of science. Alignment of the Physical Chemistry and Modern Physics curriculum and the results of this alignment with the 'Big Ideas' identified by NCLT, was completed previous to the design of new laboratory experiences in order to ensure that the targeted concepts and skills are properly developed, while introducing the students to a new field. This project has catalyzed the development of four new laboratory experiences, already implemented and tested, and three are currently being developed. Assessment of student learning is underway and dissemination of these materials will be done via the IFN website and collaborators' web-based libraries. A.-R. Mayol, M. Gomez, C. Marin, R. Palai, A. Biaggi, J. Ramos, J. Morales, Institute for Functional Nanomaterials (IFN), University of Puerto Rico

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Presenter: Ana-Rita Mayol, Institute of Functional Nanomaterials, University of Puerto Rico
Poster Title: Bringing Nanoscience to the General Public: success story of the IFN Education and Outreach Program

The Institute for Functional Nanomaterials (IFN) at the University of Puerto Rico is a multicampus research institute composed of 32 scientists. It has a very strong and active Education and Outreach Program lead by a Nano Interdisciplinary Education Team (NIET). The program uses cutting edge results to bring key concepts and applications in Nanoscience to the general public, students and teachers in the K-16 levels. This project has catalyzed the development and implementation of a Nanoscience Exhibits for general public; seven workshops for the K-14 level; three new laboratory experiences for advanced undergraduates; and one interdisciplinary graduate course, reaching more the 1000 persons during the first year; the objective of all these activities is to motivate students to pursue careers in nanoscience. The IFN successfully participated in NanoDays developing demonstrations to teach the core concepts and applications in the field in an interactive and approachable fashion to all ages. The Nanoscience Display used trained high school students as presenters. Assessment of these activities is underway. The IFN has created strong collaborations with NSF-funded education programs such as National Center for Learning and Teaching (NCLT) and Cornell Center for Materials Research (CCMR), and a PR based non-profit organization Operación Exito (OE) to ensure breadth and depth in reaching all educational levels. Dissemination of these materials will be done via the IFN website and collaborators' web-based libraries. The program is working to expand its resources by training qualified master teachers and high school students to serve as presenters. A.-R. Mayol, N. Cardona, R. Palai, M. Gomez, B. Santos, J. Ramos Institute for Functional Nanomaterials, University of Puerto Rico

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Presenter: Thomas Moher, University of Illinois/Chicago
Poster Title: Design First: Instructional Strategies and Tool Affordances in the Introduction of Nanoscale Self-Assembly to Middle School Learners

In a one-week pilot study, we investigated the effects of the two alternative instructional sequences of the introduction of domain-specific concepts and terminology on students' conceptual understandings and ability to perform simple nanoscale self-assembly design tasks. We employed a quasi-experimental design, assigning two intact urban sixth-grade classrooms. In a "domain-framed" treatment, the phenomena were described in domain terms at the outset and followed the conventional order of science instruction: formal instruction followed by design activities. In the "practice-framed" treatment, the phenomena were described using morphological nouns (e.g., "blobs" instead of "molecules") and

verbs common to younger learners (e.g., "sticking" rather than "bonding"); the design sessions were then followed by a "bridging lesson" that related the objects and verbs of the design activity to their domain-specific vocabulary and concepts. The design activities were scripted using the Concord Consortium's Molecular Workbench. Paper-and-pencil assessments of self-assembly content knowledge and design capability were administered to each group following the first instructional phase and again at the study's completion. Post-test outcomes trended in favor of the practice-framed treatment for both conceptual understanding and design proficiency, but high variances precluded claims of statistical significance except on an assessment item asking students to generate the design of a self-assembled target shape. Notably, while students appeared to gain insight into molecular motion, geometries, and heterogeneously distributed surface charge, the simulation environment offered control affordances that raised significant misconceptions about the self-assembly design process.

Presenter: Juana Moreno, Louisiana State University
Poster Title: Our Nanoworld: Introduction to Nanoscience and Nanotechnology for middle and high school teachers

We discuss our experience on developing and teaching a nanoscience/nanotechnology workshop for grade 6-12 teachers at the University of North Dakota. This workshop is an activity-based inquiry program in nanoscience specially designed for school teachers. Twenty three local teachers with degrees in Education, Chemistry, Biology and Physics have participated in the workshop in the last three years.

Presenter: Carolyn Nichol, Rice University
Poster Title: Using nanoparticle assembled capsules (NACs) to illustrate self assembly and bottom up design on the nanoscale

To show students that under the correct conditions on the nanoscale molecules can connect in a simple ways to form specific shapes and intricate patterns, we developed a hands-on activity using "NACs', a new type of self-assembled nanomaterial shaped like hollow spheres. A procedure to illustrate this process of self assembly was developed by Michelle Dean, a 9th grade science teacher in the Houston Independent School District (ISD) in collaboration with Dr. Hitesh Bagaria, a postdoctoral fellow, and Professor Michael Wong in the Department of Chemical and Biomolecular Engineering at Rice University. To link research in nanotechnology to K-12 education, this hands-on activity is a modification of nanotechnology research described in the Journal of Physical Chemistry . Food coloring is encapsulated in the nanocapsules via a two step process. First there is the complexation of the polycation polyallylamine hydrochloride with the anion sodium citrate to form crosslinked polymer aggregates. Then Snowtex-O (colloidal silica 12-13 nm) is added to form a shell around the aggregates and produce the NACs. NACs can be used for drug delivery and also to form the bulking blocks for superlattices or nanowires. In July 2008, this activity was filmed as a segment for PBS's Dragonfly NanoTV and will be aired nationally in December. In the Dragonfly episode, the microencapsulation activity was linked to a new exhibit at the Houston Children's Museum about the bottom up versus top down self assembly of carbon nanotubes. This is one of the outcomes of Center for Biological and Environmental Nanotechnology's (CBEN) CHEM 570 Nanotechnology for Teachers semester course and summer laboratory internships. 1. Murthy, VS, Rana, RK and Wong, MS J. Phys. Chem. B 2006, 110, 25619-25627.

Presenter: Julie Nucci, Center for Nanoscale Systems, CNS Institute for Physics Teachers
Poster Title: Successful High School and Undergraduate Education Programs of the Cornell NSEC Emphasize Hands-On Activities

The Center for Nanoscale Systems (CNS), Cornell's NSEC, offers an education program consisting of both high school and undergraduate programs. The focal point of the high school effort is the CNS Institute for Physics Teachers (CIPT), which updates teachers on recent advances in physics and related technologies and provides participants access to innovative, inquiry-based laboratory activities. The labs are designed to meet the time constraints of a typical high school and fit into the standard, often state-mandated, curriculum. The CIPT currently offers approximately 30 lab activities, which are available to program participants trained to use them free of charge via an equipment lending library. Teachers are trained to use the lab kits during annual workshops and summer graduate courses, which also feature faculty lectures and research lab tours. The CIPT has trained over 1000 different teachers since 2001 and the lending library has provided lab activities for over 15,000 students in the last three years. The undergraduate education program features a freshman-level course, 'Introduction to Nanoscience and Engineering', offered by the Applied an Engineering Physics Department. This lecture/laboratory course is designed to introduce freshmen to basic nano concepts, to the techniques and the tools central to the rapidly developing field of nanoscience and nanotechnology, and to some of the important scientific and technological innovations that are now emerging, or are expected to emerge, from this field. Student evaluations of this very popular course highlight the value of the hands-on activities in promoting interest in this field.

Presenter: Rene Overney, University of Washington
Poster Title: NUE UNIQUE: Hands-on Teaching of Nanoscale Fundamentals with the Light Microscope Equivalent of this Century - Scanning Probe Microscopy

Over the past decade enormous progress has been made in applied nanotechnology, in particular, in materials and products engineering. At the same time education has struggled to keep pace, and to provide the industry with the necessary workforce. The major challenges our educational core programs are facing today originate from the highly multidisciplinary character of the underlying theories. We are confronted with the difficult task to formulate a basic framework that properly classifies them, and generally lack the tools to teach them effectively in a classroom/lab setting. Over the past two years, within the undergraduate educational NSF program NUE UNIQUE (Using Nanoscience Instrumentation for Quality Undergraduate Education), we have developed an effective Nanoscience teaching model by (i) introducing a coherent program with focus on fundamentals that fit into the core program of many engineering and natural science disciplines, (ii) providing true hands-on experience with top-notch equipment (scanning probe methods) in an authentic undergraduate laboratory setting, and (iii) establishing a transferable and mobile model adaptable by most educational institutions. It is the mobility and transferability that makes this program unique. To date, we have run two successful undergraduate laboratory workshops, where students were able to have extensive hands-on experience on five SPM modes of operation including:
(i) electrostatic force microscopy involving photovoltaic polymeric materials,
(ii) tunneling microscopy and the determination of the workfunction,
(iii) modulation force microscopy with a glass transition analysis,

(iv) force-displacement analysis under controlled humidity conditions to distinguish capillary forces from Van der Waals interactions,
(v) non-contact force microscopy for protein adsorption studies in air and liquid environment,
(vi) SPM dip-pin nanolithography.1

1http://depts.washington.edu/nanolab/NUE_UNIQUE/NUE_UNIQUE.htm

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Presenter: Rene Overney, University of Washington
Poster Title: Intrinsic Friction Analysis - A Nanoscopic Method to Extract Submolecular Mobility Information from Complex Organic Structured or Amorphous Systems

Condensed organic materials designed for nanotechnological applications are impacted significantly by internal and external constraints. Internal constraints are inherent to the molecular architecture, and generally result from direct bonding, dipole interactions, or steric effects. This type of constraint can be incorporated a priori into molecular designs, as a prescription for desired material properties. External constraints stem from interactions with system boundaries. They arise in the vicinity of interfaces or other hetero-junctions, and propagate over a finite distance. Both types of constraints are affecting the mobility of the material on the submolecular, molecular, or cooperative (meso) scale. Today's challenge lies in obtaining convenient access to the molecular mobility, in particular, in thin organic structured or unstructured films. Here, we introduce a novel scanning probe methodology, called intrinsic friction analysis (IFA), which is based on lateral force microscopy. Intrinsic frictional mobility of molecular segments can be analyzed with this method on a local scale two-fold; i.e., based on its energetics and cooperativity. If combined with a spectroscopic method, such as dielectric spectroscopy, it is the only existing analysis method that provides length scale information about cooperativity without any model assumptions.[1] IFA has been employed successfully to a wide variety of research areas and materials from fundamental aspect of the glass forming process,[1] the mobility in non-linear optical photonic materials involving side-chain polymers[2] and self-assembling amorphous molecular glasses[3], to fundamental dissipation processes in tribology.
[1] S. Sills, T. Gray., and R. M. Overney, J. Chem. Phys. 123, 134902 (2005).
[2] T. Gray, R. M. Overney, M. Haller, et al., Appl. Phys. Lett. 86, 211908 (2005).
[3] T. Gray, T.D. Kim, D.B. Knorr, A.K.Y Jen, R.M. Overney, Nano Letters, 8, 754 (2008)

Presenter: Kim Pacheco, University of Northern Colorado
Poster Title: Nanoscience education for freshmen and pre-service teachers at UNC

Nanoscience concepts have been integrated into both a one hour learning community course for freshman and the three hour physical science course for pre-service teachers at the University of Northern Colorado. Students in the learning community course take a look at current nanoscience research and get hands on experience using an AFM and STM. Pre-service teachers also are exposed to a brief introduction regarding techniques used in the field of nanoscience and then image a sample using an AFM. Students in both courses appreciate the exposure to current techniques and have shown learning gains in the areas of nanoscience concepts.

Presenter: Elisabeth Palmer, ASPEN Associates, Inc.
Poster Title: Evaluation for Research and Development

This poster will demonstrate how evaluation data can be utilized to support research and development by sharing evaluation methods and findings from the NanoLeap project.

Presenter: Su-Seng Pang, Louisiana State University
Poster Title: Boiling Heat Transfer Enhancement Using Surface Microstructures

The goal of this research is to enhance the heat exchanger efficiency of pressurized water reactor (PWR) by using LIGA or LIGA-like technique made microstructures. The heat transfer inside the boiler is the complex combination of different physical phenomena, which, besides the traditional convection, conduction, and radiation, includes liquid to vapor phase change, vapor nucleation and evolution, surface tension between the liquid and heating element, and so on. This poster presents the updated total heat transfer enhancement results of boiling process by adding microstructures on the surface of the heating elements. Different types of microstructure configurations were tested. The input power, temperature of the heating element, and boiling phenomena were recorded. The behavior of power increasing versus temperature rising of testing coupon is used to evaluate the heat transfer efficiency of the heating element. The steam generating efficiency at fixed input power and fixed temperature have been used to assess the performance of heating elements with different microstructure configurations. The preliminary results show that by simply adding micro-sized poles on the surface of the heating element, the input power can be increased almost 100% higher than that without poles on the surface at 360 ºC. The current results suggest that the main factors leading to the enhanced boiling process are the surface morphology and configuration of the microstructures, which provide enhanced vapor nucleation sites at heating surface, result in a better vapor evolution processes, yield a low superheat temperature, and eventually achieve a higher boiling heat transfer efficiency. (M. Zhang, K. Lian, A. Maha, S.S. Pang, G. Li, S.I. Ibekwe)

Presenter: Monica Plisch, American Physical Society
Poster Title: Assessing the Impact of an Introductory Course on Nanotechnology for Freshmen

Freshmen arrive on campus eager to learn about opportunities that are awaiting them. This is a prime time to capitalize on student interest in nanotechnology, and to develop a deeper awareness and interest in this area. We describe an introductory lecture and lab course on nanotechnology designed for freshman engineering students at Cornell University. In post-surveys of students, conducted at the end of the course and later in students' undergraduate careers, we learned that students highly valued the course compared to other courses and they experienced a sustained increase in their interest in nano. We present evidence that the course was a significant factor in increasing enrollment in the Applied and Engineering Physics major.

Presenter: Karen Pollard, Science Museum of Minnesota
Poster Title: NanoDays 2009, March 28-April 5 - A week of community-based educational outreach events to raise public awareness of nanoscale science and engineering

The inaugural NanoDays week was March 29 to April 6, 2008. Partners participating in NanoDays organized outreach events unique to their local communities -- art events, lab tours, lectures, and many other types of events -- and then reported back to the Network about their NanoDays experiences. The Network expected the first NanoDays to be a small roll-out involving only a handful of institutions. Instead, NanoDays kits were distributed to 100 institutions across the country. The kits include a planning guide, marketing materials, background information, and the materials necessary to do six different nano-based activities.

Presenter: Liangti Qu, University of Dayton
Poster Title: Super-strong anisotropic aligned carbon nanotube dry adhesives

The driving force for holding gecko lizards on a vertical solid surface to defy gravity comes from its remarkable feet and toes that are made of aligned microscopic elastic hairs. Using a rationally designed carbon nanotube arrays that are dominated by a straight body-segment but with curly entangled top, we have created gecko-foot-mimetic dry adhesives that showed the reported macroscopic adhesive force of ~100 N/cm 2 , almost ten times of that of a gecko foot (10 N/cm 2). More importantly, these hierarchically-structured nanotube adhesives exhibited a much stronger shear adhesion force than the normal adhesion force (~10 N/cm 2) to ensure a strong binding along the shear direction and easy lifting in the normal direction. This anisotropic force distribution is due to the shear-induced alignments of the curly segments of the nanotubes at the array top in parallel to the solid surface, which results in 'line' contact instead of 'point' contact. Thus, the mimetic adhesives can be alternatively binding-on and lifting-off for simulating the walking of a living gecko.

Presenter: B. Ramakrishna, Arizona State
Poster Title: Interactive Applets for Nanotechnology Education

The Interactive Nano-Visualization in Science and Engineering Education (IN-VSEE) project combines advances in telecommunications, instructional technologies, and science and engineering research to provide a comprehensive set of resources for Nanotechnology education and training over the World Wide Web. This novel visualization-centered, distance learning project has produced discovery-based interactive educational learning modules to bring the excitement of research to upper-level high school and first-year college students and teachers regardless of budgetary or geographic barriers. The educational modules are embellished with interactive discovery-based learning activities in the form of applets. Applets are a powerful way to promote Interactive Web-based learning. Applets integrate Animations, Mathematical processing and Imaging making them the ideal instruments to deliver Educational content on the Web. The driving force behind the use of applets is to provide any Internet user to have hands on access to programs, which enable him/her to comprehend complex concepts through the use of online simulations and animations. A suitable scenario that explains a basic concept in science or engineering is considered for translation into an interactive activity by the

educator/content expert. After an initial analysis the educator/content experts comes up with a schematic for the applet and discusses them during a meeting with the software engineer. The potential for visualization, animation and mathematical processing are evaluated. Two representative Applets, from over 50 that have been developed - one on Avagadro number and the other on DNA base pairs, will be illustrated.

Presenter: John Ristvey, Mid-Continent Research for Education and Learning
Poster Title: NanoLeap Field Test Findings

Two proof-of-concept modules featuring hands-on activities, assessments, and interactive multimedia were developed and tested for teachers and students in high-school physical science and chemistry classes. During the 2007-2008 school year, the NanoLeap project field tested the two modules by high school physical science teachers (N=19) and high school chemistry teachers (N= 20). The treatment teachers administered pre and post assessments, and student surveys. Project evaluators conducted observations and interviews during the implementation of the modules. Teachers also completed a fidelity checklist with feedback for developers to consider during subsequent revisions. The data collected from the treatment teachers will be compared with a control group who administered identical assessments before and after a unit on forces and motion (physical science, N= 20); and at the conclusion of a first year chemistry course, (chemistry N= 18).

Presenter: Mehmet Sarikaya, University of Washington
Poster Title: Global Biomimetics Network

We are establishing a Global Biomimetics Network (GloBN) to initiate, nurture, enhance and expand international collaborations between scientists and educators at the University of Washington (UW), other US universities some with MRSECs, and at institutions located in 15 countries in Europe, Asia, Africa, and South America. The GloBN will energize and transform materials research by coordinating international education and translational projects on molecular biomimetics, an emerging interdisciplinary field that blends major science fields of materials sciences & engineering, molecular biology & genomics, bioinformatics & computational modeling all connected with cyberinfrastructure GloBN's overarching goals are to: (i) Create of a global biomolecular materials network that will push the boundaries of materials research in translational molecular biomimetics with applications in technology and medicine; (ii) Train a new generation of polydisciplinary scientists and engineers equipped with international leadership skills; (iii) Build platforms for technology transfer; and (iv) Promote outreach and international public interest.

Presenter: Martin Schubert, cc-NanoChem e. V. - Competence Center Chemical Nanotechnology for New Materials
Poster Title: Working group of the Centers of Competence of Nanotechnology in Germany: AGeNT-D

Eleven Nanotechnology Competence Centers in Germany have established the consortium AGeNT-D (Arbeitsgemeinschaft der Nanotechnologie-Kompetenzzentren in Deutschland). The CCNanos are acting nationwide and are located in various regions of Germany. All together they cover the whole range of nanotechnology's research and application areas. Almost all CCNanos arised from a call from the

Ministry of Education and Research (BMBF) in 1998, each with a special focus on different topics of nanotechnology. Thus clusters of highly cross-linked enterprises, research institutions and universities were formed in various spots in Germany in the recent years. Because of new funding models in the following years there was an increasing concentration on regional subjects of the competence centers. Therefore, several competence centers developed similar organization platforms and paid attention to societal issues. At this point the cross-linking of the competence centers started and resulted in the establishment of AGeNT. The management of decisive tasks could be concerted to increase the efficiency and to successfully reach joint goals. The consortium is enabled by the financial support of the Ministry of Education and Research (BMBF). At the 1st February 2007 AGeNT-D started to work. It is open to new members according to its statutes.

Presenter: Martin Schubert, cc-NanoChem e. V. - Competence Center Chemical Nanotechnology for New Materials
Poster Title: Teaching Nano with Experimental Kits in Germany

In the past ten years, some teaching materials for secondary education have been developed in Germany. In addition to presentation sets for the public and for use in schools, four experimental kits are currently available for demonstration of nano-effects by the teacher or for performing nano-experiments by the students themselves. Beside the presentation of the contents of these kits, an overview about available teaching materials and online resources for teachers in Germany will be given.

Presenter: Vesselin Shanov, University of Cincinnati
Poster Title: Progress in Synthesis of Centimeter Long Aligned Carbon Nanotubes

Intense research efforts have been undertaken to synthesize long, aligned CNTs because of their potential applications in nanomedicine, aerospace, electronics and many other areas. Nevertheless, many limitations to synthesize long CNT arrays still remain. The main obstacle to wider application of CNTs is their nature to grow in bundles resembling, "spaghetti" type morphology. Recently, UC researchers developed a novel composite catalyst for oriented growth and succeeded to produce the longest to our knowledge Multi Wall CNT arrays (18 mm) reported in the literature [1]. This poster will focus on the latest results in catalytic synthesis of centimeter long CNT arrays by CVD, achieved at the University of Cincinnati. The role of the catalyst design on the substrate surface and its impact on the length of the oriented carbon nanotubes will be revealed. Additionally, characterization of the arrays by ESEM, HRTEM, Micro-Raman Spectroscopy, and TGA will be discussed. The poster will illustrate exiting applications of the CNT arrays related to their unique properties. Recent advances in the development of 'Black Cotton TM', which is centimeter long CNT arrays grown on large substrates, will be presented. Applications of nanotechnology under development in our lab include spinning Black Cotton into thread to produce a new materials. The poster will also present current research efforts to scale up the cultivated process, and to develop the manufacturing tools and methods that industry needs to 'mass produce' aligned nanotubes.
References: [1] http://www.nsf.gov/news/news_summ.jsp?cntn_id=108992&org=NSF&from=news
Vesselin N. Shanov1*, Mark J. Schulz2, Supriya Chackrabarti11, Chaminda Jayasinghe1, Ge Lee1, Emily Head1, Wondong Cho1, YeoHeung Yun2, and Pravahan Salunke1 1-Department of Chemical and Materials Engineering, University of Cincinnati, Cincinnati, OH 45221, USA 2-Department of Mechanical Engineering, University of Cincinnati, Cincinnati, OH 45221, USA *Corresponding author and presenter: vesselin.shanov@uc.edu

Presenter: Tina Stanford, SRI International
Poster Title: NanoSense: The Basic Sense Behind Nanoscience Patricia Schank and Tina Stanford, SRI International Alyssa Wise, Simon Fraser University

NanoSense has developed 4 curriculum units for use in high-school science classrooms. The units have been distributed to teachers at professional development workshops and are freely available at http://nanosense.org. The first unit, Size Matters, provides an introduction to nanoscience, focusing on concepts of size and scale, unique properties at the nanoscale, and tools of the nanoscale. The remaining units each explore the science behind an interesting application: Clear (nanoparticulate) Sunscreen, Clean (nanosolar) Energy, and Fine (nano) Filters. Each unit includes PowerPoint slides, hands-on activities, labs and student handouts, readings, and assessments. The materials have been enthusiastically received at professional development workshops, although teachers report time to prepare to teach the new, interdisciplinary material as a barrier to use. Evaluation data was collected from 11 implementations lasting from one to five class periods depending on teacher constraints. Students showed significant gains on unit-specific pre/post tests with large effect sizes and were interested and excited by the units, but learning often remained at a superficial level. For example, students could describe what properties change at the nanoscale, but had difficulties explaining why these properties were different. Encouragingly, when teachers took the time to do hands-on activities and spend multiple days on a unit, students at lower levels (e.g. 9th grade biology) were able to show gains equivalent to those seen for high achieving upper level students (11th & 12th grade biotechnology). Pre/post surveys of student attitudes about science showed significant gains, mainly on how students perceived the usefulness of science to everyday life.

Presenter: Mary Anne White, Dalhousie University
Poster Title: Thermal Properties of Nano-Scale Materials

This poster will summarize our recent experimental findings, especially concerning thermal conductivity of materials with nano-scale features. The materials range from minerals (zeolites) to biomaterials (ivory) and carbon nanotube composites.

Presenter: Melinda Wong, Northwestern University
Poster Title: NCLT: Center Highlights and Future Initiatives

National Center for Learning and Teaching in Nanoscale Science and Engineering (NCLT) is designed to help respond to the future nanotechnology labor challenge by anchoring Nanoscale Science and Engineering (NSE) into Science, Technology, Engineering, and Math (STEM) education. The NCLT is comprised of 11 founding partner institutions with interdisciplinary teams of experts in nano science, engineering and education. In addition, NCLT has collaboration with nano experts from academia and national laboratories throughout the US. These teams are conducting learning research on the best approaches for integration of NSE into the classroom and are contributing in several areas: learning progressions for nanoscience, establishing nanoconcept inventories and assessments, and research on the motivations of students towards learning nanoscience for grades 7-16. The Center operation is designed to rapidly integrate the latest nanoscience concepts into the classroom. To do this, the Center

provides professional development and faculty workshops, nano curriculum, and research, which is disseminated through an interactive virtual resource Portal (www.nanoed.org).

Presenter: Guoping Zhang, Indiana State University
Poster Title: Manifestation of the electron-electron interactions in time-resolved ultrafast pump-probe spectroscopy in $\mathbf{C}_{60}$ Theory

{The electron-electron interaction (EEI) is at the core of modern physics from high-temperature superconductivity to giant magneto-resistance. Nanostructures in general and C60 in particular open a new frontier for study of the electron correlation effect in quasi-zero-dimensional materials. Here, a direct investigation of the time-resolved pump-probe signal in C60 shows that the on-site electron-electron interaction manifests itself in two aspects in the early stage of ultrashort laser excitation. First, it pushes the signal peak to an earlier time delay for below-resonance excitation and narrows the peak-time change with probe detuning. Second, it shortens the quasiparticle lifetime, and if the interaction is strong enough, it diminishes the spike in the lifetime at resonance. These features are detectable experimentally, and the findings here suggest a new route to detect dynamical EEI in nanostructures.

Presenter: Guoping Zhang, Indiana State University
Poster Title: Nanoscience education: Curriculum / Course Development

With support from National Science Foundation (NSF), we have developed a nanoscience course for the first time at Indiana State University. We have written and published a book. We have taught this course twice. Here we will show what worked and what did not. One big challenge is that we need additional support to acquire some demonstrable facilities. This will help not only students to learn nanoscience but also reach the public in a broader scope.

Presenter: John Zhang, The University of Texas at Austin
Poster Title: Interactive Web-based Multi-scale Engineering Education on Micro-Nano Biomedical Devices

We started the development of an interactive and animated website to describe and teach scaling effects across multiple physical disciplines with focus on Micro and Nano biomedical device physics and applications. In addition to lecture notes and power point slide shows, the site features the multimedia presentations and videos of principles of micro and nano devices, materials and processes over disparate time and length scales. Through the modular 'knowledge nodes', we expect to help the undergraduate students and the general public better understand why, in some cases, it makes sense to miniaturize a device for reasons beyond economics, volume, and weight. There are two parts in the project. Part I: we will deal with the development of enhanced web-based visual learning portal using Flash animation, video streaming and audio/text annotations). Part II: we will select representative research projects, and present them online using JavaScript 3D tools. We expect that the success of this program will greatly enhance this inter-institutional teaching effort to cover broad applications using nanotechnologies for imaging and therapy in medicines. The technological platform will be readily extendable to other engineering classes in the broad areas of advanced material, product design and fabrication at disparate scales, and multiscale simulations.

Appendix 5: Biographies of Speakers & Panelists

Speakers:

Dr. Mihail C. Roco

Senior Advisor for Nanotechnology, National Science Foundation Chair, U.S. National Science, Engineering and Technology Council's Subcommittee on Nanoscale Science, Engineering and Technology (NSET).

Dr. Roco chairs the National Science and Technology Council's subcommittee on Nanoscale Science, Engineering and Technology (NSET), and is Senior Advisor for Nanotechnology at the National Science Foundation. He also coordinates the programs on academic liaison with industry (GOALI). Prior to joining National Science Foundation, he was Professor of Mechanical Engineering at the University of Kentucky (1981-1995), and held visiting professorships at the California Institute of Technology (1988-89), Johns Hopkins University (1993-1995), Tohoku University (1989), and Delft University of Technology (1997-98).

Dr. Roco is credited with 13 inventions, has authored/co-authored numerous archival articles and twelve books including Slurry Flow: Theory and Practice (Butterworth, 1991), "Particulate Two-phase Flow" (Butterworth, 1993), "Nanostructure Science and Technology" (Kluwer Acad., 1999), Societal Implications of Nanoscience and Nanotechnology (Kluwer Acad., 2001), Converging Technologies for Improving Human Performance(Kluwer Acad., 2003) and The Coevolution of Human Potential and Converging Technologies: (N.Y. Acad. of Sciences, 2004). He is a key architect of the National Nanotechnology Initiative, and coordinated the preparation of the U.S. National Science and Technology Council reports on "Nanotechnology Research Directions" (NSTC, 1999) and "National Nanotechnology Initiative" (NSTC, 2000).

Dr. Roco is a Correspondent Member of the Swiss Academy of Engineering Sciences, a Fellow of the American Society of Mechanical Engineers, a Fellow of the Institute of Physics, and a Fellow of the American Institute of Chemical Engineers. He has been co-founder and Chair of the AIChE Particle Technology Forum and of the International Multiphase Flow Council. He has served as editor for Journal of Fluids Engineering and Journal of Measurement Science and Technology, and is Editor-in-chief of the Journal of Nanoparticle Research. He is member in the Executive Governance Board for SNL-LANL, Review Board for National Research Council Institute (Canada) and other boards in Europe and Asia including the S&T Council of the International Risk Governance Council. He was honored as recipient of the Carl Duisberg Award in Germany, “Burgers Professorship Award" in Netherlands and the University Research Professorship award in U.S., the "Engineer of the Year" (two times, in 1999 and 2004) by the U.S. National Society of Professional Engineers and NSF, “Best of Small Tech Awards" ("Leader of the American nanotech revolution", 2002), and "First in Nanotechnology's Power Brokers", Forbes (Leading Architect of NNI).

Prof. Frank F. S. Shieu

Director, Program Office of National Nanotechnology Human Resource Development, Taiwan
Distinguished Professor, Department of Materials Science & Engineering, National Chung Hsing University, Taiwan.

Prof. Shieu received his B. S. in Materials Science & Engineering from National Tsing Hua University, Taiwan, in 1981 and his Ph. D. in Materials Science & Engineering from Cornell University in 1990. As a professor in the Department of Materials Science & Engineering, he also serves as the director of the Division of Materials Science & Engineering, National Science Council, Taiwan. His research interests include thin films and coating technology, electron microscopy, nanomaterials and functional materials with emphasis on transparent conducting oxides and membrane electrode assembly for fuel cells. In addition to materials research and education, he has actively involved in nano-education for K-12 teachers and students in central Taiwan since 2003. He is appointed as the director of the National Nanotechnology Human Resource Development program in January, 2008. By this program and team efforts, Taiwan has been recognized as a leading country in K-12 nano-education in the world.

Christophe Vieu

Professor, Department of Physics, the National Institute of Applied Sciences (INSA), an Enginnering School of Toulouse.

Prof. Christophe Vieu is heading a research group dedicated to Nanobiotechnologies in the Laboratory of Architecture and Analysis of Systems (LAAS) of CNRS organisation. Main field of interests are: Nanopatterning, Biopatterning, Nanoscale devices and tools for biodetection and medecine, education in Nanotechnologies. He is also responsible for a bio-nano-technological platform of the Institute of Advanced Technologies for Life Sciences (ITAV), recently created at Toulouse close to the Canceropole.

Nathalie Panissal

Doctor, Cognitive Psychology, Senior lecturer, the University of Toulouse.

Dr. Nathalie Panissal is involved in the training of school educators. She develops a research in education sciences in the Laboratoire Jacques Lordat, an interdisciplinary research unit in cognitive sciences. Her main fields of interest are: Didactics of science, technology and French language.

Panelists:

Lynn A. Bryan

Professor, Science Education, Purdue University.

Lynn A. Bryan is a Professor of Science Education at Purdue University. After obtaining her Ph.D. at Purdue University in 1997, she joined the faculty in the Department of Science Education at the University of Georgia. In 2005, she returned to Purdue where she now holds a joint appointment in the Department of Curriculum and Instruction and the Department of Physics. Professor Bryan is Co-Director of the Professional Development Program for the National Center for Learning and Teaching Nanoscience and Engineering. This program currently is offered at seven universities around the U.S. , and aims to provide science teachers with the knowledge, skills, and resources for infusing nanoscience and engineering in grades 7-12 science curricula. Professor Bryan has been recognized for her scholarship in science teacher education at the international, national, and local levels, including being named a Purdue University Faculty Scholar in 2007. She is currently Co-Editor-in-Chief for the Journal of Science Teacher Education and a member of the Executive Board of the National Association for

Research in Science Teaching. She is an internationally recognized science educator who has conducted research, teaching, and engagement activities in numerous countries including China, Mexico, Honduras, Japan, and the Philippines.

Michael A. De Miranda, Ph.D.

Professor, Engineering Education in the School of Education and College of Engineering, Colorado State University.

Michael De Miranda's expertise in engineering and technology education focuses in the areas related to curriculum selection and use of cognitively-based instructional strategies, materials, and activities that support the integration of science, technology, engineering, and mathematics (STEM) in K-12 classrooms. In addition to serving as an international consultant and workshop provider in over 9 different countries, Professor De Miranda has made numerous presentations at regional national, and international conferences.

Luis Fuentes

Senior Researcher, Advanced Materials Research Center, Chihuahua, Mexico.

Luis Fuentes is a Senior Researcher of the Advanced Materials Research Center, Chihuahua, Mexico. Fuentes obtained his PhD from Havana University in 1982 and performed Post Doc studies at the Joint Institute of Nuclear Research, Dubna, Russia. His research field is Crystal Physics, where he has published a hundred referred papers. Science Education activity of Fuentes has been focused on Electromagnetism and Crystallography, where he has written four books and tutored seven PhD theses. For approximately twenty years, he has guided high-school teachers training. During the last five years his main project has been the introduction of Prof. Chang's Materials World Modules (MWM) Program in Mexico. Some thousands of students and a couple of hundreds of teachers from about 10 Mexican cities participate today in the MWM Project. Presently, MWM Nanotechnology Module is being adapted to Spanish-speaking students by Fuentes group.

James Hone

Department of Mechanical Engineering and NSEC, Columbia University.

James Hone is currently Associate Professor of Mechanical Engineering at Columbia University . He received his PhD in experimental condensed matter physics from UC Berkeley in 1998, and did postdoctoral work at the University of Pennsylvania and Caltech, where he was a Millikan Fellow. He joined the Columbia faculty in 2003. His current research interests include, synthesis, characterization, manipulation, and applications of carbon nanotubes; graphene; nanomechanical devices; and nano-biology.

Tadashi Itoh, Ph.D

Professor, Division of Frontier Material Science, the Graduate School of Engineering Science
Osaka University.

Tadashi Itoh is specialized in experimental research works on laser spectroscopy of nano-structured materials. He is also the vice director of the organization for the promotion of research on nanoscience and nanotechnology which offers the graduate programs for Master and PhD courses and also for refresher course for more than four years. As the preparation of the second renewal stage of these programs, he organized mini symposium for nanoscience education and research training. He opened the joint MSC program with Vietnamese institutions and also held a short-term training program at the Nano-Laboratory in Osaka.

Joseph S. Krajcik

Professor, Science Education and Associate Dean for Research in the School of Education
the University of Michigan.

Joseph S. Krajcik, a Professor of Science Education and Associate Dean for Research in the School of Education at the University of Michigan, works with teachers in science classrooms to bring about sustained change by creating classroom environments in which students find solutions to important intellectual questions that subsume essential learning goals and use learning technologies as productivity tools. He seeks to discover the depth of student learning in such environments, as well as to explore and find solutions to challenges that teachers face in enacting such complex instruction. In collaboration with colleagues from Northwestern University , American Association of Science, and Michigan State , Joe, through funding from the NSF, is a principle investigator in a materials development project that aims to design, develop and test the next generation of middle school curriculum materials to engage students in obtaining deep understandings of science content and practices. Professor Krajcik has authored and co-authored over 100 manuscripts and makes frequent presentations at international, national and regional conferences that focus on his research as well as presentations that translate research findings into classroom practice. He is a fellow of the American Association for the Advancement of Science and served as president of the National Association for Research in Science Teaching in 1999. Joe co-directs the IDEA Institute and Center for Highly Interactive Classrooms, Curriculum and Computing in Education (hi-ce) at the University of Michigan and is a co-principle investigator in the National Center for Learning and Teaching Nanoscale Science and Engineering. In 2002, Professor Krajcik was honored to receive a Guest Professorship from Beijing Normal University in Beijing , China . In winter 2005, Joe was the Weston Visiting Professor of Science Education at the Weizmann Institute of Science in Rehovot , Israel . Before obtaining his Ph.D. in Science Education, Joe taught high school chemistry for seven years in Milwaukee , Wisconsin . He received a Ph.D. in Science Education from the University of Iowa in 1986. His home page is located at: http://www.umich.edu/~krajcik . His project web sites include: http://hice.org and http://hice.org/IQWST .

Frances P. Lawrenz

Psychological foundations and quantitative methods in education, Associate vice president for research, University of Minnesota.

Dr. Lawrenz is the Associate Vice President for Research at the University of Minnesota and the Wallace Professor of Teaching and Learning in Department of Educational Psychology at the University. She has served as Assistant Vice President for Research and Associate Dean of the Graduate School at the University of Minnesota, as Associate Dean for Research in the College of Education and Human Development, as Department Chair of Educational Psychology, as a Fulbright Scholar at the University of

the Western Cape in South Africa, and as senior evaluation and science education specialist at the National Science Foundation. She has numerous publications including 90 refereed publications, 29 monographs/ chapters, four curriculum projects and 175 evaluation reports. She presently is working on five funded evaluation projects.

Sebastian Lourdudoss

Professor, Semiconductor Materials School of Information and Communication Technology KTH, Sweden.

Sebastian Lourdudoss gained his M.Sc. degree in chemistry from Madras University, India in 1976 and Ph.D. degree in physical chemistry from Faculté Libre des Sciences, Lille, France in 1979. From 1980-85 he was working at KTH, Sweden, on physico-chemical aspects of thermochemical energy storage and chemical absorption heat pumps. From 1985-93, he was with Swedish Institute of Microelectronics, Kista, Sweden where he developed vapour phase epitaxial and other processing techniques for III-V semiconductor based devices for photonic applications. In 1993, he moved back to KTH, where he is currently a professor and head of the department of Laboratory of semiconductor materials. His current interests are monolithic photonic integration on InP and III-V's on Si for nanophotonics and optical interconnects. He is a director of graduate education at KTH and also the director of the graduate school within the national excellence centre, Linné Centre for optics and photonics at KTH. He is responsible as the workpackage leader for education and training within the European network of excellence, PhOREMOST (Nanophotonics to realise molecular scale technologies) comprising of 34 institutions from 17 countries. He has published over 185 articles in international journals and conference proceedings.

Teri W. Odom

Associate Professor and Dow Chemical Company Research Professor, Department of Chemistry and Materials Science and Engineering, Northwestern University.

Teri W. Odom received her B.S. degree from Stanford University in 1996 and her Ph.D. from Harvard University in 2001. She joined Northwestern in 2002 and was the inaugural recipient of the Dow Teacher-Scholar Award. Odom has received a Research Innovation Award (Research Corporation, 2002), the Victor K. LaMer Award (ACS Surface Science and Colloids, 2003), and the National Science Foundation's CAREER Award (2004). She was also named as one of MIT Technology Review's Top 100 Innovators in 2004. Odom is a David and Lucile Packard Fellow (2003), an Alfred P. Sloan Fellow (2005), and a Cottrell Scholar of Research Corporation (2005). In 2006, she was awarded the ExxonMobil Solid State Chemistry Faculty Fellowship, and in 2007, she was awarded the Rohm and Haas New Faculty Award. Odom 's research focuses on controlling materials at the 100-nm scale and investigating their size and shape-dependent properties. Specifically, she has developed multi-scale nanoscale patterning tools that can generate new types of noble metal (plasmonic) structures that can manipulate light at the nanoscale. In addition, she has pioneered a new area called chemical nanofabrication, which combines chemistry and fabrication to assemble functional nanomaterials.

Jim W. Pellegrino

Liberal Arts and Sciences Distinguished Professor and Distinguished Professor of Education, the University of Illinois at Chicago.

James W. Pellegrino is Liberal Arts and Sciences Distinguished Professor and Distinguished Professor of Education at the University of Illinois at Chicago. He also serves as Co-director of UIC's interdisciplinary Learning Sciences Research Institute. Dr. Pellegrino's research and development interests focus on children's and adult's thinking and learning and the implications of cognitive research and theory for assessment and instructional practice. Much of his current work is focused on analyses of complex learning and instructional environments, including those incorporating powerful information technology tools, with the goal of better understanding the nature of student learning and the conditions that enhance deep understanding. A special concern of his research is the incorporation of effective formative assessment practices, assisted by technology, to maximize student learning and understanding. He has authored or co-authored over 250 books, chapters, journal articles, and reports in the areas of cognition, instruction and assessment and has made numerous invited presentations at local, state, national and international meetings and at universities throughout the world. Dr. Pellegrino's unique blend of expertise which combines knowledge of cognitive science, psychometrics, educational technology, instructional practice, and educational policy has led to appointment as head of several National Academy of Science/National Research Council study committees. These include chair of the Study Committee for the Evaluation of the National and State Assessments of Educational Progress, co-chair of the NRC/NAS Study Committee on Learning Research and Educational Practice, and co-chair of the NRC/NAS Study Committee on the Foundations of Assessment which issued the report Knowing What Students Know: The Science and Design of Educational Assessment. He was a member of the NRC/NAS/NAE Study Committee on Improving Learning with Information Technology and chaired the NRC/NAS Panel on Research on Learning and Instruction for the Strategic Education Research Partnership. Most recently he completed service as a member of the NRC/NAS Study Committee on Test Design for K-12 Science Achievement. He is a lifetime National Associate of the National Academy of Sciences and a member of the Board on Testing and Assessment of the National Research Council. He was recently elected to lifetime membership in the National Academy of Education.

John D. Ristvey, Jr.

Principal Consultant, Education and Public Outreach, Mid-continent Research for Education and Learning (McREL).

John D. Ristvey, Jr. Manages Mid-continent Research for Education and Learning (McREL)'s education and public outreach (E / PO) team. He specializes in technical and science education expertise, instructional materials design, and professional development. Mr. Ristvey holds an M.S. in Secondary Science Education from the University of Houston-Clear Lake, Texas and a B.S. in Biology from Grove City College, Pennsylvania along with certifications in teaching secondary science. A Principal Consultant at McREL, he is responsible for managing the work and resources of multiple contracts including education and public outreach for NASA's Dawn mission with UCLA, EPOXI mission with University of Maryland, and Stardust/NEXT mission with the Jet Propulsion Laboratory. He has also managed contracts for Marshall Space Flight Center, Disney Educational Productions, and the ABC News Classroom Edition. Mr. Ristvey is currently the PI for a National Science Foundation-funded instructional materials development project, A NanoLeap into New Science (# ESI-0426401), which is translating current nanoscale science and technology research into content appropriate for high school students.

Linda S. Schadler

Professor, Materials Science and Engineering Department, Rensselaer Polytechnic Institute.

Dr. Linda S. Schadler joined Rensselaer Polytechnic Institute in 1996 and is currently a full Professor in Materials Science and Engineering. She graduated from Cornell University in 1985 with a B.S. in materials science and engineering and received a PhD in materials science and engineering in 1990 from the University of Pennsylvania. After two years of post-doctoral work at IBM Yorktown Heights, Schadler served as a faculty member at Drexel University in Philadelphia, PA before coming to Rensselaer.

Martin Schubert

Managing Director, Competence Center cc-NanoChem e. V. (Germany).

Dr. Martin Schubert studied physics in Frankfurt am Main and went to Leipzig in 1996 to do his doctorate in solid-state-physics within a research program called Phenomena at Miniaturization Limits. Meanwhile he built up a spin-off company for ultrasonic measurement devices. In 2001 he changed the branch and become a managing director of a school for vocational and advanced training. In the middle of 2004 Dr. Schubert went to Saarbr ue cken to the INM - Leibniz Institute for New Materials which is the most famous nanotechnology institute in Germany. Within the INM he is responsible for the nanotechnology competence center cc-NanoChem which was initiated by the German federal ministry of eductaion and research in 1999. cc-NanoChem was led over to a non-profit association in 2006.

Appendix 6: Breakout Session Participants

Breakout Session I: Engagement of Students, Teachers and General Public

Groups 1: Nano Research & Concepts Integrate at pre-college level

- Kristy Brumfield, Louisiana State University
- Susan Kowalski, BSCS (Biological Sciences Curriculum Study)
- Carolyn Nichol, Rice University
- Matthew Hsu, Northwestern University
- Lynn Bryan, Purdue University
- Shelley Lee, Wisconsin Department of Public Instruction
- Otto Wilson, Catholic University of America
- Tina Stanford, SRI International
- Julia Cothron, MathScience Innovation Center
- John Ristvey, Mid-Continent Research for Education and Learning
- Polly Kroha, Nano-CEMMS, University of Illinois at Urbana-Champaign
- Michael Carpenter, University at Albany, College of Nanoscale Science and Engineering

Groups 2: Nano Research & Concepts Integrate at pre-college level

- Nathaniel Cady, College of Nanoscale Science & Engineering, University at Albany
- Nathalie Panissal, University of Toulouse
- Christophe VIEU, INSA Toulouse
- Andrea Harmer, Lehigh University
- Ethan Allen, University of Washington

- George Kiriakidis, University of Crete and IESL/FORTH, Greece
- Richard Braatz, University of Illinois/Urbana-Champaign
- Joseph Krajcik, University of Michigan
- Megan O'Sullivan, MRI at Northwestern University
- Jill Robinson, Indiana University
- Lyle Schwartz, U. Maryland

Groups 3: Nano Research & Concepts Integrate at college level & above

- Ana-Rita Mayol, Institute of Functional Nanomaterials, University of Puerto Rico
- David McIlroy, University of Idaho
- Philip Lippel, National Nanotechnology Coordination Office
- Monica Plisch, American Physical Society
- Jeffrey Simpson, Towson University
- Matthew Edwards, Alabama A&M University
- Gregory Light, Northwestern University
- Emily Weiss, Northwestern University
- Sinead Kennedy, Catalan Institute of Nanotechnology
- Nebojsa Jaksic, Colorado State University - Pueblo
- Zi Kang Tang, Hong Kong University of Science and Technology
- Robert Ehrmann, Penn State Center for Nanotechnology Education & Utilization

Groups 4: Nano Research & Concepts Integrate at college level & above

- Rene Overney, University of Washington
- Guoping Zhang, Indiana State University
- Kasif Teker, Frostburg State University
- Lisa Klein, Rutgers University
- Vesselin Shanov, University of Cincinnati
- Hamid Ghandehari, University of Utah
- Laura Bartolo, Kent State University
- Mary Anne White, Dalhousie University
- Ron Naaman, Weizmann Institute
- Tom Mason, Northwestern University
- Mehmet Sarikaya, University of Washington
- Liangti Qu, University of Dayton

Groups 5: International Perspectives – pre-college and college Programs and Projects

- Mary Hobbs, MathScience Innovation Center
- Fuh-Sheng Shieu, National Chung Hsing University
- Maria Elena Montero Cabrera, Centro de Investigacion en Materiales Avanzados (Advanced Materials Research Center)
- Mohammad Islam, American University of Sharjah
- Martin Schubert, cc-NanoChem e. V. - Competence Center Chemical Nanotechnology for New Materials
- Luis Fuentes-Cobas, Centro de InvestigaciÃ³n en Materiales Avanzados
- Zhen Chen, University of Missouri
- Heather Evans, National Nanotechnology Coordination Office

- B. Ramakrishna, Arizona State University
- Jennifer Shanahan, Materials Research Institute, Northwestern University
- James Hone, Columbia University
- Teri Odom, Northwestern University

Groups 6: International Perspectives – pre-college and college Programs and Projects

- Manuel Gomez, Institute of Functional Nanomaterials, University of Puerto Rico
- Robert Chang, Northwestern University
- Kim Pacheco, University of Northern Colorado
- Abdou Lachgar, Wake Forest University
- John Zhang, The University of Texas at Austin
- Melinda Wong, Northwestern University
- Aldrin Sweeney, University of Central Florida
- Heh-Nan Lin, National Tsing Hua University
- Shadi Shahedipour-Sandvik, UAlbany-State University of New York
- Su-Seng Pang, Louisiana State University
- Jean-Marie Mayas, The MayaTech Corporation

Groups 7: Informal Education & General Public Outreach

- Carol Lynn Alpert, Museum of Science, Boston
- Marilyn Johnson, Oregon Museum of Science and Industry
- Amy Brunner, Penn State University
- Margaret Glass, Association of Science-Technology Centers
- Rae Ostman, Sciencenter
- Brian Augustine, James Madison University
- James Murday, University of Southern California
- Eileen Sheu, University of Chicago Materials Research Center
- Murray Norton, Washington State University
- Vance Ablott, Triangle Coalition for Science and Technology Education
- Kimberly Duncan, University of Wisconsin-Madison Materials Research Science and Engineering Center
- Dyneisha Herbert-Felder, The MayaTech Corporation
- Alexander Fiorentino, Museum of Science, Boston

Groups 8: Informal Education & General Public Outreach

- Juana Moreno, Louisiana State University
- Kate Duckworth, Exploratorium
- Karen Pollard, Science Museum of Minnesota
- Nicholas Giordano, Purdue University
- Eric Marshall, New York Hall of Science
- Brenda Lopez Silva, University of Illinois at Chicago
- Larry Bell, Museum of Science, Boston
- Paul Martin, Science Museum of Minnesota
- Margaret Kroto, None - freelance
- Elory Rozner, Museum of Science and Industry
- Deb Ovenden, The SPECTRUM Group

- Robert Semper, Exploratorium
- Olivia Castellini, Museum of Science and Industry

Group 9: Education Research/Assessment Practices/Evaluation – pre-college including general public

- Julie Nucci, Center for Nanoscale Systems, CNS Institute for Physics Teachers
- Seng-tiong Ho, Northwestern University
- April Hill, Penn State University Center for Nanoscale Science
- Eric Hagedorn, UTEP
- Elisabeth Palmer, ASPEN Associates, Inc.
- LeRoy Lee, Wisconsin Science Network
- Harold Kroto, The Florida State University
- Christine Morrow, University of Colorado/Boulder
- Michael De Miranda, Colorado State University
- Christine Reich, Museum of Science, Boston
- Zuleika Medina Torres, Penn State
- Frances Lawrenz, University of Minnesota
- Andrew Greenberg, University of Wisconsin/Madison
- Thomas Moher, University of Illinois/Chicago
- Kevin Conley, Forsyth Technical Community College

Group 10: Education Research/Assessment Practices/Evaluation – college level

- Kristin Black, Center on Polymer Interfaces and Macromolecular Assemblies
- Denise Drane, Searle Center for Teaching Excellence
- Sarah Dugan, Northwestern University
- Jim Pellegrino, University of Illinois/Chicago
- Tadashi Itoh, Division of Frontier Materials Science, Graduate School of Engineering Science, Osaka
- University
- Krish Mathur, U.S. Department of Education
- Richard Matyi, College of Nanoscale Science and Engineering, University at Albany
- John D'Agati, University at Albany, College of Nanoscale Science and Engineering
- Bartlett Sheinberg, Houston Community College District
- Julie Dillemuth, Center for Nanotechnology in Society, University of California Santa Barbara
- Sebastian Lourdudoss, Royal Institute of Technology
- Hanjo Lim, Department of Electrical & Computer Engineering, Ajou University

Breakout Session II: Best Practices Curriculum/Course Development/Outreach to General Public

Groups 1: Informal Education & Community Outreach

- Philip Lippel, National Nanotechnology CoordinationOffice
- Kate Duckworth, Exploratorium
- Karen Pollard, Science Museum of Minnesota
- April Hill, Penn State University Center for Nanoscale Science
- Brenda Lopez Silva, University of Illinois at Chicago
- Alexander Fiorentino, Museum of Science, Boston
- Murray Norton, Washington State University

- Margaret Kroto, None - freelance
- Harold Kroto, The Florida State University
- Robert Westervelt, Harvard University
- Larry Bell, Museum of Science, Boston
- Jill Robinson, Indiana University

Groups 2: Informal Education & Community Outreach

- Marilyn Johnson, Oregon Museum of Science and Industry
- Amy Brunner, Penn State University
- Christine Reich, Museum of Science, Boston
- Martin Schubert, cc-NanoChem e. V. - Competence Center Chemical Nanotechnology for New Materials
- Nathaniel Cady, College of Nanoscale Science & Engineering, University at Albany
- Julie Dillemuth, Center for Nanotechnology in Society, University of California Santa Barbara
- Zuleika Medina Torres, Penn State
- Kimberly Duncan, University of Wisconsin-Madison Materials Research Science and Engineering Center
- Elory Rozner, Museum of Science and Industry
- Eileen Sheu, University of Chicago Materials Research Center
- Ana-Rita Mayol, Institute of Functional Nanomaterials, University of Puerto Rico
- Paul Martin, Science Museum of Minnesota

Groups 3: Professional Development

- LeRoy Lee, Wisconsin Science Network
- Christine Morrow, University of Colorado/Boulder
- Tina Stanford, SRI International
- Joseph Krajcik, University of Michigan
- Carolyn Nichol, Rice University
- Deb Ovenden, The SPECTRUM Group
- Rae Ostman, Sciencenter
- Nebojsa Jaksic, Colorado State University - Pueblo
- Andrea Harmer, Lehigh University
- Seng-tiong Ho, Northwestern University
- Nicholas Giordano, Purdue University
- Liangti Qu, University of Dayton

Groups 4: Professional Development

- John Zhang, The University of Texas at Austin
- Gregory Light, Northwestern University
- Elisabeth Palmer, ASPEN Associates, Inc.
- Lynn Bryan, Purdue University
- Julia Cothron, MathScience Innovation Center
- John Ristvey, Mid-Continent Research for Education and Learning
- Mohammad Islam, American University of Sharjah
- Matthew Hsu, Northwestern University
- Vance Ablott, Triangle Coalition for Science and Technology Education

- Jean-Marie Mayas, The MayaTech Corporation
- Zi Kang Tang, Hong Kong University of Science and Technology

Groups 5: Pre-College Curriculum

- Kristy Brumfield, Louisiana State University
- Julie Nucci, Center for Nanoscale Systems, CNS Institute for Physics Teachers
- Susan Kowalski, BSCS (Biological Sciences Curriculum Study)
- Eric Hagedorn, UTEP
- Manuel Gomez, Institute of Functional Nanomaterials, University of Puerto Rico
- Shelley Lee, Wisconsin Department of Public Instruction
- Nathalie Panissal, University of Toulouse
- Mary Hobbs, MathScience Innovation Center
- Linda Schadler, Rensselaer Polytechnic Institute
- Jim Pellegrino, University of Illinois/Chicago
- B. Ramakrishna, Arizona State University
- Lyle Schwartz, U. Maryland

Groups 6: Pre-College Curriculum

- Krish Mathur, U.S. Department of Education
- Michael De Miranda, Colorado State University
- Christophe Vieu, INSA Toulouse
- James Murday, University of Southern California
- Luis Fuentes-Cobas, Centro de InvestigaciÃ³n en Materiales Avanzados
- Bartlett Sheinberg, Houston Community College District
- Jennifer Shanahan, Materials Research Institute, Northwestern University
- Frances Lawrenz, University of Minnesota
- Mary Anne White, Dalhousie University
- Thomas Moher, University of Illinois/Chicago
- Richard Braatz, University of Illinois/Urbana-Champaign
- Polly Kroha, Nano-CEMMS, University of Illinois at Urbana-Champaign
- Robert Chang, Northwestern University

Groups 7: College Curriculum

- David McIlroy, University of Idaho
- Juana Moreno, Louisiana State University
- Denise Drane, Searle Center for Teaching Excellence
- Fuh-Sheng Shieu, National Chung Hsing University
- Otto Wilson, Catholic University of America
- Teri Odom, Northwestern University
- Kim Pacheco, University of Northern Colorado
- Robert Ehrmann, Penn State Center for Nanotechnology Education & Utilization
- Aldrin Sweeney, University of Central Florida
- Richard Matyi, College of Nanoscale Science and Engineering, University at Albany
- Michael Carpenter, University at Albany, College of Nanoscale Science and Engineering
- Brian Augustine, James Madison University

Groups 8: College Curriculum

- Abdou Lachgar, Wake Forest University
- Rene Overney, University of Washington
- Kasif Teker, Frostburg State University
- John D'Agati, University at Albany, College of Nanoscale Science and Engineering
- Lisa Klein, Rutgers University
- Vesselin Shanov, University of Cincinnati
- Ron Naaman, Weizmann Institute
- Zhen Chen, University of Missouri
- Tom Mason, Northwestern University
- Shadi Shahedipour-Sandvik, UAlbany-State University of New York
- Mehmet Sarikaya, University of Washington
- Sarah Dugan, Northwestern University
- Emily Weiss, Northwestern University

Groups 9: Networking & Collaborations

- Melinda Wong, Northwestern University
- Kevin Conley, Forsyth Technical Community College
- Hamid Ghandehari, University of Utah
- Matthew Edwards, Alabama A&M University
- Kristin Black, Center on Polymer Interfaces and Macromolecular Assemblies
- Eric Marshall, New York Hall of Science
- Sinead Kennedy, Catalan Institute of Nanotechnology
- Tadashi Itoh, Division of Frontier Materials Science, Graduate School of Engineering Science, Osaka University
- Robert Semper, Exploratorium
- Su-Seng Pang, Louisiana State University
- Dyneisha Herbert-Felder, The MayaTech Corporation

Groups 10: Networking & Collaborations

- Maria Elena Montero Cabrera, Centro de Investigacion en Materiales Avanzados (Advanced Materials Research Center)
- Carol Lynn Alpert, Museum of Science, Boston
- Margaret Glass, Association of Science-Technology Centers
- Guoping Zhang, Indiana State University
- Sebastian Lourdudoss, Royal Institute of Technology
- Hanjo Lim, Department of Electrical & Computer Engineering, Ajou University
- Laura Bartolo, Kent State University
- Ethan Allen, University of Washington
- George Kiriakidis, University of Crete and IESL/FORTH, Greece
- Megan O'Sullivan, MRI at Northwestern University
- Heh-Nan Lin, National Tsing Hua University
- Heather Evans, National Nanotechnology Coordination Office