TESTIMONY

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Hearing on Nanotechnology Education

Chairman Baird, Ranking Member Ehlers, and distinguished members of the Subcommittee, thank you for the opportunity to describe National Science Foundation (NSF) education programs based on nanoscale science, engineering, and technology.

The NSF invests in a comprehensive set of programs in formal and informal nanoscale science and engineering education (NSEE). Overall, these programs seek to address the "Learning" goal in the NSF FY 2006-2011 Strategic Plan *(Investing in America's Future*[1]), which is to cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens. In addition, the programs seek to increase understanding through research and evaluation of effective learning and teaching about nanoscience and technology. Thus, they also address the "Discovery" goal to foster research that will advance the frontiers of knowledge. These investments contribute to the National Nanotechnology Initiative (NNI) Societal Dimensions Program Component Area subtopic: Education-related activities such as development of materials for K-12 schools, undergraduate programs, technical training, learning in informal settings, and public outreach (PCA 7[2]).

Background

[1] National Science Foundation Investing in America's Future: Strategic Plan FY 2006-2011. http://www.nsf.gov/strategicplan; last accessed 09/24/2007.

[2] The National Nanotechnology Initiative: Research and Development Leading to a Revolution in Technology and Industry. Supplement to the President's 2007 Budget. July 2006. p. 25. http://www.nano.gov/NNI_07Budget.pdf; last accessed 09/24/2007.

The NSF investment in NSEE is important for several reasons. Nanotechnology is an emerging field with enormous potential economic impact and implications for preparing our future workforce. In addition, NSEE opens new prospects for teaching and learning science and technology . It is inherently inter-disciplinary, drawing from physics, chemistry, biology, engineering, and other fields. It focuses on a size range (one to 100 nanometers) intermediate between the atomic and macroscopic scale that heretofore has been less studied and taught, yet involves new materials exhibiting unique and useful properties. As a result, nanotechnology offers a nearly limitless range of interesting applications that will likely impact our lives and society. For this reason, an informed public is essential. NSEE fits into the larger picture of improving science and engineering education and literacy by providing a vehicle for engaging learners in current research and the ongoing process of discovery.

NSEE also presents challenges. The concept of scale, particularly outside the realm of our everyday experience, is difficult to grasp. Content drawn from nanoscale science and engineering (NSE) is abstract, complex, and involves quantum effects that are also challenging to understand. Like other areas of current science and technology, the body of knowledge constantly changes as new discoveries are made daily around the world. From an instructional standpoint, NSE content is not a part of the mainstream K-12 curriculum. Because they were developed a decade ago, the National Science Education Standards make no mention of NSE. Widely used and tested NSE curricula do not yet exist, and it is difficult to add new content to existing overcrowded curricula, state standards, assessments, and textbooks. There is limited educational research and evaluation about learning and teaching in this area.

This context has guided NSF program development in NSEE. The NSF investment for NSEE awards in FY 2007 was $28 million, out of a total NSF NNI investment of $373 million. The educational investments are made by the Directorate for Education and Human Resources, of which I am part, as well as by the Directorates for Research and Related Activities. Like other NSF education programs, the NSEE programs seek to target nearly all audiences, from young learners to older adults, through a wide range of educational activities. They 1) develop and research instructional resources for students in grades 7 -12 and their teachers; 2) develop and research undergraduate NSE programs; 3) promote public engagement and understanding through museum exhibits, programs, media, and web sites; 4) offer education and outreach programs in conjunction with NSE research centers; 5) incorporate NSEE within core programs, such as those that provide research experiences to teachers and students; and 6) study the impact of these educational efforts through research and evaluation. Awards are made based on proposals submitted to NSF and recommended through the merit review process.

I would like to highlight examples that demonstrate the range of audiences and activities addressed through these educational investments.

K-12 Nanoscale Science and Engineering Education

Students in grades 7 to 12 are a key audience for introducing NSEE because many are beginning to consider future careers. NSF has funded a flagship program to bridge formal education and NSE research through the *National Center for Learning and Teaching in Nanoscale Science and Engineering* (NCLT) at Northwestern University, in partnership with Purdue University, University of Michigan, University of Illinois at Chicago, and University of Illinois at Urbana-Champaign (with collaborating partners Alabama A & M University, Argonne National Laboratory, Fisk University, Hampton University, Morehouse College, University of Texas at El Paso, and several public school systems). The mission of NCLT is to develop the next generation of leaders in NSE teaching and learning, with an emphasis on capacity building. The work is organized around five themes: Learning Research and Development—developing, testing, and disseminating learning activities; Nanoconcept Research and Development—introducing the latest concepts into science and engineering courses; Higher Education— training faculty and developing undergraduate courses and programs; Professional Development for High School Teachers—training teachers in nanoscience/engineering concepts; and Evaluation. Additional information can be found at http://www.nclt.us

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David A. Ucko serves as Deputy Division Director for the Division of Research on Learning in Formal and Informal Settings at the National Science Foundation, where he was previously Section Head for Science Literacy and Program Director for Informal Science Education. Formerly, he served as Executive Director of the Koshland Science Museum at the National Academy of Sciences; founding President of Science City at Union Station and President of the Kansas City Museum; Chief Deputy Director of the California Museum of Science & Industry in Los Angeles; and Vice President for Programs at the Museum of Science & Industry in Chicago. Ucko was appointed by the President and confirmed by the Senate to the National Museum Services Board. He has chaired the Advocacy Committee and the Publications Committee of the Association of Science-Technology Centers. Prior to entering the museum field, he wrote two college chemistry textbooks while teaching at the City University of N.Y and at Antioch College in Ohio. Ucko is a Fellow of the American Association for the Advancement of Science and a Woodrow Wilson Fellow. He received his Ph.D. in inorganic chemistry from M.I.T. and B.A. from Columbia. E-mail: DUcko@nsf.gov.