Testimony before the U.S. House of Representatives Committee on Science and Technology Subcommittee on Research and Science Education

Federal STEM Education Programs: Educators' Perspectives

George D. Nelson, Western Washington University

May 15, 2007

Chairman Baird and members of the committee, it is a privilege to accept your invitation to participate in the hearing and provide my perspective on the STEM education programs of the federal mission agencies.

My primary perspective comes from my recent roles in STEM education reform as Directory of Science, Mathematics, and Technology Education at Western Washington University, and my previous position as Director of Project 2061 at the American Association for the Advancement of Science. I am also Principal Investigator of a targeted Mathematics and Science Partnership grant from NSF that brings together 28 regional school districts, Washington State LASER, three state community colleges, the Northwest Indian College, and Western Washington University in an effort to reform science education with a particular focus on improving K-16 science teacher preparation.

Personal experiences from previous positions have profoundly influenced my perspective towards STEM education and general education reform. I have worked as a research astrophysicist, flown three missions on the U.S. Space Shuttle as a NASA astronaut, served as Associate Vice Provost for Research at the University of Washington, and taught at all levels in higher education. I have spent considerable time thinking about and engaging in discussions with NASA and the Department of Energy about their K-12 education programs, and served on numerous advisory committees, commissions, and on boards of directors including the Pacific Science Center, the Art Institute of Seattle, and the Center for Occupational Research and Development (CORD). I am also the proud father of a dedicated and outspoken middle school mathematics and science teacher from Katy, Texas.

This testimony will focus on the role of the federal mission agencies, but it is always good to keep the big picture in mind. The American education system is enormous, with over 50 million students and 3.1 million teachers. Counting the critical role of STEM learning in the elementary grades, more than half of these teachers are responsible for teaching mathematics and science. The system is also decentralized, locally funded and governed, and subject to myriad regulations. Mr. Lach has provided a compelling picture of the Chicago system. There are 15,000 other districts in America, each with its own unique strengths and challenges.

Since the federal mission agencies depend so heavily on both a literate citizenry for continued support and STEM professionals at all levels to carry out their missions, it is in the interest of the agencies to contribute appropriately to achieving two STEM education goals: 1) universal math and science literacy and 2) significantly increasing the number and diversity of American students entering and successfully exiting the STEM pipeline.

I shall now address the committee's specific questions. To approach a model for how the federal mission agencies can contribute, it is reasonable to ask, what resources can the mission agencies focus on the two goals of literacy and workforce development? Here is my short list.

- A skilled and knowledgeable workforce of scientists, engineers, and technicians engaged in cutting edge science and technology development focused on missions critical to the country
- Research and technology partnerships with industry and universities
- World-class and unique laboratories and facilities
- Long-term funding

It is also important to ask, what resources do the mission agencies generally lack?

- Knowledge of the K-12 education system, how it is structured and regulated
- Internal expertise in education research, curriculum development, effective instruction, or teacher preparation

1. *In what ways can federal R&D mission agencies contribute most effectively to improve K-12 STEM education? Can you give examples of particularly effective programs?*

Taking advantage of their strengths, agency professionals can collaborate with appropriate education organizations and industry to develop and support Career Pathways for students in high schools and community colleges, for example in high need areas like photonics or nanotechnology. The agency can promote its mission through carefully designed, implemented, and evaluated technology education programs targeting the future workforce. These programs can take full advantage of the agency talent pool. The NSF Advanced Technology Education program has created some effective models at the community college level. Agencies could expand this work, help bring it into high school Career and Technical Education programs, and provide sustaining funding that is not available from NSF R&D programs.

Research scientists, engineers, and technicians can help museums or other informal education entities display and communicate—both in real- and cyberspace—the new science and technology that is coming out of the agencies to excite and inform students, parents, and voters. Additionally, the personal stories of STEM workers at all levels, including clear maps of the paths through school that qualify them for those jobs can help motivate students to enter the Career Pathways.

My current work includes exploring the preparation of effective new STEM teachers and helping current teachers improve their practice. This is not a part-time job, or one for the feint of heart. Agencies should encourage and provide incentives for their STEM retirees to become teachers, again making use of their talented workforce. They should also collaborate with excellent teacher preparation programs and support their rigorous evaluation. Poor preparation for entering the classroom results in ineffective instruction and low retention.

2. *At the undergraduate level, what type of support could the federal R&D mission agencies provide that would recruit more students into pursuing careers in the physical sciences?*

Agencies can support undergraduate, graduate, and postdoctoral students to engage in mission-related research, and then hire the best of them into meaningful jobs. They can support students on campuses to work with faculty engaged in mission-relevant research. They can also provide undergraduate and graduate students authentic research experiences in their centers and laboratories—again with the prospect of meaningful jobs. As a graduate student, I spent two invaluable stints at the Air Force Cambridge Research Laboratory solar observatory in Sunspot, New Mexico engaged in cutting edge research with world-class instruments.

The NASA Space Grant program in Washington State is a positive example. NASA funds support around 150 undergraduate students every year to engage in STEM research, mentored by faculty at institutions throughout the state, internships at companies or NASA centers, or participation on student design teams. Last year 100% of the Space Grant scholar graduates went on to STEM graduate work or employment. While the program keeps good statistics, it could benefit from a more sophisticated evaluation effort.

3. *How does the lack of coordination and overarching strategy for STEM education programs hinder the agencies from making an impact?*

There is a huge inventory of poorly designed and under-evaluated mission-related curricula (posters and lesson plans and associated professional development) rarely used in classrooms and with no natural home in a coherent standards-based curriculum. The constant barrage of new "resources" adds to the noise in the system and contributes to the "mile wide, inch deep" problem. Effective curriculum development requires a deep collaboration with a team of professional curriculum developers, education researchers, and classroom teachers.

In that light, I do have one positive example. I recently received a copy an astronomy curriculum for grades 3-5 that was developed collaboratively by NASA and the professional science educators and developers at the Lawrence Hall of Science and UC Berkeley. It is high quality and it fills a real need for instructional materials at this level. A collaborative curriculum development model such as this is rare. Adding a rigorous evaluation component to explore ho well the curriculum helps teachers teach and students learn could make it exemplary.

Summary
A focus on 1) partnering with high schools and community colleges along with appropriate education professionals and industry partners on mission-related technology education programs for the future technical workforce, and 2) supporting mission-related research for undergraduate and graduate students both in agency facilities and on university campuses could pay major dividends. This would require an achievable overarching strategy, but not necessarily significant coordination among the agencies. The critical collaboration would be with STEM education professionals (not just K-12 teachers), university faculty, and industry partners.

GEORGE D. NELSON

Biographical Sketch

Dr. George D. Nelson is the director of Science Mathematics, and Technology Education and professor of physics and astronomy at Western Washington University in Bellingham, Washington. The program is responsible for the preparation of future K-12 science, mathematics, and technology teachers. It is also a research and development center with a focus on teacher preparation and science, mathematics, and technology education reform. He is currently the principal investigator on a $12 million NSF project, the North Cascades and Olympic Science Partnership.

Prior to joining Western Washington University in 2002, Dr. Nelson was director of Project 2061 and a member of the senior staff of the American Association for the Advancement of Science. Project 2061 is engaged in the reform of science, mathematics, and technology education at all levels with a focus on helping to create a system where all high school graduates are literate in science, mathematics, and technology. Under Dr. Nelson's leadership Project 2061 produced a number of groundbreaking publications including *Blueprints for Reform, Designs for Science Literacy*, and the *Atlas of Science Literacy*. The project also developed unique and rigorous procedures for evaluating curriculum materials and assessments, and greatly expanded its professional development activities.

From 1989 to 1996 Dr. Nelson was associate vice provost for research and associate professor of astronomy and education at the University of Washington. His administrative responsibilities included research policy, government-university-industry interactions, university-K-12 education interactions, and federal relations. He taught graduate courses in stellar atmospheres and solar physics and undergraduate courses in general astronomy. In the college of education he taught an innovative seminar on science education for scientists, graduate students, and teachers using Project 2061 as the underlying foundation. During the 1992-93 academic year, Dr. Nelson was a fellow of the American Council on Education.

From 1978 to 1989 he served as a NASA astronaut and flew as a mission specialist aboard three space shuttle flights. These missions included the first on-orbit satellite repair in 1984. Dr. Nelson was the pilot of the first operational flight of the manned maneuvering unit and the primary extravehicular crewman. He also served on the crew of the flight of Discovery in September 1989 immediately following the loss of the Challenger and was extensively involved in the rework of all crew procedures and the re-engineering of space shuttle components and software. He has advised NASA through service on a number of committees, most recently as chair the Hubble Space Telescope Servicing Missions 3A and 3B External Independent Readiness Review Team.

Dr. Nelson has served on several boards of directors including the Art Institute of Seattle, Analytic Services Inc., and the Pacific Science Center. He received his B.S. in physics from Harvey Mudd College and M.S. and Ph.D. in astronomy from the University of Washington. His research interests include science education, education reform, and radiative transfer and hydrodynamics applied to interesting problems in astrophysics.

He lives in Bellingham with his wife, Susie. They have two grown daughters; Aimee Nelson-Engle and Marti Nelson-Frazier and three perfect grandsons, Pierce, Langston, and Andrew.

May 2007