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Federal STEM Education Programs: Educators' Perspectives

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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.