

**COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION
U.S. HOUSE OF REPRESENTATIVES**

HEARING CHARTER

Improving the Laboratory Experience for America's High School Students

Thursday, March 8, 2007
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

Purpose

On March 8, 2007 the Committee on Science and Technology will hold a hearing to receive testimony on the shortcomings of the use of laboratories in high school science education and to consider related legislation. H.R. 524 directs the National Science Foundation (NSF) to establish a pilot program of grants to partnerships of high schools and other institutions to identify best practices for improving the educational effectiveness of science laboratories. The bill is in response to the findings of the National Research Council's (NRC) 2005 report, *America's Lab Report: Investigations in High School Science*.

This hearing will discuss how issues like lack of coordination between the laboratory exercises and classroom lectures, inadequately trained teachers, languishing facilities, and current high school organization diminish the value these exercises can have or prohibit them all together. Most importantly, this hearing will highlight how a strong hands-on experience can create scientifically literate students, interested in pursuing a career in science.

Witnesses

Dr. Arthur Eisenkraft, Distinguished Professor of Science Education, Director of the Center of Science and Math in Context, University of Massachusetts, Boston, Graduate College of Education; co-author of *America's Lab Report: Investigations in High School Science*.

Mrs. Linda Froschauer, President, National Science Teachers Association.

Dr. Jerry Mundell, Adjunct Professor and General Chemistry Laboratory Manager, Department of Chemistry, Cleveland State University, Cleveland, Ohio

Overarching Questions

- How important is the laboratory experience in teaching students to understand

scientific concepts?

- What are the common obstacles for creating and maintaining laboratories and developing curriculum to teach laboratory experiences?
- Will H.R. 524 help address those obstacles and make lab instruction more accessible to all students?

Summary of National Research Council's *America's Lab Report: Investigations in High School Science*

In 2005 the National Research Council Published *America's Lab Report: Investigations in High School Science*, a study which looked at the role laboratory learning can have for the country's high school students, the current situation of laboratory learning, and what can be done to improve these often unproductive programs. The NSF commissioned this study as a precursor to fulfilling the mandate Congress gave the agency in the 2002 NSF Authorization Act (P.L. 107-368) to launch a secondary school systemic initiative, which would "promote scientific literacy" and "meet the mathematics and science needs for students at risk of not achieving State student academic achievement standards." Specifically, section 8(E) of the law required NSF to support programs for such activities as "laboratory improvement and provision of instrumentation as part of a comprehensive program to enhance the quality of mathematics, science, engineering, and technology instruction." As scientific and technical fields become an increasing part of the global economy, it is imperative that America's students be adequately prepared to compete for high-tech jobs and create the innovation that drives the economy.

The NRC report found that the laboratory science programs in high school classrooms are in disarray, and certain factors seriously hamper efforts to improve them. The NRC report committee concluded that there exists no commonly agreed upon definition of laboratories in high schools amongst researchers and educators. Without agreement on a definition of laboratory exercise, research and the accumulation of knowledge on specific methods to improve the experience for student is undirected, difficult to classify, and difficult to draw conclusions from.

Though research on laboratory exercises may not be well delineated, American students poor achievement in science is. Assessments of national trends in science learning show that American students at all levels are at roughly the same level of proficiency in science that they were at 30 years ago. International assessments show American students fare worse than their peers in other countries. It is clear from studies of undergraduate science students that many are unprepared for college-level work. A 2002 survey of first-year students planning a major in science, technology, engineering, or mathematics (STEM) showed 20% in need of remedial math work and 10% in need of remedial science work. Those who come unprepared for college-level work often do not succeed and will leave the STEM fields.

Through their review of the available studies, the NRC report committee developed a list of desired outcomes for laboratory experiences. The studies showed that laboratory

experiences may enhance mastery of subject matter, develop practical skills with tools and instrumentation, develop teamwork abilities, and cultivate an interest in science. Additionally, the NRC committee noted that laboratory experiences expose students to the complexity and ambiguity of real empirical work. These concepts cannot be taught in lectures or textbooks. Students must interact directly with scientific phenomena to appreciate this aspect of science.

Unfortunately, the typical laboratory experience for most of the country's high school students is poor. Studying the current situation in the classroom, the NRC report committee concluded that teachers often implement laboratory exercises that are not synchronized to the classroom lecture, do not have clear learning goals, neglect student feedback and discussion, or are not designed to integrate the learning of science material with the learning of scientific process. Teachers are rarely adequately trained to lead these exercises, nor are they given the opportunity for development once they start teaching. The lack of flexibility in high school organization can also impede the implementation of more effective laboratory exercises.

The NRC report committee came to the conclusion that state standards are also to blame for the failures in the laboratory. Teachers face covering an extensive list of standards, leaving little time for the development and implementation of laboratory curriculum. The NRC report points to one study of California state standards showing students are required to carry out laboratory exercises that engage in activities like hypothesis forming, data collection, problem solving, but at the same time they must also master an extensive list of science topics that puts impossible time constraints on laboratory exercises. And, since large-scale assessments of science mastery are not designed to measure student attainment of laboratory goals, laboratory exercises are further neglected.

H.R. 524

H.R. 524 amends the NSF Authorization Act of 2002 to establish a pilot program at NSF to fund grants to improve laboratory sciences. The grants, which require a funding match, must go to partnerships between high schools and institutions of higher learning (including community colleges), businesses, eligible non-profit organizations, State educational, or other public agencies, National labs, or community-based organizations. These grants are intended to support the development of laboratory exercises integrated with classroom curriculum and teacher development, and to provide for the acquisition of laboratory equipment and instrumentation. A provision is also made in the bill for supporting these activities in schools serving minority populations under-represented in science and engineering.

The pilot projects authorized by H.R. 524 will address some of the needs for research and demonstration activities raised by the NRC report. Because the NRC committee found the evidence on best practices for high school science laboratories too inconclusive to make specific recommendations, they delivered a series of questions in five broad categories for policy makers, researchers, and educators to address. These areas are: the

assessment of student learning in laboratory exercises; the most effective pedagogy methods for laboratory exercises; how to serve a diverse population of learners; the best organization of schools and school systems for a well-functioning laboratory program; and the best way to prepare educators to administer effective laboratory programs.

Questions for Witnesses

The panelists were asked to address the following questions in their testimony before the Subcommittee:

Dr. Arthur Eisenkraft

- Please explain the background that was the impetus of the National Research Council's report *America's Lab Report: Investigations in High School Science*. What were the report's findings? Can you characterize one or two as being the most critical in implementing a successful laboratory program?
- What recommendations would the study committee make to improve the laboratory experience for students?

Mrs. Linda Froschauer

- How important is the laboratory experience for students in understanding scientific concepts? What is current state of laboratory facilities and instruction in the country?
- What are the biggest concerns your member science teachers have about laboratory education and implementing an effective program?
- Will H.R. 524 assist in developing and implementing effective science laboratory programs for high school students?

Dr. Jerry Mundell

- Please describe the curriculum you've developed for students in the Cleveland Public schools. How has your position at Cleveland State University informed your motivation and ideas for high school laboratory curriculum?
- What obstacles have you encountered in creating lab programs for high school students? Have you assessed students' mastery of concepts using the curriculum you've developed? What methods have you used to measure this?
- Will H.R. 524 assist in developing and implementing effective science laboratory programs for high school students?

H.R. 524, To Establish a Laboratory Science Pilot Program at the National Science Foundation

Summary of Major Provisions of the Bill

This bill would establish a pilot program at the National Science Foundation to award grants to partnerships to improve science laboratories at the secondary school level. The grants may be used for a variety of activities to improve the laboratory experience for high school students with particular regard to minorities who are under represented in science and engineering.

Section by Section Analysis of H.R. 524

Section 1. Findings

Section 2. Grant Program

-Amends Section 8(8) of the National Science Foundation Authorization Act of 2002 to include a section authorizing a laboratory science pilot program for secondary schools.

-Requires the National Science Foundation Director to establish a pilot program designated as 'Partnerships for Access to Laboratory Science' to award grants to partnerships to improve laboratories and provide instrumentation as part of a comprehensive program to enhance the quality of mathematics, science, engineering, and technology instruction at the secondary school level.

-Requires that the grants awarded be used for the following types of activities: to purchase, rent, or lease equipment; maintain, renovate, or improve laboratory facilities; engage in professional development and training activities for teachers; develop instructional programs designed to integrate the laboratory experience with classroom instruction and be consistent with State mathematics and science academic achievement standards; the training in laboratory safety for school personnel; the design and implementation of hands-on laboratory experience to encourage the interest of individuals identified in section 33 or 34 of the Science and Engineering Equal Opportunities Act (42 U.S.C. 1885a or 1885b) in mathematics, science, engineering, and technology and help prepare such individuals to pursue postsecondary studies in these fields; and assessment of the activities funded by this pilot program.

-Requires the grants awarded under amended subparagraph A be to a partnership that includes an institution of higher education or a community college, a high-need local educational agency, a business or eligible nonprofit organization, and may include a State educational agency, or other public agency, National Laboratory, or community-based organization.

-Requires that the Federal cost share for these grants be no more than 50 percent.

Section 3. Report

-Requires the Director of the National Science Foundation to evaluate the effectiveness of activities carried out under this grant program and submit a report, no later than 5 years after the enactment of the act, to the Committee on Science and Technology of the House of Representatives, and the Committees on Commerce, Science, and Transportation and on Health, Education, Labor, and Pensions of the Senate. The report shall identify best practices and materials developed and demonstrated by grant awardees.

Section 4. Authorization of Appropriations

-Authorizes the appropriation of \$5,000,000 to the National Science Foundation for fiscal year 2008 and such sums that may be necessary for the three succeeding fiscal years to carry out this Act.