Testimony

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Statement of Dr. Gerald Wheeler
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Mr. Chairman and Members of the Committee

Thank you for this opportunity to present testimony on behalf of the National Science Teachers Association. My name is Gerry Wheeler and for the last 12 years I have served as Executive Director of the National Science Teachers Association.

The National Science Teachers Association is committed to promoting excellence and innovation in science teaching and learning for all. We offer members a wide variety of resources and support, including high quality professional development, publications, networking opportunities, and curriculum materials. The majority of our members are high school teachers and supervisors responsible for the lab experiences of hundreds of thousands of students every year.

Mr. Chairman, NSTA has been privileged to provide testimony on a number of key issues before this committee in support of very valuable initiatives, such as the Partnerships for Laboratory Access bill, and federal programs available to K-12 STEM. We thank you for again inviting us to speak to this important issue of labs and nanotechnology.

While we understand the importance of nanotechnology and its application for a wide range of technologies, and the importance of introducing nanotechnology to our students, we have serious concerns about H.R. 2436, the Nanotechnology in the Schools Act. In light of the many challenges we face in science education, we believe this legislation places inappropriate attention and emphasis on nanotechnology at the high school level. I would like to bring 5 key points to your attention.

First, we believe this legislation does not recognize the serious concerns about high school laboratory experiences raised in the National Academy of Sciences report *America's Lab Report: Investigations in High School Science* and other key federal reports.

The NAS report found that in the vast majority of schools, which includes schools with AP and IP programs, there is a lack of agreement on how to define high school science laboratories and a defined lack of consensus on the goals of laboratory experiences.

The report also found that many teachers are not well prepared to lead high school labs. There is a lack of effective undergraduate laboratory experiences for future teachers. Further, there is a lack of comprehensive systems of support at the school, district, and state levels for high school laboratory experiences.

Laboratory science is a high-priced luxury beyond the reach of far too many public high schools, especially high need schools. A 1995 report from the U.S General Accounting Office titled *School Facilities: America's Schools Not Designed or Equipped for the 21st Century,* found that 42 percent of all schools surveyed nationally reported that they were **not well at all** equipped in the area of laboratory science. In addition the report found that:

- 43 states reported that one-third or more of their schools met functional requirements for laboratory science **not well at all**.

- 49 percent of schools with a minority student population greater than 50 percent reported meeting functional requirements for laboratory science **not well at all**.

- Over 48 percent of schools where 40 percent of the student population qualified for free or reduced lunch reported meeting functional requirements for laboratory science **not at all**.

An email survey we did this past March further illustrates the points made in the NAS lab report. We asked teachers and science supervisors to describe the problems with the lab experience in their school. I have included some of the more representative comments in my written testimony, and would like to share a few comments here today.

- In my urban, inner city school, I teach a lab science in an old business room. There are no tables, benches, water or gas service, sinks, fire extinguisher, eye wash stations, fire blankets, or other equipment. In addition, while there is a high rate of attrition towards the end of the year, each September starts with 50 students in each class.

- I have no specific, safe area in which to conduct labs. My yearly budget is the same as it was 12 years ago. I must purchase all my own equipment and supplies. I have no safety equipment other than a portable eyewash station and a fire extinguisher. My district claims labs are "extracurricular" and not mandated by my subject. My kids are used to labs using kitchenware or materials purchased at Wal-Mart. They have no idea how to use scientific equipment or even what it looks like due to a lack of funding.

- I have been teaching high school biology for ten years. I have old microscopes that I could swap for coke bottles and not notice a difference. However, the greatest problem I see is my lack of skill in the area of lab investigations. I agree that this is the best source of learning that my kids can get; I just simply do not have the skill to design these labs. IF the NSTA wants to make a change in science education, THIS is where it should be done... TRAINING.

- My high school building was built in 1970. The budget for yearly supplies has not changed in the 6 years I have been here. I have a supply budget of $750 per year. I teach between 3 and 4 science subjects per year 7 classes per day, two of them being chemistry and physics. I have absolutely no supplies to teach electricity and magnetism or optics. My chemistry supplies are even worse. My lab facilities are set up for physics, but I am expected to teach chemistry in low benches. I don't know a chemist who will use a bunsen burner sitting down. Hence, I do not teach the labs that require bunsen burners because I feel it is unsafe to use the burners in my room. I also do not have a ventilation hood in my room.

- We do not have any rooms to use as actual laboratories. Although we have lots of equipment, we have no place to safely use it and few teachers who know how to use it. Currently the one room that had been a lab is used by teachers to sell hot chocolate and nachos to students to raise money for trips to Washington, DC for a very small group of students...the lab cannot be used as a lab...they removed the lab tables and installed desks for all the student

- I have not learned how to facilitate real thinking and essential planning for authentic lab experiences. I don't know what students really need in an introductory chemistry experience at the high school level, and I cannot figure out how to teach logical thinking and sequencing to 20+ students in lab at the same time. My time management skills are lacking. There's much more, too.

- I teach chemistry and earth science in a room with 6 lab tables; it was originally designed to be a physics lab room. There is electricity to the tables, but it doesn't work. There are not sinks, therefore no eye-washes; there are no gas outlets. The sink at my instructors table has the water turned off and the gas turned off. We were given a budget of $5000 for each department last year, but the orders were not filled because .... who knows? I have not received the supplies I ordered for 8 out of the last 10 years. When first took over this class-lab room and associated storeroom, there was a great amount of equipment and glassware and old kits and a little of everything. It is not possible to do any other than the most elementary labs at this school. It would be unsafe and probably criminally liable to attempt most chemistry labs. The fire extinguisher doesn't work.

- While I do not teach high school science currently but do teach in a 2-year community college, I see many students entering with virtually no lab experience. While some students come quite prepared, it's very frustrating for me to have students coming into a college biology class with no knowledge of basic lab equipment and techniques, such as using beakers, graduated cylinders, pipettes, or even basic microscopy skills.

- Our school does not provide enough funding for lab experiments. In addition, senior members of the department do not believe that other than AP students and some honors classes - should have access to lab experiments. Therefore the classes I teach - college bound and special education - have little to no money that goes towards lab science in the Biology classroom. Furthermore, the set up of the classroom also is a problem when it comes time to do lab experiments.

- I teach biology in a portable without any sinks, no storage, and only four outlets. It's such a challenge to put together a real lab. My portable is far away from the real science labs so it's hard to even get materials over here. There's no prep area out here so I have to go to one of the main buildings to prep. Yet those prep rooms are not easily accessed if you don't have an attached classroom. My room

has carpet so I am reluctant to use many chemicals because they are difficult to clean up if spilled.

- Our school has minimal funding for improving the quality of lab sciences. Individual teachers are encouraged to write for grants using their own time without pay. Three of our four science rooms do not have eye wash stations or proper venting equipment. There is no interest in funding the purchase of electronic data collection equipment/computer based labs by the administration. Little effort is made in our district to train teachers to improve the quality of lab experiments and the necessary follow-up assessment.

Mr. Chairman, it is clear that the biggest need is not for high tech, specialized equipment in the classroom. Many high school labs are in desperate need for facilities, equipment and teacher training simply to teach chemistry, physics or biology. Teachers need basic, solid equipment - and more of it.

Second, the role of high tech equipment in secondary schools is extremely limited. Most teachers would have limited use for an electron microscope in their schools. It might be of value to select schools where great emphasis and opportunities exist for cutting edge Science Fair projects or where Intel Talent Search type of programs are encouraged. It might have some use in a specialized science magnet school. But we question how many labs could realistically be structured around nanotechnology.

Third, space limitations, safety limitations, training and service limitations, budget limitations, and curriculum limitations all hinder full use of such specialized equipment in most schools. The training to incorporate into the curriculum and the training to use and maintain the high tech equipment alone almost nullify any hope of seriously implementing it into secondary schools. Even if the high tech equipment were donated, the vast majority of teachers would be unable to service and repair these instruments.

Fourth, nanotechnology is not tied to any existing content standards. High school teachers have a number of topics to cover in the short time allotted for science education and labs For the most part when teachers introduce new experiences to students, these experiences and the curriculum they use must be mapped to the learning outcomes as defined in their state content standards. Given the research on student misconceptions and the poor scores we are experiencing on NAEP and on international tests, focusing on nanotechnology may require under-prepared teachers to do lots of “hand waving” rather than focus on the instruction of the current fundamental sciences.

Fifth, science must be for all. As noted earlier, grants for nanotechnology equipment would undoubtedly benefit schools with already strong AP/IB programs in affluent neighborhoods. There are far too many high-risk schools with limited lab resources, few AP/IB programs, and fewer still qualified science teachers that desperately need assistance to teach even the basic sciences. These needs must be addressed first so that Science truly can be for all.

Mr. Chairman, the Internet can and does provide a host of rich learning experiences for students on nanotechnology. A search on NSTA SciLinks shows a number of rich learning experiences for both students and teachers, sponsored by universities such as Leigh University and Rice University; Foresight, a leading think tank and public interest institute on nanotechnology; Quanteg LLC, a company which focuses on nanotech education and networking; and Technology Research News also provide good resources on this subject. Some of these sites are listed below.

For teachers:All About Nanotechnology
Find the answer to that question and discover additional information on Nanotechnology, what it consists of as well as its current and future impacts on the world of science.
http://www.livescience.com/nanotechnology/

Nanotech Now: Tiny Technology All Around You
Scientists who work in the nanotech industry have long promised better products in basic technologies and human health. While many of the applications have yet to leave the lab, nanotech is all around you. Discover some products of nanotechnology.
http://www.livescience.com/technology/060330_nanotech_now.html

About Nanotechnology
Here you will find the answers to eleven of the most frequently asked questions about nanotechnology.
http://www.foresight.org/nano/whatisnano.html

It's a Small, Small, Small, Small World
Learn the advantages of nanotechnology.
http://science.howstuffworks.com/framed.htm?parent=nanotechnology.htm&url=http://www.actionbioscienc...

For students: Nanotechnology in Agriculture and Food Production
What nano-engineered food products will appear on the market over the next year or two? What are the potential benefits and risks? Who will be affected? And how can consumers become engaged early on?
http://www.pewtrusts.org/pdf/Nanotech_agfood_090406.pdf

Introduction to Nanotechnology
Discover how the discovery of the bucky ball has helped pave the way for nanoscience research.
http://www.lehigh.edu/~inimagin/intronano.html

How Nanotechnology Will Work
In this edition of How Stuff Will Work, you will learn how nanomachines will manufacture products, and what impact nanotechnology will have on various industries in the coming decades.
http://www.howstuffworks.com/nanotechnology.htm

Nanokids: Explore
Nanotechnology becomes fun with the adventures of NanoKids™, who materialize after a computer crashes in chemist Jim Tour's lab! Information is fun for the user to learn with and contains basic nanotechnology information.
http://cohesion.rice.edu/naturalsciences/nanokids/explore.cfm

Nanotube Memory
This is a news article of the scientific publication of a joint design by 2 universities for a magnetic nanotube flash memory, which promises to be very compact and fast.
http://www.trnmag.com/Stories/2005/051805/Nanotube_memory_scheme_is_magnetic_051805.html

Understanding Nanotechnology
This site gives the past, present, and future of nanotechnology with some palatable science. It may spark attention with some of the nanotechnology in everyday life. A phone interview with a high school class is one article.
http://www.understandingnano.com/

Introduction to Nanotechnology
Here you will learn about nanotechnology and what it may bring in the future.
http://www.nanoword.net/pages/intro.htm

In closing Mr. Chairman, as clearly identified in the report *Rising Against the Gathering Storm*, and raised repeatedly in Science Committee hearings and in the Senate, there are a number of critical needs in science education that can and must be addressed by federal programs.

With so many challenges to current high school lab science and science education in general, we do not believe that legislation that would authorize $15 million to “strengthen the capacity of United States secondary schools to prepare students for careers in nanotechnology” is the best use of limited federal funds.

NSTA would prefer that grant funds be provided so that labs could be able to purchase basic equipment and supplies so that EVERY high school lab in America have enough microscopes so that EVERY child could use one rather than 2 or 3 students sharing one, old microscope.

Grant funds should also be used for more high-quality teacher training. Science teachers don't need more "fun" activities for students. Don’t give teachers more pretty toys to play with - toys that don’t have a strong base in a fundamental science curriculum tied to standards. Instead, teach them how to structure solid lab experiences and incorporate them into a well-organized and rich science curriculum for students.

I look forward to answering any questions you may have.

Biography
Dr. Gerald Wheeler
Executive Director
National Science Teachers Association

Dr. Gerald Wheeler is the Executive Director of the National Science Teachers Association, the largest science teacher organization in the world. Prior to joining NSTA, Dr. Wheeler was Director of the Science/Math Resource Center and Professor of Physics at Montana State University. He also headed the Public Understanding of Science and Technology Division at the American Association for the Advancement of Science (AAAS) and has served as President of the American Association of Physics Teachers (AAPT).

Since joining the Association in 1995, Dr. Wheeler has overseen the creation of several science education initiatives and resources aimed at strengthening the quality of science teaching and learning. Dr. Wheeler was the driving force behind SciLinks®, a collaborative project with major publishers that links science textbooks to teacher-approved web sites, and Building a Presence for Science, a program that works to identify then connect science education contacts in each school building nationwide and provide them with teaching resources and professional development opportunities. Most recently, Dr. Wheeler was instrumental in the formation of the NSTA Learning Center, the national "home base" for science educators in search of quality content-based professional development and the NSTA New Science Teachers Academy, a professional development program, co-founded by the Amgen Foundation, designed to encourage and support new middle and high school science educators in their first few years of teaching.

For much of his career Dr. Wheeler has played a key role in the development of mass media projects that showcase science for students. He was involved in the creation of 3-2-1 Contact for the Children's Television Workshop, served on advisory boards for the Voyage of the Mimi and the PBS children's series CRO, and created and hosted Sidewalk Science, a television show for young people on CBS-affiliate WCAU-TV in Philadelphia. Dr. Wheeler has co-directed the National Teachers Enhancement Network, an NSF-funded distance learning project offering science and math courses nationwide.

Dr. Wheeler received an undergraduate degree in science education from Boston University and a master's degree in physics and a Ph.D. in experimental nuclear physics, both from the State University of New York at Stony Brook. Between undergraduate and graduate school, he taught high school physics, chemistry, and physical science.