Testimony of

Dr. Joseph Heppert

to the

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Introduction

Mr. Chairman and distinguished members of the Committee:

Good Morning.

I am addressing you today as both the Chair of the Chemistry Department at the University of Kansas and as the Chair of the American Chemical Society's Committee on Education.

It is a distinct pleasure to address the Committee on a subject of the utmost importance to the future of our country – how our nation is going to tackle the challenge of preparing our next generation of scientists, technical workers, engineers, and mathematicians (the so-called "STEM workforce") to compete in the global economy of the 21st century.

As everyone in this room now recognizes, when it comes time to find a job in the life sciences, my daughter Jennifer, who is sitting right behind me, will no longer be competing with her fellow American students for an "American" job. She will be competing with all of the outstanding students

in her field on the planet for the best, most rewarding high-tech jobs – jobs that know no national or geographic boundaries. In such an environment, she and other students of her generation need to be well prepared.

The subject of today's hearing – the role of the National Science Foundation in promoting effective pre-college STEM instruction and learning – is an absolutely critical element in our national response to this competitiveness challenge. If we engage in a comprehensive examination of the health of our pre-college STEM programs, we will find a muddled diagnosis. There is much to be proud of in our accomplishments in elementary and secondary math and science education; many exemplary programs to emulate, challenging curricula to adopt and adapt on a local level, and many outstanding teachers who can help to lead our educational system into the future. Yet, we also see components of our pre-college STEM programs that are desperately struggling; unsatisfactorily low student scores on international tests of science knowledge, declining student interest in science careers, and many high school graduates who do not have sufficient preparation to choose scientific and technical career pathways.

There is no doubt that NSF is one of the premier agencies that supports STEM research in the world, or that maintaining this title is a point of pride for the Foundation. I believe that NSF should also proudly hold the title of being the world's leader in educational innovation; helping educators to more effectively deliver a 21st century STEM education to eager young minds.

The Role of NSF in Education

For the record, I have submitted a copy of “Science Education Policies for Sustainable Reform”, the American Chemical Society’s comprehensive statement on priorities, practices, and policies related to science education at all levels. I respectfully suggest that the Committee review the Society’s recommendations on a wide range of science education issues.

NSF’s leadership in these arenas takes many forms. I would like to begin my testimony by describing some areas in which I have observed NSF programs provide focused, effective leadership in addressing the Nation’s K-12 STEM challenges, and a few areas in which NSF needs additional support and direction in order to most effectively adopt its appropriate role. I intend to conclude my remarks with a discussion of recommendations relating to NSF’s role in strengthening our STEM education programs.

It would be an epic understatement to characterize educational systems as ‘complicated’. I believe that educational systems are among the most complicated systems that humans have constructed, and this complexity arises from many sources. Take, for example, students. Pre-college students progress through many stages of cognitive, physical, emotional, and social development during their years of preparation for adulthood. Creating an excellent educational environment requires understanding the developmental progress of students at a particular grade level, and then engineering sufficient flexibility into that learning environment to accommodate very real variations in developmental progress among individuals. We can also examine societal stakeholders as another source of complexity in educational systems. Stakeholders in K-12 educational systems include students, parents,

teachers, educational administrators, higher education, private sector employers, community leaders and organizations, officials of state and federal governments, and American society as a whole. Though all of these stakeholders embrace the common goal of providing the best possible education for American children, their different expertise, experiences, and goals influences the priorities they set for fostering educational change and the strategies they propose for achieving that change. We already have an incredibly complicated description of educational systems, and we have only barely described two parameters in a system with many, many more variables.

We are asking NSF to step into the midst of the multidimensional problem and affect positive change. It is entirely reasonable to ask what unique qualifications and characteristics NSF brings to this task.

NSF is the federal agency with the broadest expertise with STEM content knowledge; consequently, it is the agency best able to oversee the development of quality STEM curricula for all educational levels, evaluate the quality of existing curricula and programs, and develop research and assessment methods that successfully evaluate student learning of science.

Through its reputation and resources, NSF has enormous power to convene. NSF education programs often mandate that scientists, mathematicians, educational professionals and educational policy specialists all collaborate on the development of solutions to problems in STEM education. These are exactly the type of multidisciplinary consortia that are required to formulate and implement solutions to complex educational issues.

Many NSF programs thrust STEM content professionals into leadership roles in educational research projects. NSF is one of the select Federal agencies funding educational research that guarantee STEM professionals a voice at the table in projects affecting the future of their own disciplines. This approach is crucial for building a sense of responsibility for educational progress in STEM fields among scientists, mathematicians and engineers. It also results in the development of enhanced educational research capacity among STEM professionals. Late last year, I participated in a National Academies workshop funded by NSF that focused on assessing the status of STEM education research faculty in STEM discipline departments. NSF is clearly interested in fostering the careers of science, mathematics and engineering faculty engaged in STEM education research, and in supporting an appropriate increase in the numbers of such researchers. This is a praiseworthy objective.

NSF's strength lies in its emphases on innovation and on fostering broader societal impact through the programs it funds. Research and development are NSF's dual specialties; so it follows that its mission is admirably suited to provide oversight of STEM educational research.

There are areas in which NSF could improve its programs, and its advocacy and support for STEM education research. Scientists, mathematicians and engineers occasionally fall into the trap of behaving as if funding for our 'traditional' research programs is our sole priority and only use of resources that will benefit for our particular discipline. This is not true. Without sufficient funding for educational research that fosters improvement in

STEM learning at all educational levels—the type of research that renews our disciplinary core content, enlivens our teaching, improves student comprehension, informs us about more effective uses of technology, and increases student wonder about the character of the natural systems in which we live—our disciplines will inevitably suffer. Our disciplines, and NSF as the proxy for research in those disciplines, must constantly balance the need for investment in research with the equally crucial need for fundamental research in STEM education. NSF's emphasis on using research as a driver of innovation and its strong focus on the content of STEM disciplines makes it the best agency to manage this educational research mission.

Paradoxically, the funding needs of No Child Left Behind programs, which are intended to foster near-term improvement in student achievement, have created a countervailing pressure on NSF resources that support the basic educational research that is foundational for longer-term improvements in STEM education. Substantial NSF funding has been re-tasked from programs that cultivated K-12 curriculum innovation and developed new models for enhancing the pedagogical content knowledge of inservice teachers. As a result, these programs are funding fewer initiatives that will provide new strategies to improve student achievement.

In order to drive change in K-12 education, it is necessary to create change in how colleges and universities teach STEM content to future teachers. Instructional strategies at universities are notoriously difficult to change. NSF resources have, in previous initiatives, provided an important impetus for innovation in college and university STEM instruction. Such programs are sorely under-funded in the current NSF educational research portfolio.

Now, as we need to increase the number of students choosing to major in K-12 STEM teaching, is the time to enhance support for these programs.

Recommendations Regarding Future Action

The American Chemical Society supports the recent recommendations of (1) the National Academies, (2) the Council on Competitiveness, and (3) the Task Force on the Future of American Innovation. These organizations have established a powerful roadmap showing how the United States should respond to existing threats to our scientific and technological leadership. Furthermore, the American Chemical Society is prepared and committed to contribute to the development of a national innovation strategy for the 21st century and to support legislation that embodies key elements of these reports.

Today, I have five specific recommendations for the Committee that relate to NSF's role in improving K-12 education:

First, I would encourage the Committee to continue efforts to develop comprehensive legislation that lays out a concerted national response to the innovation and competitiveness challenge.

If we are to sustain a national focus on this issue– as we most certainly must do if we are to succeed--we need to forge a clearly articulated national strategy, endorsed by a significant, bi-partisan mandate from Congress.

Second, such legislation must clearly acknowledge and recognize the key role of NSF in improving K-12 math and science education, and must also address, in concrete terms, how NSF's Education and Human Resources (EHR) Directorate will work together with the Department of Education and other federal agencies on improving student achievement in K-12 science and mathematics. NSF provides leadership in research on human learning, and is at the forefront of research on STEM education pedagogy, curricula, and assessment. The Department of Education has an extensive network of contacts with state and local educational agencies that can scale up and fund the dissemination of the innovative programs produced by NSF. It is essential that these two agencies form an effective partnership to deliver the best new educational strategies and materials to K-12 educators.

Third, I believe that NSF should maintain its strong educational research focus, playing a central role in improving student achievement in the STEM fields.

As with every major challenge that our country has faced over the course of our history, our ability to innovate—our vision to invest in fundamental research—will play a decisive role in improving student achievement in math and science.

NSF should be the lead agency in fostering the development our STEM education pipeline; from evaluating the best textbooks, to pioneering new student learning methods and new curricula, to developing better ways to employ technology in the classroom.

NSF has a unique role as the bridge between the science and education communities. It is the only federal agency that can attract all of the best minds in both communities to the table with the common intention of solving some of our thorniest problems facing our system of science education.

Fourth, NSF should devote significant resources to programs that increase the number of career K-12 STEM teachers with detailed science knowledge and/or STEM degrees emerging from American universities. This issue cannot be addressed solely by providing more numerous scholarships, and better salaries and resources for preservice teachers. The resolution of this issue requires that we foster changes that have only begun to occur in the culture of most universities. We must induce Schools of Education, Science and Engineering to form more effective partnerships to address these issues. NSF already has substantial experience in forging these relationships, and, with the cooperation of the private sector, is ideally suited to facilitate partnerships that can tackle this particular challenge.

I believe that there is evidence that teacher preparation programs that emphasize strong preservice teacher engagement with scientific content, including undergraduate research experiences, are very effective at attracting and retaining new science teachers. My institution will be examining how we can adapt elements of the UTeach program, one such program developed at the University of Texas, to enhance our science teacher preparation efforts.

Fifth, I think NSF can contribute to the successes of the No Child Left Behind program by providing scalable model programs that help achieve improvements in student science and mathematics performance in specific areas of focus.

As an example, a recently publicized release of data from NSF's Math and Science Partnership program has established that the innovative, rigorously evaluated programs supported by NSF's EHR Directorate can produce dramatic, measurable improvements in student performance. In the instance that I cite, high-school students showed a 14% improvement in math proficiency after one year under the MSP program.

I hope we can effectively work together to continue this and other successful programs funded by NSF, and to fund new NSF education initiatives that hold the promise of improving the quality of STEM education for our children.

Conclusion

In closing, I would like to thank the Committee for the opportunity to testify here today. In my research experiences, I have seen first hand the success of NSF programs in improving K-12 science and math teaching and learning.

I cannot emphasize strongly enough that NSF is uniquely situated as the agency that can best bridge the gulf between the scientific and education communities. If, in responding to the math and science challenge our nation

faces, we do not take full advantage of the unique strengths of NSF, we will be making a mistake.

I am confident that the investments we are making in NSF today will result in a brighter future for our children. Thank you.