

**Science Museums as Partners in STEM Education:
Providing Impactful Programs that Improve Science Engagement**

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Andrea J. Ingram
Vice President, Education and Guest Services
Museum of Science and Industry, Chicago

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Introduction

Good morning, Representative Bucshon and members of the Subcommittee. I'm Andrea Ingram, vice president of education and guest services at the Museum of Science and Industry, Chicago. I appreciate the invitation to speak today about our STEM education initiatives, their impact and the important role that non-profit institutions like science museums play in science education.

As you are aware, science, technology, engineering, and mathematics (STEM) are critically important to our well-being, our nation's economic growth and our environment. Our future depends on encouraging creativity, innovation, collaboration and critical thinking in students today. Countries around the world are investing in science education and innovation like never before. It's a highly competitive race for the future, education leaders from a growing list of countries – including China, South Korea and Israel – are traveling to the Museum of Science and Industry to learn about our innovative STEM initiatives. At the invitation of the Korea Foundation for the Advancement of Science and Creativity (KOFAC), the leading STEM policy and programming organization of South Korea's Ministry of Education, I've traveled to South Korea twice, most recently last December, to speak about the Museum's cutting edge models. These countries recognize that this race will not be won by test scores; it will be won with youth who are well positioned to lead our economies into the future.

At a time when American schools face shrinking resources and growing demands, non-profit institutions such as science museums have become important partners in STEM education. We are in hundreds of communities across the country and reach millions of children and families every year. We are nimble and strategic, with programs designed not only to fill the gaps in local education systems, but to offer valuable STEM engagement that cannot be found in the classroom.

The Museum of Science and Industry, Chicago (MSI) is a leader in science learning. The largest science museum in the Western Hemisphere, MSI welcomes 1.5 million guests each year who explore award-winning exhibits and engage in cutting-edge educational experiences. Our vision is to inspire and motivate our children to achieve their full potential in the fields of science, technology, engineering and medicine. To do that, we created MSI's Center for the Advancement of Science Education and have moved beyond the traditional museum visit experience to make science accessible in the classrooms, homes and communities where children live their lives. The Center for the Advancement of Science Education works with local school systems and collaborates with some of the best minds and institutions in science and education to develop, evaluate and deliver effective STEM education initiatives.

MSI's science education programs are supported by corporate, civic and philanthropic leaders in the Chicago area who understand first-hand the need for a more knowledgeable workforce. We also have received some federal funding for our STEM programs, and I urge this Subcommittee to strongly support programs within the National Science Foundation (NSF), National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA) that are directly accessible by science centers and museums. This public and private support allows us to expand the depth and reach of our programs to engage even more students, families, teachers, schools and communities. As a result, MSI and other science museums have become a nexus where corporations, civic institutions and government can come together to champion effective, impactful STEM education programs.

I urge this Subcommittee's strong support for the few STEM education programs within the federal agencies that are directly accessible by science centers and museums, specifically:

- NSF's Advancing Informal Science Learning (AISL) program,
- NOAA's Environmental Literacy Grants (ELG) program,
- NASA's Competitive Program for Science Museums and Planetariums (CP4SMP),
- and, though it is outside the Committee's direct jurisdiction, the National Institutes of Health Science Education Partnership Awards (SEPA) program.

Science Museums and STEM Education

Science centers in communities throughout the country are providing unique educational programs that excite, energize and enrich our understanding of science and its many applications—frequently with support from agencies like NSF, NOAA, and NASA. The Association of Science-Technology Centers (ASTC), which represents our field, counts 383 science museums and science centers as members across the United States; their statistics show more than 65 million visits by your constituents every year, including 13 million schoolchildren.

But we are much more than an inspiring field trip destination. Our strategic vision, robust education programming, and inspirational exhibits linked to classroom curriculum make science museums and centers natural partners in science education. According to ASTC:

- 89 percent of science centers offer school outreach programs.
- 82 percent offer teacher workshops and programs.
- 75 percent offer curriculum materials.
- 56 percent offer after-school programs.
- 39 percent offer youth employment programs.

Museum-based science education programs are designed to meet local educational needs and fill gaps in local educational systems. A major factor in student achievement in science is the quality of science education provided in school. Science teachers, especially those in the middle grades, often lack the knowledge, experience and resources to teach science effectively. In Chicago, an estimated 70 percent of teachers who teach science in the middle grades have no background or experience in science. Responding to this need, the Museum of Science and Industry developed science teacher education courses rich in science content and hands-on, inquiry-based teaching strategies. Courses are targeted to teachers in high-needs schools and are provided at no cost. As one result, 25 percent of K-8 schools in the Chicago Public Schools system have at least one MSI-trained teacher.

Museums also are strategic in implementing STEM education initiatives. They leverage the inspiration, affinity and expertise of their institution to determine program priorities. With the pending release of the Next Generation Science Standards, teachers and schools are being asked to implement new practices, standards and assessments in science education. The standards will place a strong focus on actively engaging students in science and engineering practices as well as recognizing and applying crosscutting concepts – the exact type of experiential learning promoted by the Museum of Science and Industry and other science museums. We are uniquely poised to provide vital support during this transition, and our science education programs can help to advance science instruction and boost student science achievement.

MSI's STEM Education Initiatives

Several years ago, the Museum of Science and Industry convened corporate and civic leaders, scientists, educators and national experts to brainstorm ways to teach and inspire children. We developed a bold plan with three strategies:

- Place educational programming at the heart of the Museum experience by developing and expanding the Center for the Advancement of Science Education.
- Provide spectacular, transformative exhibitions that grab attention and lead to learning.
- Enhance the experience of Museum guests by presenting a unique, dynamic visit that engages people in interactive science experiences that make learning fun.

As a result, the Museum has revolutionized the way we work with students, teachers, families, communities and school systems. Programs aim to shape the attitudes about and participation in science by youth – especially minority youth traditionally underrepresented in the sciences – during their middle- and high-school years. By taking a comprehensive approach to science education, we aim to connect the Museum and the community in a sustainable partnership where learning takes place in many different locations.

As cross-disciplinary teams, we develop and implement a variety of strategies to engage and inspire our audiences through exhibitions and programming. Our newest permanent exhibitions, including the award-winning *Science Storms* and *YOU! The Experience*, were created with a materially different approach. Education experts were integrated onto the design teams to ensure the exhibit is developmentally appropriate for our youth audiences, includes content that corresponds to classroom learning standards, and reflects evidence-based practices on learning. These exhibitions are learning tools for advancing science education.

Programs offered by the Center for the Advancement of Science Education extend the content of Museum exhibitions through strategies that empower teachers, engage the community, and excite students and Museum guests. Initiatives reach beyond the Museum walls into schools and community organizations across the Chicago area, places where students are spending their time. Programs are designed to provide much-needed support to teachers, reach children in a variety of settings, and make it easy to participate by removing barriers.

Science Teacher Education

The Museum's science teacher education courses invite teachers to explore science topics relevant to their science curriculum and return to the classroom with new ideas, greater confidence and the resources they need to make science engaging for their students. Effective classroom teaching helps children develop the essential thinking skills they need to weigh evidence, solve problems, balance risks and rewards and make sense of their environment.

MSI teacher courses are designed to:

- Improve science instruction by advancing teachers' science content knowledge, use of effective classroom strategies and integration of external resources into their science instruction.
- Promote student growth and achievement by enhancing their science content knowledge and skills while promoting a positive attitude toward science and science-related careers.
- Build a presence for science in schools by providing teachers and administrators with resources and support for quality science

MSI offers two courses each school year (six sessions each) and two courses each summer (five sessions each), all at no cost to teachers who are selected to participate through a competitive application process. Courses are designed in accordance with state and national science education standards. We currently offer four courses – physical, environmental, life and Earth systems science – and are developing a new course on space science to debut in 2014. Our Earth systems science course is supported by an environmental literacy grant from NOAA; MSI was one of eight grant recipients nationwide and the only museum to receive funding.

Through partnerships with local universities – including Illinois Institute of Technology and Valparaiso University – teachers have been able to apply MSI courses to a middle-grades science endorsement or toward master's degree programs. Our focus is on enabling teachers who are in the classroom today and creating a pipeline of quality teachers with the skills to inspire passion and excitement of about science. We work to build whole school engagement and teacher communities; teachers are recruited in pairs to ensure shared resources and continuity within schools.

Since 2006, the Museum has served 650 teachers through these sustained programs. We emphasize serving teachers from high-needs schools. About 60 percent of teachers work in Chicago Public Schools, while the other 40 percent teach at private, parochial or suburban public schools, mostly in high-needs communities. In addition, the Museum partners with the Academy for Urban School Leadership to support teachers in the most chronically struggling “turnaround” schools in the Chicago Public Schools system.

Multi-year internal and external evaluation of science teacher education programming has indicated that a teacher's participation leads to increases in knowledge of and confidence in science content and best practices in science teaching. We also have evidence that the teachers implement practices learned in the courses in their classrooms. To better understand our impact, we have partnered with Michigan State University's Institute for Research on Mathematics and Science Education on a robust research analysis of the impact that MSI's teacher courses have on students. The goal of the research is to better understand the impacts of MSI's model of science teacher instruction and to inform the creation of a model that can be replicated nationally. The research study is led by William Schmidt, a Michigan State University Distinguished Professor who has overseen the United States' participation in the Trends in International Mathematics and Science Study (TIMSS), one of two key benchmarks that measure international student achievement.

Student and Guest Experiences

The Museum offers a variety of engaging, hands-on learning opportunities that allow children, families and guests to explore new ideas at their own pace. These interactive experiences are

designed to meet different learning styles. Museum exhibits foster engagement through guided exploration and facilitated activities. State-of-the-art labs allow guests to participate in more complex experiments, like dissecting an eyeball or designing and manufacturing personalized items in the Wanger Family Fab Lab, MSI's state-of-the-art digital fabrication workshop.

Programs for school groups extend and deepen the educational impact of Museum exhibits. We aim to provide students and teachers with meaningful learning experiences that begin in the classroom, focus their Museum visit and illuminate areas for further science engagement back at school. By narrowing the scope of a field trip to focus on curriculum areas connected directly to the classroom, these programs can:

- Increase student content knowledge in specific science subject areas.
- Engage students in the scientific process and build scientific habits of mind.
- Provide insight into real-world applications of science and introduce students to science-related careers.

MSI's Learning Labs address a range of science topics including life, physical and environmental science. These hands-on programs are aligned with state and national science education standards and have pre- and post-visit activities along with additional resources to enhance what students learn once they return to their classroom. More than 20,000 students in grades 3 to 12 participate annually.

New programs provide unique opportunities to connect students and teachers to real-world science and working STEM professionals:

- *Mission to Mars* is a NASA-funded partnership that allows urban and rural middle-school students to work with real NASA experts in simulated missions to travel to and explore Mars. Students at MSI and at two Challenger Learning Centers collaborate on hands-on activities and talk live via videoconference with experts at NASA's Johnson Space Center, Marshall Space Flight Center and Jet Propulsion Laboratory.
- *SimLab* is a National Institutes of Health-funded initiative currently in development that will allow students to explore community health issues using the Museum's high-tech human-patient simulator, iStan™.

Community Initiatives and Youth Science Engagement

The Museum has expanded our role in communities by partnering with schools and community organizations to extending science learning into places where students already spend their time after school. Children and teens can discover new interests, develop new skills, prepare for college, and learn about careers in science and engineering. Our Science Minors series of programs aim to increase science literacy and interest in science in high-needs neighborhoods, influence youth to choose STEM careers and sustain a supportive climate at the community level for science engagement and participation. The series includes three levels of engagement which reach more than 5,000 students each year.

In the first level, pre-teen students receive early, hands-on exposure to science through our network of after-school Science Minors Clubs. The program aims to increase science literacy and interest in science in underserved neighborhoods. Currently there are 72 sites throughout the Chicago area and northwest Indiana reaching an estimated 5,000 students annually. Participating organizations receive science curriculum modules, training and on-site support, materials for activities and a field trip and family day at the Museum. The clubs emphasize informal learning that builds curiosity and encourages teamwork.

In the second level, teens in the Science Minors youth development program attend 10 weeks of science education and training before they volunteer to demonstrate science experiments for Museum guests. These teens gain a better understanding of science, a first-hand look at science career opportunities, and public speaking skills.

In the third and most engaging level, Science Achievers deepen their work with the Museum by pursuing more rigorous science topics and preparing for college and careers. These teens meet with science professionals, have the opportunity for paid internships, mentor new classes of Science Minors, develop leadership skills and work on project-based learning in the Wanger Family Fab Lab. About 200 teens participate in the Science Minors and Science Achievers programs each year.

Students credit these programs with showing them the range of science careers that exist, teaching them to be effective public speakers and demonstrating the benefits of teamwork. After-school program providers in our science club network credit MSI with exposing children to new ideas and opportunities.

Public Funding for Museums Spurs Increased Support from Non-Governmental Entities

Museum-based STEM initiatives are supported by corporate, civic and philanthropic leaders who understand first-hand the need for a more knowledgeable workforce. The Museum of Science and Industry's Board of Trustees includes CEOs and presidents of corporations, organizations and foundations who are strongly committed to our work. Consider these remarks from just a few of the trustees who have also provided financial support to the Museum's education programs and exhibitions:

W. James Farrell, retired chairman, Illinois Tool Works (\$17.8 billion corporation): "Our goal is to inspire new generations of scientists and engineers who can take on our society's biggest challenges. And we're convinced the Museum is the only institution in Chicago that can do this important job."

Tom Wilson, CEO, Allstate Corporation (\$32.65 billion corporation): "The Museum of Science and Industry does a wonderful job of engaging children at an early age and starting them on what we hope is a lifelong path of learning. The new *Science Storms* exhibit in Allstate Court effortlessly captures this concept. It's a powerful teaching tool that inspires our future scientists."

Robert Livingston, CEO, Dover Corporation (\$8 billion corporation): "To compete and win in a global economy, we need innovators who know how to apply science and technology to enrich our lives. Science education truly enriches the lives of our children."

Since 2010, the Museum has received nearly \$3.5 million in federal agency grants for its STEM initiatives for students and teachers. This funding has helped the Museum generate nearly \$9.7 million in matching donations from individuals, foundations and corporations. This 1:3 ratio of public to private funding is reported by many of our peers.

The Museum of Science, Boston has attracted \$9 million in corporate and philanthropic contributions to support an elementary engineering education initiative launched by a \$2.7 million NSF R&D investment. That doesn't include additional private investments made in the project at other science centers and universities including Purdue University, Science Museum of Minnesota and the Arizona Science Center. In another example, a \$500,000 U.S. Department

of Energy grant helped the Connecticut Science Center create a LEEDS Gold certified “green building,” including an American-made fuel cell that provides two-thirds of the museum’s electricity and a major interactive exhibition utilized by school groups on clean energy technologies.

These examples illustrate how science museums and centers have become a nexus where corporations, foundations, individuals and government can come together to support effective, impactful STEM education programs.

NSF Support for Impactful STEM Programs

The Founding Charter of NSF states: *The Foundation is authorized and directed to initiate and support basic scientific research and programs to **strengthen scientific research potential and science education programs at all levels** in the mathematical, physical, medical, biological, engineering, social, and other sciences by making ... arrangements to support such scientific and educational activities* (emphasis ours).

NSF has the defining leadership role in STEM education, from pre-K to grade, by charter and by historical precedent. Since its inception, NSF has funded initiatives that support STEM education at all levels, including the renowned Teacher Institutes and teacher education at the K-12 and undergraduate levels. However, this commitment has fallen off sharply since 2003 with the reduction and eventual elimination of the Teacher Enhancement Program—a program the Museum community would support being resurrected at levels commensurate with both history and current need.

While schools provide direct educational experiences for students, and districts and states implement policies and programs for instruction, improvement requires that students have greater access to—and engagement with—good teaching, better-designed materials and tests, and more opportunities with high-quality, out-of-school learning experiences. Improving classrooms and strengthening the systems that support them requires a capacity that might be called the nation’s “educational improvement infrastructure.” I urge continued NSF investments in the people, ideas and tools that comprise this infrastructure and support improvement in STEM education.

For more than 50 years, NSF has accumulated knowledge and generations of people that enable better improvement efforts, stronger management of systems, breakthrough ideas and valuable tools, unmatched by any other federal agency or program. Now, more than ever, support for innovation in education is integral, and NSF could reward creative new ways of educating our students and teachers. Uniquely qualified to be the primary sponsor of the nation’s STEM innovation, invention and improvement infrastructure, we urge the NSF to pull on the traditions of science and the nation’s scientific and educational expertise to take promising ideas and move them from research into approaches, programs and tools that work in everyday classrooms.

With this, science centers and museums largely support the Advancing Informal STEM Learning (AISL) program—formerly known as Informal Science Education (ISE)—within the Directorate for Education and Human Resources. I am concerned, however, that a change in the program’s focus has had a detrimental effect on the positive impact science centers and museums can have on their communities by securing ISE awards, primarily by shifting from direct program support of highly innovative, impactful or experimental programs to more strongly focused research initiatives.

That said, NSF has retained this important program for public engagement with science and deserves the lion's share of credit for what other countries recognize as the most robust system of public science programs in the world. Our lead in this area is fading quickly, however. I've already mentioned the interest among Asian nations in the Museum's STEM initiatives. The European Union has fostered a continent-wide program for public engagement of science—modeled after NSF's—that is largely responsible for the proliferation of science cafés in nearly every major city in Europe. China has embarked on a campaign to build 300 new public science centers, the government of Saudi Arabia has announced a program to build 25 new science centers, and the Turkish Ministry of Science and Technology has plans for 23 new science centers in the next five to 10 years.

Therefore, I urge the Subcommittee to ask NSF to reconsider its rationale for altering the AISL program and to consider offering future solicitations that re-emphasize the importance of direct programming that delivers education experiences for students and teachers and public engagement (of all ages and backgrounds) in some of the cutting-edge science being produced in this country. NSF did this quite successfully with its Nanoscale Informal Science Education Network initiative just a few years ago.

Expand Access to NOAA and NASA Funding for Science Museums and Centers

Since 2005, NOAA's Office of Education has helped advance public environmental literacy and STEM learning through the Environmental Literacy Grants (ELG) program, a competitive grant program that supports formal and informal/non-formal education projects implemented on regional to national scales. The ELG program's mission is to increase the understanding and use of environmental information to promote stewardship and increase informed decision-making by U.S. educators, students and the public, which directly contributes to NOAA's mission. The ELG program is the longest standing and most comprehensive national grants program focused on environmental literacy (in existence since 2005), and through this focus it makes a distinctive contribution to STEM education.

NASA's Competitive Program for Science Museums, Planetariums and NASA Visitor Centers Plus Other Opportunities (CP4SMP+) is offered to "continue the Agency's tradition of investing in the Nation's education programs and supporting the country's educators who play a key role in preparing, inspiring, exciting, encouraging, and nurturing the young minds of today that will manage and lead the Nation's laboratories and research centers of tomorrow ... (and) NASA's investment in education is directly linked to inspiring the next generation of explorers and innovators" (2013 CP4SMP+ NASA Research Announcement). To date, this relatively new program (initiated in 2008) has supported 20 science museums, yet FY13 Senate Report Language would convert eligibility for NASA's CP4SMP+ program to a non-competitive set-aside for "NASA Visitor Centers" alone. I urge Congress to sustain NASA's CP4SMP+ program as a national competitive opportunity that will welcome proposals from science centers, museums, and also independently operated visitor centers near NASA Centers.

These NOAA and NASA programs are just two of a few federal grant programs science centers can access and that recognize the importance of STEM education both inside and outside the classroom. These are also an exemplary, well-run grant programs. They require robust project evaluation, promote best practices, emphasize partnerships that facilitate the integration of agency assets into education programs and promote STEM literacy. These projects nicely complement—but do not duplicate—grant programs and other educational efforts offered by the federal agencies.

Cutting or eliminating these competitive grant programs will cripple these relatively new investments. Since 2005, NOAA has made 72 competitive awards totaling \$34.1 million. This program funded the Museum of Science and Industry's Great Lakes Rocks teacher professional development course on Earth systems science. During our first year of funding, not only are 128 high-needs Chicago-area teachers eligible to receive graduate credit for their participation, this grant allows MSI to develop and test an eight-month syllabus for teacher professional development in climate and earth science literacy, the use of NOAA's online visualizations of research data about Earth's dynamic systems and lesson development and sharing among peers. Because the ELG program encourages collaboration with NOAA, our teachers will connect with Great Lakes Environmental Research Lab scientists who will demonstrate their research and will participate, via videoconference, in a "live dive" with the Thunder Bay National Marine Sanctuary as they explore shipwrecks covered with non-indigenous mussels.

Demand for these awards is very high, and NOAA has been able to fund only 14 percent of the applications received. In FY10, 357 letters of intent, 95 full applications were reviewed and 17 new awards were made. To date, more than 27 million people have experienced these learning institutions with NOAA-funded public engagement projects and programming for students and teachers.

Conclusion

I hope that my testimony today has described how science museums and centers are important partners in improving STEM education, and that STEM education investments by NSF, NOAA and NASA are critical to our success. Our nation's economic success, global competitiveness and national security depend on a scientifically literate and skilled workforce—not just scientists and engineers but nurses, medical technicians, biotechnology lab technicians and even manufacturing plant supervisors.

China, India and other countries recognize this and are heavily investing in their scientific infrastructures, from education and research labs to science centers and public science engagement programs. Without the programmatic support that NSF, NOAA and NASA offer through these nationally competitive STEM education grants, we will lose sources of new leadership and ideas at a critical time. This loss will be a detriment to our economy because we will have failed to prepare our next generation of innovators and scientists.