

Redefining the Role of Museums in Science Education

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Abstract

Informal learning institutions such as museums and science centers play an important role in promoting science for all learners. Informal learning environments provide unique opportunities to spark student interest in science and to deepen student engagement [1]. They can reinforce scientific concepts and practices [2], [5], while developing an appreciation for and interest in the pursuit of science in school and in daily life [3]. Recent reports emphasize the importance of learning science in informal environments and provide clear evidence that these experiences can promote science learning in ways that strengthen and enrich school science [4], [6]. Informal learning has also been shown to provide important and unique opportunities to engage students who come from communities historically underrepresented in science-related fields [1], [3].

In order to prepare the next generation to actively contribute to a global society that is being shaped by science and technology, the Museum of Science and Industry (MSI) in Chicago, IL, USA established a vision which aims to inspire and motivate our children to achieve their full potential in the fields of science, engineering, technology and medicine. To meet the challenge of this vision, MSI has redefined the role informal learning institutions must play to improve the quality of science education in our communities and to build a scientifically literate citizenry. MSI has developed and launched a long-term strategy that provides a comprehensive suite of science education programs focused at their center on engaging underserved youth in science learning, but also their influencers – the communities, families and schools – who support them [7].

This paper outlines the components of a comprehensive model for using the resources of informal learning institutions to strengthen science learning both in and out of the school setting. We explore science education program strategies that target students, teachers, community organizations, and families at a community-wide level. We share practical and effective approaches that aim to raise interest and participation in science by students across grade levels; influence youth to choose careers in science, technology, medicine, and engineering; sustain a supportive community climate for science engagement; and facilitate high-quality science teaching and learning in schools.

1. Introduction

Informal learning institutions such as museums and science centers play an important role in promoting science for all learners. Informal learning environments provide unique opportunities to spark student interest in science and to deepen student engagement [1]. They can reinforce scientific concepts and practices [2], [5], while developing an appreciation for and interest in the pursuit of science in school and in daily life [3]. Recent reports emphasize the importance of learning science in informal environments and provide clear evidence that these experiences can promote science learning in ways that strengthen and enrich school science [4], [6]. Informal learning has also been shown to provide important and unique opportunities to engage students who come from communities historically underrepresented in science-related fields [1], [3]. As a result, science museums and other informal learning institutions have the opportunity to play a key role in improving the quality of science education for all learners.

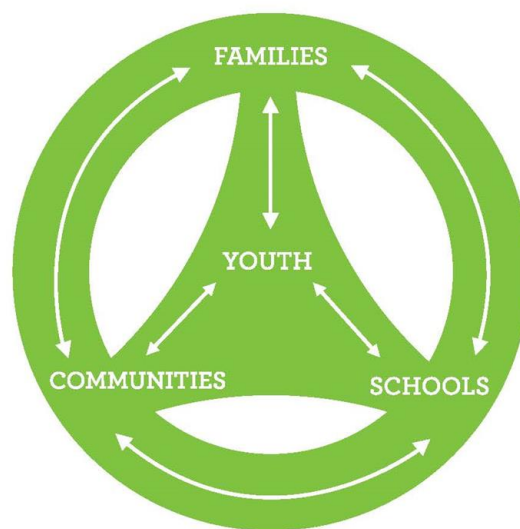
2. Changing the Museum Context

The Museum of Science and Industry has delivered inspiring science experiences to more than 180 million guests since opening its doors in 1933, and continues to act as a science resource for the local community and visitors from around the globe. MSI's vision *to inspire and motivate children to achieve their full potential in science, technology, medicine and engineering* serves as the Museum's guiding principal every day - both inside and outside of its walls. 1.4 million visitors experience live science at MSI each year, including 340,000 students on school field trips. MSI delivers science engagement to the people that need access the most—Museum entry is always free to Illinois school children and teachers on field trips and 52 free days are offered each year, eliminating the financial barrier to visiting MSI.

In 2008, the Museum launched the Center for the Advancement of Science Education (CASE), following the convening of a national advisory committee comprised of civic leaders, senior staff from regional non-profits serving at-risk youth and national leaders in science education. The committee informed the strategic plan for CASE, with educational services for schools and community groups placed firmly at its center.

CASE leverages the Museum's unique offerings and is dedicated to fostering more and diverse future scientists, increasing public science literacy and improving science learning in our schools. Through CASE, MSI has reinvented the role informal learning institutions must play to improve the quality of science education in our communities and to build a scientifically literate citizenry. MSI's long-term strategy provides a comprehensive suite of science education programs focused at their core on engaging underserved youth in science learning, but also their influencers – the communities, families and schools – who support them [7]. Figure 1 depicts the relationships between these important audiences and serves as a model that guides the Museum's educational efforts.

Figure 1. *Center for the Advancement of Science Education (CASE) Model*



CASE programs are designed to extend the content of the Museum's exhibits through strategies that empower teachers, engage families and their communities, and excite students. The resulting programmatic framework is based upon an approach that is multifaceted and targets students, teachers, community organizations, and families at a community-wide level. The education programs aim to raise interest and participation in science by students during their middle- and high-school years; influence youth to choose careers in science, technology, engineering and medicine; sustain a supportive community climate for science engagement; and facilitate high-quality science teaching and learning in schools. The MSI model focuses on programs supporting learning both during the traditional school day and during out of school time.

3. School Programs

With the recent release of the Next Generation Science Standards (NGSS) [5], teachers and schools in the Museum's region are being asked to implement new practices, standards and assessments in science education. The NGSS place a strong focus on actively engaging students in science and engineering practices as well as recognizing and applying crosscutting concepts and understanding core ideas. Through student experiences, science teacher education and the Museum's new Science Leadership Initiative, MSI is uniquely poised to provide vital support to teachers and schools during this fundamental transition.

3.1. Student Experiences

Student experiences provide opportunities for school groups visiting MSI on field trips to participate in hands-on labs and exhibit exploration, using the Museum's inspirational spaces to investigate the science behind everyday life. Multi-disciplinary and aligned with the NGSS, student experiences extend and deepen the educational impact of our exhibits, providing students and teachers with meaningful learning experiences that begin in the classroom, center on Museum exploration and

illuminate areas for further science engagement back at school. By narrowing the scope of field trips to focus on specific curriculum areas connected directly to the classroom, student experiences:

- 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 STEM careers.

Learning Labs, the foundation of student experiences, are hands-on workshops on a range of science topics. Labs also provide professional development for teachers as Museum staff model effective and engaging hands-on science instruction that teachers can replicate in their classrooms. Two Learning Labs, Live...from the Heart and Mission to Mars, use videoconferencing to provide real-time access to STEM professionals in the field, further supporting career connections for students. Learning Labs serve approximately 20,000 3rd-12th grade students each year.

3.2 Science Teacher Education

MSI seeks to improve science instruction and boost student achievement in the middle grades by providing sustained and comprehensive science teacher coursework. The Museum's Institute for Quality Science Teaching (IQST) helps teachers deliver effective STEM education through experiential, immersive professional development that readily translates to classroom instruction. IQST goals include:

- Improving teachers' science content knowledge
- Increasing teachers' use of hands-on and inquiry-based strategies in the classroom
- Building teachers' use of external resources (i.e. how to use resources such as MSI, other informal learning institutions, real-time data, etc. to improve their science teaching).

IQST targets teachers in 4th-8th grade, a critical time when science becomes more challenging and teachers may not have science expertise. Teachers develop a broad background in science that is aligned with classroom curriculum (life, physical, environmental, Earth and space science), and modeled on the NGSS. Each year, approximately 200 teachers from over 50 schools participate in academic year courses and summer institutes. To date, 913 teachers from 364 schools have participated, impacting an estimated 196,406 students during and immediately following their IQST courses. IQST serves teachers from Chicago's neediest schools. 63% of teacher participants come from the Chicago Public Schools, the nation's 3rd largest district where 87% of students live in low-income households. Other teachers come from surrounding high-need public, private, parochial and charter schools.

Recent research by Michigan State University indicates that MSI teacher courses significantly improve what teachers and their students know and understand about science [6].

3.3 Science Leadership Initiative

The growth and impact of IQST has positioned MSI to address the significant need to transform science education on a whole-school level through an innovative new Science Leadership Initiative. This Initiative, poised to launch a pilot implementation phase in early 2015, aims to:

- Ensure that Chicago-area K-8 children attend a school that demonstrates an exceptional learning environment for science
- Engage educators in the necessary training and tools to deliver high quality science instruction
- Support a network of schools in providing exceptional science education, and that work to support each other in improving science teaching and learning.

To achieve these objectives, MSI will create a research-based self-assessment tool for schools to identify how well they support science teaching and learning, develop a reward and recognition program for schools that model effective science education, and design additional supports to aid in the success of improving schools.

The Museum has convened three advisory committees (national and regional science education policy and research leaders, local teacher leaders and local administrative leaders) to guide this work. Five partner schools will begin piloting initial program components in spring, 2015.

4. Out of School Time Programs

There is a growing recognition that social and economic factors play an important role in student success and that today's youth require supports that extend beyond the school walls and school day [4]. The MSI model employs the concept of a learning ecosystem [3], placing youth at the center, with resources and supports organized around them. In this approach, schools are extremely important, but are just one of many influencers in a young person's life, including peers, family, and community. MSI's efforts in out of school time complement our school-based strategies to maximize the potential impact on our children and youth [7].

4.1 Youth Development

MSI has a strong tradition of engaging youth in science learning. Our Science Minors and Science Achievers youth development programs provide opportunities and access for high school age youth from backgrounds traditionally underrepresented in STEM fields. Programs are designed to promote leadership, college and career readiness and service learning, inspiring our youth to be the next generation of science leaders. MSI's youth development programs provide the greatest depth of experience among all of our education programs by developing sustained relationships with youth throughout their high school years and beyond. MSI's youth development programs draw upon the unique resources of the Museum to:

- Provide diverse youth with access to science learning experiences
- Open pathways for youth to pursue post-secondary education and consider STEM-related careers
- Position youth as ambassadors for science learning in the Museum and in the community.

Science Minors and Achievers serve approximately 250 youth each year, providing weekly opportunities to participate in STEM learning, develop communication skills by leading science experiences with Museum guests, and explore college and career pathways. Each summer nearly 50 youth are hired into paid science education internships, offering a first work experience while expanding the Museum's reach. The 26 graduating seniors from the 2014 class of Science Achievers volunteered over 6,200 service learning hours, were accepted to 44 colleges and universities, and earned over \$550,000 in scholarships.

4.2 Afterschool Science

The Museum has developed a successful strategy for supporting afterschool science learning that is currently implemented across the Chicago area. By establishing partnerships with local community-based organizations, schools, and other social service agencies, the Museum has tapped into existing community networks to better understand and meet the needs of local audiences who have been traditionally underrepresented in STEM fields. MSI Science Minors Clubs are based upon an approach that builds the capacity of partner organizations to integrate science into their existing out of school time programs for elementary and middle grade students. The Museum's afterschool science programs are designed to:

- Build a presence for science within communities
- Expand the capacity of partner organizations to integrate science learning into existing programs
- Engage children and youth in science learning beyond the traditional school day.

During the current school year, MSI is working with 110 local school and community-based partners to offer weekly afterschool science programming for nearly 10,000 children. Through the design of flexible curricula, professional development for after school program staff, and implementation support for partner organizations, MSI Science Minors Clubs serve as a model for how museums can support science learning in a wide range of non-traditional learning environments.

4.3 Family Engagement

MSI has developed a wide range of resources and programs that encourage family science learning. Family learning is at the core of the Museum experience - occurring within our transformative exhibition halls, at community-based family science events, and continuing through at-home science learning. The Museum's family engagement programs aim to:

- Provide resources and opportunities for family members of all ages to learn science together
- Help schools and community-based organizations employ effective strategies for engaging the families of their students in science
- Encourage parents and caregivers to become actively involved in their child's science education.

Through a partnership with the Chicago Public Library system, MSI supports over 72,000 children and their families in learning together through the summer months when school is not in session. In addition, the Museum hosts family science events at community partner sites throughout the year to help families gain access science resources in their neighborhood, and works to bring families from underserved communities to the Museum to celebrate science learning at MSI Family Days. -3

By empowering families, the Museum maximizes the potential for making an impact on the children and youth in our region.

5. Conclusion

The work accomplished at the Museum of Science and Industry, Chicago represents a step forward in the evolution of science and technology museums. By establishing a core focus on advancing science education, informal learning institutions are well positioned to play a greater role in the broader science education arena. Through strategies that extend learning beyond the walls of museums, expand access and opportunities for youth and families, and support improved science teaching and learning in our schools and communities, informal learning institutions can inspire and motivate the next generation to:

- Participate as members of a competitive and capable workforce equipped with the technical and quantitative skills to succeed in the global marketplace
- Invent the creative solutions to the most pressing issues facing our world—climate change, energy independence, health and safety, etc.
- Make fundamental discoveries about our world and ourselves and develop the technological solutions that will shape the future.

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