National Governors Association

Issue Brief

The Role of Informal Science in the State Education Agenda

Executive Summary

Since the 1990s a global shift has begun in the location of science, technology, engineering, and math (STEM) talent. While the United States remains the world hub of science and technology capacity, its dominance is being challenged by the fast growth of STEM talent in Asia and other parts of the developing world. In contrast, the number of U.S. students pursuing STEM studies and careers each year is showing little change. In response, many states have launched aggressive education campaigns to increase student STEM proficiency and bring more students into the STEM education and career pipeline. Informal science education—which largely takes place outside the classroom at museums, science centers, and other institutions—can be an effective tool in a broader STEM agenda to help states achieve their goals.

Informal science education extends student learning beyond the classroom through hands-on activities that let youth discover and practice STEM concepts. Evaluations over the last decade of organized informal science programs consistently have shown that such programs (1) raise student interest, confidence, and classroom achievement in math and science and (2) generate student interest in pursuing STEM studies and careers. Evidence also suggests that teacher professional development at informal science institutions can improve teacher effectiveness in the classroom.
Informal science activities can take several forms:

- **Sustained student learning beyond the classroom**. These programs provide K-12 students afterschool, weekend, and summer activities over multiple years at institutions such as science museums, zoos, local universities, and research centers. The programs are structured and goal-oriented, and often involve STEM professionals mentoring students in science projects and career choices.
- **Limited-duration programs that complement classroom learning**. These programs last from a semester up to a year at partnering institutions outside the classroom. These programs are similar to sustained learning programs in that they focus on helping students gain comfort in math and science concepts and see the connections to real-word applications. They frequently include science projects, experiments, demonstrations, and the involvement of professional scientists as mentors.
- **Teacher professional development programs**. Many informal science institutions hold weekend and summer programs that prepare teachers in leading hands-on science activities for students and conducting lesson plans. Those professional development activities often are integrated with student programs at the institutions, helping teachers practice skills to become more effective in the classroom.
- **Bringing resources to the classroom and to students**. A number of informal science institutions, like museums and research centers, provide materials that can be used in the classroom or at other venues to teach students STEM skills and pique their interest in science. Those programs may include visits by scientists to the

classroom to demonstrate and discuss concepts and web-based activities.

Unfortunately, states do not consistently make informal science a partner in the state STEM agenda. Partly that is because states provide only a small share of direct funding to informal science institutions, such as museums, while the majority of funding comes from the federal government, corporate and private foundations, and the general public. However, that same fact also makes informal science a low-cost, high value option for states. Thus, governors pursing a state STEM strategy should consider the following actions:

- Explicitly include informal science education as a key part of an action agenda to improve STEM literacy and proficiency among the state's youth. Include representatives from informal science institutions on state STEM advisory councils along with business and philanthropic members. Encourage the councils to identify programs with demonstrated results and recommend options that promote partnerships between formal and informal education institutions. That is similar to the approach taken by the Governor's STEM Advisory Council in Iowa which, among its objectives, seeks to "…collaborate with participants and parties from the public and private sectors to promote STEM education, innovation and careers statewide."[1]
- Continue to support quality informal science programs in the state such as those offered by museums and science centers. In most cases, state funds are matched several times over by other donations and grants to run these programs. Those programs not only complement classroom instruction, but they frequently include teacher professional development, which improves teacher effectiveness.
- Encourage districts to support more project-based STEM learning in afterschool environments. One example is including a science exit project for middle or high school students similar in nature to the one implemented in New York City schools. Informal science institutions are uniquely positioned to support the activities needed to complete such projects in their afterschool programs.
- Encourage the governor's STEM council or state education agency to oversee the creation of an on-line catalogue of informal science activities offered throughout the state and a compendium of program evaluations. Such a catalogue would be useful to schools, teachers, parents, and students and could help identify if any gaps exist in the type of programs offered.

Introduction

Many governors have launched initiatives to raise student proficiency in math and science and encourage youth to pursue careers in STEM fields (i.e., science, technology, engineering, and math). Individuals with strong STEM skills play vital roles in technological innovation and economic growth and are rewarded with more secure jobs and higher compensation throughout their lifetimes compared to those without such skills.

Many obstacles stand in the way of improving STEM outcomes, not the least of which is increasing the number of students who are interested in entering the STEM pipeline. Students must be motivated to pursue STEM. They must have time, resources, and opportunities to learn and practice STEM skills. And they must see the connections between STEM knowledge and the real world so they can envision careers. Given that students in grades 1-12 spend only about 18.5 percent of their waking hours in formal classroom environments, spread across multiple subjects, there simply is not enough time for many students to learn STEM skills, apply them, and understand how they relate to potential STEM careers.[2] Informal science can help students overcome those obstacles by generating interest in science, stimulating inquiry through organized activities outside the classroom, and exposing youth to the opportunities that STEM knowledge presents. Informal science experiences can help students see how their continued investment in STEM education opens doors to an exciting future.

Is America Losing its Edge in Science Talent?

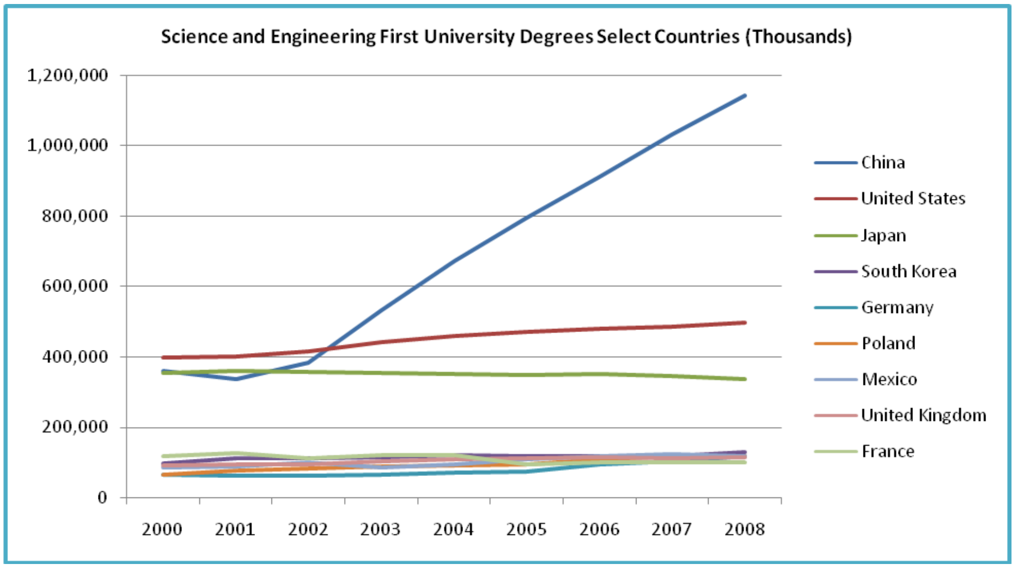
The latest national and international statistics from the National Science Board paint a troubling picture for the United States' as a future world hub of innovation and scientific talent. Most first university degrees in STEM—broadly comparable to a U.S. baccalaureate—are now awarded in Asian countries, chiefly China. Over half (51 percent) of the world's share of STEM researchers now live outside the United States and the 27 EU-membered countries. In China alone, the number of researchers tripled from 1995 to 2008. The report concludes:

"In most broad aspects of S&T (science and technology) activities, the United States continues to maintain a position of leadership. But it has experienced a gradual erosion of its position in many specific areas. Two contributing developments to this erosion are the rapid increase in a broad range of Asian S&T capabilities outside of Japan and the effects of EU efforts to boost its relative competitiveness in R&D, innovation, and high technology.

This paper reviews the value of informal science activities, which can occur at after-school and summer programs for children, in science centers and museums, through virtual programs over the internet, and through science competitions, to name a few examples. The paper also discusses how states can maximize the role of informal science in the state education agenda, and take advantage of a resource that can help achieve the states' STEM goals.

This brief is a companion document to a recent NGA Center report, "Building a Science, Technology, Engineering, and Math Education Agenda: an Update of State Actions."[3] That report described the strong benefits to individuals and society of STEM education and outlined the key policy actions states can and are taking to boost the number of individuals pursuing STEM education and careers. Maximizing informal science educational opportunities is one of those policy actions.

The goal of generating greater numbers of students in-



terested in science and pursuing STEM education and careers is vital to all regional economies and the country. As developing nations devote greater resources in producing STEM talent, a larger share of the global R&D workforce, investments, and benefits will reside outside the United States (see sidebar and Figure 1)[4,5]. A focused state STEM agenda coupled with support from informal science institutions can help reverse this trend.

The Value of Informal Science

Over the last decade, the number of studies on the value of informal science on student learning and motivation has grown so swiftly that it is not possible to comprehensively review all of them in this paper. However, the collective message of these studies is that organized informal science activities can play a powerful role in motivating student interest in science and technology and raising student performance in STEM education.

Among the recent comprehensive studies often cited is a 2009 report from the National Research Council, "Learning Science in Informal Environments: People, Places, and Pursuits."[6] The report brought together experts in informal science to assess the evidence of science learning across settings, age groups, and duration.

Among its conclusions:

> *"There is mounting evidence that structured, non-school science programs can feed or stimulate the science-specific interests of adults and children, may positively influence academic achievement for students, and may expand participants' sense of future science career options."*

A more recent study by the Afterschool Alliance examined evaluations of numerous afterschool programs across the country.[7] Their review found that attending high-quality STEM afterschool programs can yield three broad benefits: "improved attitudes toward STEM fields and careers, increased STEM knowledge and skills, and higher likelihood of graduation and pursuing a STEM career."

That good informal STEM programs can raise student success should not be surprising. Classroom research indicates that certain instructional practices—such as hands-on work and participating in a group project on STEM—appear to boost student achievement in the subjects addressed.[8] Those same attributes are found in good informal science programs.

Another benefit of informal science is its ability to increase student interest and confidence in science, potentially raising the number of students entering the pipeline to STEM study and careers. Recent research suggests that early positive experiences in science can spark an interest in pursuing a career in the field. Moreover, studies have found that students expecting to pursue a science-related career in the 8th grade were 1.9 times more likely to earn a physical science or engineering degree than students without such expectations.[9]

A 2010 study examined the experiences reported by STEM scientists and graduate students that prompted them to enter their fields. Although 45 percent of the sample indicated that the motivating source was an intrinsic self-interest in the subject, another 40 percent reported that it was related to a school or education-based experience, such as a science competition or a science camp. The previously cited study on informal STEM afterschool programs also found that many of the activities led to increased enrollment, interest, and participation in STEM-related courses and a positive shift in attitude about STEM-related careers.[10]

Nurturing interest and inspiration in math and science can be particularly important for boosting minority and female student involvement and achievement in STEM fields. Many of those students lack sufficient exposure to science and math activities and may find the subjects intimidating. Informal science activities can build student confidence in their abilities and bring more minority and female students into the STEM pipeline.

The Different Facets of Informal Science

There are several facets to informal science. This paper focusses on those programs that are organized, are structured around specific goals, and involve some collaboration with formal education institutions. To categorize those activities, this paper uses the following definitions, which are derived and modified from those used in a recent study by the Center for the Advancement of Informal Science Education:[11]

- **Sustained student learning beyond the classroom**. These programs usually work with K-12 students in afterschool, weekend, and summer programs and serve students over multiple years. These activities may be organized by the school, but rely on partnerships with outside institutions such as science museums, zoos, local universities, and community centers. Professional and academic scientists typically are involved. The activities include lesson plans, science projects, worksite visits, and mentoring.
- **Limited-duration programs that complement classroom learning**. These programs also involve collaboration with a partnering institution outside the classroom and last a semester or year at most. They tend to focus on helping students gain comfort in math and science concepts and understand connections to real-word problems. Though they are of shorter duration than sustained learning activities, they are equally structured and goal oriented. They include activities at museums, planetariums, and other science centers.
- **Teacher professional development programs**. These programs are directed at giving teachers sustained professional development and support in science instruction and enhancing science knowledge.
- **Bringing resources to the classroom and student**. Many informal science institutions produce materials that can be used in the classroom or by students outside the classroom on their own. These materials include science kits, lesson plans for experiments, computer games, and simulations. Institutions that offer classroom demonstrations and visits by outside experts—including those conducted over the internet—fall into this category.

The examples cited in the sections below represent but a small fraction of the informal science programs in existence across the United States. Many more examples of high quality programs can be found through the organizations cited in this report (see, for example, the Center for the Advancement of Informal Science Education, the Afterschool Alliance, and the National Science Foundation).

Sustained Student Learning Beyond the Classroom

Sustained afterschool informal STEM programs (which can include weekends and summer school) offer students activities over several years as they progress through different grade levels. Though the programs often are coordinated with schools, most occur at museums, science centers, and other venues and are supported by federal or philanthropic grants, with some state support going to the institution. In a survey that was last updated in 2008, the Education Commission of the States reported that 12 states provided state funds to elements of STEM-related afterschool activities, such as science competitions, state science fairs, or programs operated by other institutions.[12] However, the vast majority of funding for afterschool science activities comes from the federal government (e.g., the 21st Century Community Learning Centers),private and corporate philanthropic grants, and individuals.[13]

Techbridge, for example, is a program in Oakland, California that focuses on helping girls discover a passion for technology, science, and engineering.[14] Techbridge, which offers afterschool and summer programs throughout the Bay area, uses hands-on activities, outside experts (who also serve as role models), and worksite visits to support girls working on projects in specific disciplines, such as computer science, chemistry, or biology. The program is supported by the National Science Foundation, numerous philanthropic and corporate foundations, and individuals.

The program teaches science to students by connecting it to real-world applications. For instance, in the CSI lesson plan for grades 5-8, Techbridge exploits student interest in real and fictional crime scene investigations to teach them what forensic science involves. They learn how crime scene investigations are conducted and how to use methodical thinking to organize and examine various pieces of evidence. Experiments include: testing stomach contents for the presence of liver, dusting dishes to find and analyze fingerprints, using chromatography to compare various inks, using microscopy techniques to examine hair samples, and determining several blood types. Through those experiments (which can last between 4-6 hours over several days), students gain a further understanding of basic biological and chemical concepts. Other lesson plans cover such topics as chemical engineering, computers, design, and career exploration.

Since its founding by Chabot Space & Science Center in 2000, Techbridge has served over 5,000 girls in grades 5-12. As a result of participating in the Techbridge program in 2011, 89 percent of the students reported that they planned to study harder so they can go to college, 85 percent said they were more interested in working in science, technology, or engineering thanks to role model visits and field trips, and 82 percent could see themselves working in technology, science, or engineering.[15]

Youth Exploring Science (YES) in St. Louis, Missouri is another sustained learning example. YES is based at the Saint Louis Science Center and works with underprivileged teenagers throughout the course of their high school careers. It stresses inquiry-based learning that focuses on science, mathematics, and technology. The program was developed with funding from the National Science foundation and continues to be supported through private donations and the science center's general operating fund.[16]

Teens engage in Saturday learning labs and afterschool programs that help them build STEM skills through hands-on projects. Subjects cover such areas as astronomy, biofuels and energy, neuroscience, robotics and engineering, and agriscience.[17] In the robotics and engineering program, for example, teens build robots and explore the disciplines involved in robotics. Through the use of open source hardware and software and robotic kits such as NXT Mindstorm, teens practice engineering design, evaluate problems, and develop solutions. Teens also apply their skills through team competitions, such as the FIRST Robotics Competition discussed later in this paper.

The YES program has documented a 95 percent high school graduation and college admissions rate against a city average of less than 60 percent.[18]

Limited-Duration Programs That Complement Classroom Learning

The programs in this category are similar to the sustained learning programs in that they are structured and goal oriented. However, the programs tend to be of shorter duration—such as one semester or a year—and may closely complement classroom instruction.

For example, After-School Math PLUS (ASM+) is a national program targeting youth in grades 3-8. Its goal is to build student interest, confidence, conceptual knowledge, and skills in math. The program grew out of a pilot program funded in 2004 by the National Science Foundation and implemented by the Educational Equity Center at the Academy for Educational Development (EEC/AED) in New York.ASM+ was developed in collaboration with the New York Hall of Science (NYHS) and the St. Louis Science Center (SLSC), with participation and support from after-school centers in their communities.[19]

ASM+ activities occur over the course of a semester and involve about 10 hours of after-school sessions and from 4 to 18 hours of museum sessions, some of which include parents. The sessions are designed to complement classroom instruction by helping children see the role of math in the real world.

The program is split into four thematic units each of which teach students to see math's presence in everyday experiences, like music, art, and the built environment. In the built environment theme, for example, students explore the immediate setting around them, looking at windows, doors, buildings, streets, and fences with a mathematical eye. Students make their own meter sticks and construct a tool out of rope to measure, collect data, convert it to scale on graph paper, and draw representational maps using scale and symbols. Students use what they have learned about scale, measurement, and their immediate built environment to create a blueprint for an "ideal" community. During their sessions at the museum, students use their blueprints to build a scale model representing their ideal community which is later shared with family and friends at a culminating event.

An evaluation was conducted of pilot YES programs implemented in New York City, St. Louis, Missouri, and Louisville, Kentucky. Among the findings:[20]

- Pre/post performance assessments of students' knowledge and skills showed that many students experienced positive gains including increased understanding of mathematical concepts such as symmetry and tessellations (the process of creating a two-dimensional plane using the repetition of a geometric shape with no overlaps and no gaps), facility with fractions and knowledge of visual displays of data.
- Parents were very positive about the program. Most believed their child enjoyed the activities and that their child's participation played some role in improving their child's ability in math. In addition, most surveyed parents agreed that participation in ASM+ increased their child's interest in math.

Science competitions and science fairs also can serve as an organizing force for informal science activities. Many such events encourage and rely on informal science institutions to mentor and support the teams engaged in the competition or fair. One of the most well-known national competitions is FIRST, a 501(c)(3) not-for-profit organization that sponsors national and international robotics competi-

4-H and STEM

4-H is an example of a national organization committed to boosting student achievement in STEM, In addition to sponsoring teams that compete in robotics competitions, 4-H provides out-of-school STEM learning to more than 6 million youth through programs implemented at Land-Grant Universities and Colleges nationwide. The programs emphasize hands-on experiences in subjects such as agricultural, science, electricity, mechanics, natural sciences, rocketry, robotic, biofuels, renewable energy, and computer sciences. The stated objectives for the 4-H Science initiative “are to increase science interest and literacy among youth, to increase the number of youth pursuing post-secondary education in science, and to increase the number of youth pursuing science careers.”

tions.[21] Founded over 20 years ago by inventor Dean Kamen, the FIRST competition is open to students from across the country and around the world. The 2009-2010 FIRST season involved more than 210,000 youth and 90,000 mentors (often professional engineers), coaches, and volunteers from 56 countries. The competitions and team development are supported through corporate, foundation, and individual donations and through alliances with educational and professional institutions. Several informal science programs—such as the YES program described in the previous section and those developed by the Girl Scouts and 4-H—host and support FIRST teams (see sidebar on 4-H).[22]

FIRST has a number of programs ranging in complexity and difficulty starting with its junior FIRST Lego League, which introduces children ages 6-9 to the exciting world of science and technology. In the FIRST Tech Challenge, designed for ages 14-18, teams of up to 10 students design, build, and program their robots to compete against other teams. Teams—which include coaches, mentors, and volunteers—must develop strategy and build robots based on sound engineering principles. The competitions give students an opportunity to:

- Apply real-world math and science concepts;
- Develop problem-solving, organizational, and team-building skills;
- Compete and cooperate in alliances at tournaments;
- Earn a place in the World Championship; and
- Qualify for more than $7 million in college scholarships.

A 2005 evaluation of the program found that FIRST alumni were:[23]

- Significantly more likely to attend college on a full-time basis than comparison students(88 percent vs. 53 percent);
- Nearly two times as likely to major in a science or engineering field (55 percent vs. 28 percent) and more than three times as likely to have majored specifically in engineering (41 percent vs. 13 percent);
- Roughly 10 times as likely to have had an apprenticeship, internship, or co-op job in their freshman year (27 percent vs. 2.7 percent);
- Significantly more likely to expect to achieve a postgraduate degree (Master’s degree or higher: 77 percent vs. 69 percent); and
- More than twice as likely to expect to pursue a science or technology career (45 percent vs. 20 percent)and nearly four times as likely to expect to pursue a career specifically in engineering (31 percent vs. 8 percent).

Teacher Professional Development Programs

A large number of science institutions offer professional development to teachers wishing to improve their capabilities in science instruction. The programs typically help teachers learn how to demonstrate basic science concepts, stimulate student inquiry, and guide students in designing science experiments. Most combine professional development with student activities so the teacher can apply their acquired skills using exhibits and other resources available through the institution.

For example, the Exploratorium in San Francisco is a museum of science, art, and human perception that includes a wide range of interactive exhibits.[24] The Exploratorium also offers a number of professional development opportunities for science teachers, including spring teacher workshops, a summer institute, a beginning teacher program (which combines workshops, summer institutes and museum resources over a two-year period), and a leadership program (which trains alumni of the teacher institutes in training the novice teachers).

The two-year Beginning Teacher Program is open to middle and high school science teachers throughout the San Francisco Bay Area. It includes four Saturday workshops, a two-week summer institute led by Exploratorium staff scientists and educators, use of the museum's teacher resources, and regular meetings with a support group of other beginning teachers and an experienced science teacher. Experienced science teachers also are available to assist the beginning teachers in their classroom. At the end of each semester, participating teachers receive a stipend and are eligible for receiving continuing education credits. The institutes receive support from a variety of sources, including the National Science Foundation, Noyce Foundation, and Carnegie Corporation of America.

Another example is Urban Advantage (UA), which began as a standards-based educational partnership between New York City public schools and science institutions such as zoos, botanical gardens, museums, and science centers.[25] The program combines professional development of teachers with student learning activities that focus on developing scientific inquiry and analysis. The NYC program began partly to help students meet a city-wide mandate requiring all eighth graders to complete long-term scientific investigations (known as "exit projects"). Four types of exit projects are permitted: (1) controlled experiments; (2) field studies; (3) design projects; or (4) secondary research (in which students use scientific data sets obtained by others).The program has since grown to include Boston, Denver, and Miami.[26]

Professional development in the NYC program involves at least two years of training. The first year begins with twelve hours of orientation that includes showing teachers how to pace investigations across the school year, plan field trips, embed resources in instruction, use UA-provided equipment and resources, and teach students the process of experimental design. During the remaining 36 hours of professional development, teachers attend sessions at two institutions of their choice and complete two different kinds of exit projects themselves. The exit projects are similar to those students must conduct, essentially testing a hypothesis and explaining the findings.

The second year of professional development (teachers may continue beyond two years) involves a total of ten hours of workshop instructions offered after school and on weekends. Workshops include learning how to explain scientific concepts—such as plate tectonics, natural selections, and weather—and teaching students how to develop good scientific conclusions based on claims, evidence, and reasoning. Teachers are offered a stipend to participate in the training.

In 2010, researchers at New York University conducted an evaluation of the Urban Advantage program.[27] They found that UA schools outperformed non-UA schools in 2007-08 with an average of 54 percent of students meeting the standards on the 8th Grade New York State Science Examination, compared to 46 percent of students at non-UA schools.

Bringing Resources to the Classroom and Student

A final category of informal science involves programs that bring outside experts and/or resources into the classroom to teach and demonstrate science concepts. Those programs often provide kits and materials that can be used in the classroom or by students on their own.

For instance, for several decades the state of Washington has funded the Science on Wheels program at the Pacific Science Center in Seattle.[28] The program uses a van equipped with exhibits and lab demonstrations to bring informal science to Washington schools. A full day science van visit can include a science show, an exhibit area, and hands-on science lessons taught in the classrooms. All programs are standards-based.[29]

In the Mathfinder full-day science visit, for example, the Science on Wheels van brings tabletop exhibit sets, experiments, and activities. In addition to the exhibits and a science show, teachers can choose a 45-minute hands-on science lesson to be taught in their class. For example, grades 3-5 can receive the "Code Breakers" lesson, which shows students the math in real-life codes and messages. Students work in two-person groups to unravel secret messages, break historical codes, decipher mysteries, and create their own codes based on logic and patterns.

Another program that is national in scope and web-based is Immersion Learning™, which uses the internet to bring ocean adventures and discoveries to classrooms, after-school settings and informal learning arenas.[30] The program is a collaboration of the Mystic Aquarium and Institute for Exploration, the University of Rhode Island, and the National Oceanic and Atmospheric Administration. The program features live webcasts from one or more real-world oceangoing expeditions each year, hands-on science activities, interactive games, videos, and lesson plans. School districts apply to be a partner site so they can have access to curriculum materials, the library of materials, and webcasts.

Co-founded by Dr. Robert Ballard, who first discovered and surveyed the wreck of the HMS Titanic, Immersion Learning™ offers live interviews with scientists (including Dr. Ballard) and archived materials from previous explorations. Exploration videos, computer simulations, and other resources are combined into lesson plans that teachers can use to show students about science in the real world, such as how volcanoes create islands. Each year, Immersion hosts a professional development conference for all Immersion sites to teach them how to use the lesson plans and demonstrate new program resources.

Programs like Science on Wheels and Immersion require more direct engagement with schools since most of the resources are used in the classroom by teachers. The impact of those types of programs has not been evaluated to the degree that more structured, after-school activities have been.

Challenges

Several challenges stand in the way of states' fully utilizing informal science education. That is unfortunate, because most quality programs involve little if any direct state funding and do not compete with other state education dollars or classroom time. Instead, in most cases they present high value, low cost educational opportunities that complement and reinforce STEM classroom learning.

Perhaps the first challenge—and a key one—is that many states do not recognize and promote the role that informal science can play in buttressing other state actions around STEM. Thus, the state may be adopting more rigorous math and science standards, recruiting and retaining more qualified teachers, and providing more rigorous preparation for STEM students, while not taking full advantage of afterschool programs or teacher professional development opportunities provided through informal science institutions. As a result, school districts engage with the informal science community in a patchwork fashion, with robust activities in some areas and none in others.

Second, schools and school districts are often left on their own to find and choose quality programs. Although many websites and publications describe the role, value, and structure of individual programs, schools and teachers typically must conduct the research on their own and make their own choices. Often it is up to the informal science institution, such as a local museum, to reach out to individual schools and districts. A central clearinghouse of information on quality programs available throughout the state would be helpful.

Finally, more evaluations of programs are needed to show their impact on students, both in terms of building an interest in science *and* in improving student achievement. The informal science community strongly backs evaluations, and most good programs can provide evaluation data. But new evaluations are constantly needed as programs evolve or become transferred to new places. Generally, it is up to the individual school or district to conduct an evaluation, so cost can be an issue.

Taking Action

Because informal science offers states a powerful, low-cost way to help achieve the goals of an overall STEM strategy, governors should consider several actions to take full advantage of informal science options.

- Explicitly include informal science education as a key part of an action agenda to improve STEM literacy and proficiency among the state's youth. Include representatives from informal science institutions on state STEM advisory councils along with business and philanthropic members. Encourage the councils to identify programs with demonstrated results and recommend options that promote partnerships between formal and informal education institutions. This is similar to the approach taken by the Governor's STEM Advisory Council in Iowa which, among its objectives, seeks to "collaborate with participants and parties from the public and private sectors to promote STEM education, innovation and careers statewide."[31]
- Continue to support quality informal science programs in the state, such as those offered by museums and science centers. In most cases, state funds are matched several times over by other donations and grants to run these programs. Those programs not only complement classroom instruction, but they frequently include teacher professional development, which improves teacher effectiveness.
- Encourage districts to support more project-based STEM learning in after-school environments. One example is including a science exit project for middle or high school students similar in nature to the one implemented in New York City schools. Informal science institutions are uniquely positioned to support the activities needed to complete such projects in their after-school programs.
- Encourage the governor's STEM council or state education agency to oversee the creation of an on-line catalogue of informal science activities offered throughout the state and a compendium of program evaluations. Such a catalogue would be useful to schools, teachers, parents, and students and could help identify gaps in the type of programs offered.

By bringing informal science together with other state actions around STEM, the goal of more students pursuing STEM education and careers may be realized.

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This issue brief was written by John Thomasian of Black Point Policy Solutions, LLC.

(Endnotes)

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