## Frontiers in Urban Science Exploration

# Resource Guide

Strategies to advance informal science education in after-school

THE COLLABORATIVE *for* BUILDING AFTER-SCHOOL SYSTEMS

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# INTRODUCTION

"I want us to think about new and creative ways to engage young people in science and engineering, whether it's science festivals, robotics competitions, fairs that encourage young people to create and build and incent—to be makers of things, not just consumers of things."

*-President Barack Obama*
*(NAS Annual Meeting, 2009)*

There is widespread consensus regarding the urgent need for improved science, technology, engineering and math (STEM) education in the United States and the implications for our nation's competitiveness in science fields, particularly for underserved youth. Students' performance in science and math has been failing for years, and is reaching an all time low, with US students ranking 21st of out of 30 in science literacy and 25th out of 30 in math literacy among students from developed countries.[1] In addition, as pointed out by The White House's "Educate to Innovate" campaign, on the 2009 National Assessment of Educational Progress (NAEP) math assessment, 4th graders showed no signs of progress for the first time in many years.[2]

As a result, the White House is leading a call to action to stimulate our nation's STEM pipeline. In this call for action, policymakers and educators recognize schools can't do it alone and are urging for all hands on deck to boost STEM achievement, ignite passions in science, and expose students to career possibilities, particularly women, minority students, and kids from underserved communities. Improving science education has long been an issue for K-12 educators, and increased national attention, combined with public and private partnerships, signals an opportunity for after-school, education and informal science education proponents to join forces to revitalize science and math learning.

As Lucy Friedman and Jane Quinn stated in the *Education Week* article "Science by Stealth," "after-school programs offer an ideal setting for nurturing the potential scientist in every student, as well as for reinforcing the science taught during the school hours. Compared to the school day, these programs' smaller groups, longer time slots, and less-formal settings provide opportunities for young people to visit museums, study neighborhood environments, cultivate gardens, perform laboratory experiments, and have their love of discovery awakened in countless other ways." Despite after-school being an ideal venue for the delivery of informal science education (ISE), high-quality STEM education is not happening at scale and is not viewed as an expectation of programs, similar to art, music and physical education. ISE supports people of all ages and walks of life in exploring science, technology, engineering, and mathematics in a range of different environments and through a wide variety of experiences.[3]

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[1] US Department of Education: National Center for Education Statistics (2007) *Highlights from PISA 2006: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context.* Retrieved 5/10/10 from: http://nces.ed.gov/pubs2008/2008016.pdf

[2] http://www.whitehouse.gov/issues/education/educate-innovate

[3] Adapted from CAISE, http://caise.insci.org/what-is-ise

Through efforts by the Coalition for Science After-School (CSAS), Great Science for Girls, the National Science Foundation, capacity-building intermediaries, and many national after-school science initiatives, more after-school programs than ever are offering science, and the majority of program leaders attest to the importance of providing science. Despite this interest in science in after-school, science activities, when offered, are typically limited and sporadic, due to lack of access to training, comfort level of staff, and funding for curricula. CSAS surveyed 800 program leaders in 36 states and found that the majority of programs (60%) provided less than 40 hours of science programs a year and of those programs, 40% involved less than half of participants in science activities.[4]

In an effort to prepare all kids for post-secondary success and a lifetime of science based learning, with support from the Noyce Foundation, the Collaborative for Building After-School Systems is embarking on a national initiative to institutionalize engaging, inquiry based science experiences in after-school. Frontiers in Urban Science Exploration (FUSE) will take national the work of The After-School Corporation (TASC) to stimulate a culture shift among New York City's after-school leaders and staff to increase the demand for and delivery of high-quality informal science education (ISE) in after-school programs. FUSE employs a two-fold approach to bring about this culture shift and shape practice. First, a "grass-tops" strategy engages leaders and staff of schools and after-school programs, government officials, science organizations, policymakers and funders in awareness-raising activities in order to build enthusiasm and capacity for inquiry-based STEM learning after-school. Second, a "grass-roots" strategy provides frontline after-school staff and supervisors with the content knowledge and instructional skills to deliver high-quality ISE. FUSE aims to increase young people's interest and engagement in STEM learning in-school, after-school and over the summer.

Grounded in the informal science education experiences of our partners around the country, the Collaborative for Building After-School Systems (CBASS) developed this resource guide to profile promising strategies to advance informal STEM learning. The guide features:

1. Core elements of the national FUSE strategy
2. Overview of the The After-School Corporation's FUSE strategy and lessons learned in working to bring ISE to scale.
3. Profiles of city and county-wide initiatives, through the lens of a few key strategies to build after-school systems: advocacy, brokering relationships, building partnerships, school-district alignment and strengthening the workforce
4. After-school curriculum resources to advance STEM learning
5. Strategies to inform the development of comprehensive evaluation plans that assess the impact of ISE in after-school
6. Funding sources and partnerships to support the continued growth and long-term sustainability of after-school ISE programs
7. Resources to help support the development of inquiry-based ISE opportunities after-school

We hope these profiles and lessons from CBASS jurisdictions will stimulate a growth in after-school ISE opportunities throughout the country. If you would like additional information on the FUSE strategy and national dissemination, please contact Jessica Donner, Director, CBASS, at jdonner@tascorp.org; 646-943-8738.

[4] Chi, B., Freeman, J., Lee, S. (2008). *Science in After-School Market Research Study*. Coalition for Science After School. Retrieved 5/10/10 from: http://afterschoolscience.org/pdf/coalition_publications/Science%20in%20After-School%20Market%20Research%20Study.pdf

# CORE ELEMENTS

High-quality after-school ISE strategies are designed to be both flexible enough to be effective across jurisdictions and focused enough to result in similar, shared impact. These strategies build on local assets, while maintaining broad core elements to support program success. Core elements of after-school ISE programs fall under two categories: program and system. Program-level elements describe characteristics of high-quality after-school ISE programming, while system-level elements describe characteristics of well-coordinated systems that lead to improved quality, scale and sustainability.

## Core Elements of After-School ISE Programs

| System Level | |
|---|---|
| **Grass-Roots & Grass-Tops Approach** | A two-fold approach engages both leaders (grass-tops) and frontline staff (grass-roots) to promote and support deep change for youth – and the expectation for ISE in after-school |
| **Develop Staff** | To ensure continuity of skills and expertise from year-to-year, training and TA is:<br>> On-going: conducted in multiple sessions across the year with on-going observation and coaching<br>> Differentiated: incorporates advanced activities to ensure skill advancement for returning participants<br>> Cohort-based: involves multiple sites trained as a group<br>> Delivered to teams: supervisors and frontline staff from the same site attend together |
| **Utilize Coordinating Entity** | A coordinating agent supports the development of the ISE strategy by:<br>> Leveraging resources<br>> Vetting curricula<br>> Organizing training<br>> Disseminating promising practices<br>> Fostering partnerships and collaborations<br>> Evaluating impact and quality |

| Program Level | |
|---|---|
| **Integrate High-Quality Curricula** | High-quality curricula meet the following criteria:<br>> Designed for after-school<br>> Inquiry-based and grounded in fun<br>> Involve familiar materials to make the case that science is part of our everyday lives<br>> Promote equity among boys and girls, students of varying abilities and across ethnicities<br>> Evidence-based<br>> Affordable |
| **Promote Co-Inquiry** | Staff and students explore and test assumptions side-by-side |
| **Encourage Collaborative Learning** | Learning evolves from a “pair-based” model at elementary age to “team-based” for high school youth |

# FRONTIERS IN URBAN STEM EXPLORATION (FUSE) MODEL

## The After-School Corporation

**A grass tops and roots approach**

Founded in 1998, The After-School Corporation (TASC) is a non-profit organization in New York City that develops and promotes models for after-school and summer programs that demonstrably improve children's school engagement, motivation, and achievement at a cost public funding can sustain, and that keep kids safe while parents work. TASC launched the Frontiers in Urban Science Exploration (FUSE) program in 2007 to expand the delivery of high-quality, inquiry-based ISE in after-school.

Through on-going trainings, leadership institutes, and expansion of curricula offerings, the availability of after-school STEM programs for youth in New York City has doubled in just three years. Since 2007, more than 14,000 students have participated in ISE in after-school, with 7,000 anticipated to participate this school year. As a result of FUSE training activities, TASC has more than doubled the number of sites in NYC implementing STEM enrichment programs from 46 in 2008 to 110 in 2009.

The goals of FUSE Model are three-fold:

1. Create a culture shift by increasing stakeholders' interest and confidence in the delivery of STEM learning activities in the after-school hours.
2. Prepare and motivate an after-school workforce to deliver STEM education and retain that workforce.
3. Increase kids' interest in STEM learning, making it "cool" to participate in STEM-based after-school activities.

The FUSE model incorporates "grass-tops" activities including a leadership institute and science alliance to convene citywide stakeholders, as well as "grass-roots" activities including an ISE orientation for site staff, training for frontline staff, and a communications strategy designed to educate and inspire after-school staff and educators.

## Grass-tops Activities

Leadership Institute

TASC hosts a half-day Leadership Institute for leaders of schools, community-based organizations and government agencies in New York City with interest in after-school programming. Leadership Institute activities build confidence in and support for the introduction of inquiry-based STEM curricula in after-school settings. In addition to addressing the disparities along gender and racial lines among those represented in STEM fields, the Institute confronts misperceptions about ISE and the capacity of non-science professionals to be effective STEM educators. Evaluation from the Leadership Institute found a substantial increase in the number of participants who recognized that providers do not need to have a strong science background to deliver ISE.

Science Alliance
In an effort to strengthen the system of after-school ISE in New York City, TASC convened committed after-school stakeholders, existing ISE providers, relevant city agencies and scientists through the Science Alliance. The Science Alliance meets quarterly to develop and advance key action areas that are critical to the delivery of ISE in after-school, including:

- Identify and make use of funding mechanisms for ISE to build sustainability
- Link city agency efforts together for increased impact
- Create partnerships between schools, after-school providers and colleges/universities
- Develop credit-bearing out-of-school time experiences, to recover or accelerate science credits in high school.

## Grass-roots Activities

ISE Orientation
The ISE Orientation introduces after-school site coordinators and group leaders to the need for and potential of ISE programming. Participants are exposed to available curricular resources, which were vetted by TASC, and coached on selecting the curricula which best fit the existing structures and resources at their sites. Training partners include the New York State Department of Environmental Conservation (Conservation Club) and the Educational Equity Center at AED (After-school Science PLUS). Training is also supported by TASC staff and there is significant focus on building in-house capacity to deliver curriculum training and technical assistance.

As a result of the ISE Orientation, the number of participants who reported to be confident in presenting science increased from 73% to 93% from pre- to post-survey. Also, the percent of participants who identified specific science programs and activities that they planned to implement in the coming year increased from 52% to 71%.

Train-the-Trainer (new for 2010)
TASC will host a two-day Train-the-Trainer workshop for leaders and trainers who will be delivering ISE professional development to front-line after-school staff and supervisors. In NYC, several agencies operate 10 or more after-school sites and many of these multi-site operators have their own training department and training capacity. FUSE intends to build upon the existing training infrastructure and develop the capacity of the multi-site agencies to facilitate STEM training and deliver technical assistance.

Frontline Staff Training
Experiential training in specific ISE curricula gives site coordinators and frontline staff the curriculum, hands-on materials and coaching that they need to implement ISE at their sites. Sites generally attend in teams of three and receive technical assistance and site visits from TASC's STEM program staff.

Communications Strategy
To raise awareness about the suitability of ISE for after-school settings, TASC's Communications team prepared several multimedia presentations. TASC's June 2009 eNewsletter, entitled "Got Science?" featured students from after-school programs engaging in inquiry-based ISE. The eNewsletter included photos of students engaging in ISE activities and incorporated interviews with after-school staff members involved in the delivery of ISE and various ISE stakeholders.

TASC's Communications team also produced a series of four short videos documenting FUSE activities and shared them in TASC's January 2010 eNewsletter entitled "Making Science Cool."

Each of the videos centered on a different message, including:

- Engaging in science after school is not a substitute for having kids acquire basic math/science skills and knowledge at school.
- Programs need to put time and resources into science because the same students who attend after-school programs (students of color, girls, students with disabilities) are under-represented in science professions, leaving our nation short on STEM talent and future innovators.
- Programs don't need science or math experts to lead activities.
- After-school educators don't need expensive equipment or supplies.

The TASC eNewsletters were distributed to more than 9,000 individual subscribers and over 25 science and youth-development related websites, blogs and listservs nationally.

## Evaluation

TASC's Center for After School Excellence (the Center) is conducting an evaluation of the FUSE model, focusing on outcomes at the student- and program-levels. The Center will conduct 1) a summative evaluation to determine FUSE's influence on students, programs and staff; and 2) a formative evaluation of the Train-the-Trainer component to determine how well it was implemented in relation to the program model. The evaluation will employ site visits and observations of STEM activities as well as interviews with participants and staff. Research questions that will drive the FUSE evaluation include:

- How effective is FUSE in bringing about desired changes in students' STEM-related attitudes, engagement, knowledge and behaviors?
- What are the factors that facilitate and impede the ability of FUSE to impact participants' (i.e. staff students) attitudes, knowledge and behaviors?
- How successful is the delivery of the Train-the-Trainer program component?
- How effective is FUSE in promoting program staffs' preparation, confidence and motivation to deliver STEM activities?

## Lessons Learned from TASC's FUSE Model

Over the past two years of the FUSE initiative, TASC has reached over 700 after-school stakeholders, helping to build the capacity of the after-school field to deliver high-quality STEM learning to youth. TASC's experiences have yielded several key lessons to inform the development of an after-school ISE strategy in other jurisdictions.

**Hands-on activities in after-school can complement school-day instruction.** Aligning after-school ISE activities with school-day instruction can lead to deeper understanding of concepts and greater engagement with science content. Science teachers and ISE activity leaders should communicate and collaborate about activities and concepts so that school-day science and ISE activities in the after-school complement each other. For example, after-school ISE activities can support the inquiry component of any science activity. In some cases, the ISE activity leader may be a school-day science teacher, offering engaging ISE experiences, compensating for limited time available during the regular school day. After-school activities should focus on inquiry, a joy of science exploration and discovery, and engagement.

**Curriculum matters.** Selecting appropriate and high-quality curriculum materials is essential to providing students with hands-on ISE experiences that engage and excite them. Activities should be relevant to the participants, inquiry-based, and hands-on. Activities that are linked to service learning opportunities are appealing to students and reinforce the science concepts in the activities. Curricula that use easy to access, culturally familiar materials send a powerful message to the

participants that science is everywhere and gives them an opportunity to continue the learning beyond the after-school setting. TASC utilizes the following criteria to select STEM programs for their urban, diverse population:[5]

- inquiry-based and hands-on
- involve youth in higher-order thinking skills such as decision-making, planning, problem-solving, and reflecting
- include opportunities for parental involvement
- provide opportunities for youth to learn about role models
- encourage youth to see themselves as learners
- use techniques appropriate for a variety of learning styles, with attention to the needs of underrepresented populations
- use affordable materials that are easy to find
- easy to implement by staff who have no science background
- address the national STEM standards
- include a training component
- provide appropriate content for an urban, diverse audience

**When providing professional development train teams and not just individuals.** High turnover of after-school staff is a constant issue in program implementation that can be addressed through team-based training comprised of a staff with different roles. Team training allows for peer-to-peer support and, in the event of staff turnover, minimizes interruption in implementation as a variety of staff are trained to bring the new staff up to speed. TASC requires that at least three team members from each after-school site attend staff trainings, including the site coordinator and two front-line staff members.

**Providers need ongoing support to ensure successful delivery of ISE.** Many providers are reluctant to tackle science and math due to lack of staff buy-in, comfort in science, training and materials.[6] To get frontline staff on-board with ISE, programs must invest in quality training to implement the curriculum. Rather than offering a one-time training for staff, multiple trainings over the course of the year should be offered. In addition, TASC has found that successful, high-quality programs provide continuous support through on-site coaching opportunities where master teachers observe ISE activities and work with staff to identify areas for improvement and develop action plans.

**ISE guides don't need to be scientists or highly trained in science content.** While having scientists, particularly those from communities underrepresented in STEM careers, as a part of after-school programs can be highly effective and engaging, it is more appropriate for the activities to be led by after-school line staff since they may be more likely to model inquiry-based learning.[7] High school students can be terrific science guides, offering younger students role models from their own local communities, and offering older students a chance to hone their leadership, work, and teaching skills, mentor younger students, and learn through inquiry-based science activities alongside the younger students. For example, through TASC's After-School Education Apprenticeship program, high school students are trained in science curriculum and youth development and then put those skills into practice working with elementary students in stipended apprenticeships after-school. The high school apprentices serve as mentors to guide the younger students through STEM activities, while simultaneously gaining comfort and knowledge in science.

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[5] Criteria informed by the work of *Great Science for Girls*, an NSF funded project of the Educational Equity Center at AED.

[6] Internal evaluation findings, Center for After-School Excellence at TASC

[7] Walker, G.; Wahl, E. & Rivas, L. (2005). *NASA and Afterschool Programs: Connecting to the Future*. The National Aeronautics and Space Administration. Retrieved from: http://education.nasa.gov/divisions/informal/overview/R_NASA_and_Afterschool_Programs.html

**Students, particularly those underrepresented in STEM careers, need exposure to role models and to change their notions of *who* "does" science.** After-school programs need to change kids' perceptions of *who* does science. Women, people of color, people with disabilities, and people from low income backgrounds are traditionally underrepresented in STEM. After-school is the perfect setting for this—since group leaders are generally from the same demographic as their students, they are built-in role models. By sharing science activities in the after-school setting and by learning together, students learn that STEM is important to these significant adults in their lives.

**Parents are an integral component of the culture shift to recognizing science in everyday life and ISE activities in after-school.** For after-school ISE to really take root, there needs to be a critical mass in the community that values STEM and considers it an expected part of a comprehensive after-school system. Involving parents in ISE activities is a first step to reinforce the importance of STEM and build their knowledge-base to support science and math learning among their children. Finding ways to attract parents requires a concerted effort among program staff to keep them informed about the activities that are happening after-school and to invite them to participate in these activities. TASC encourages after-school sites to hold Science /Family Nights, which are the perfect opportunity to convey to parents the importance of STEM education to their children. Research says that one of the strongest indicators for retention in the STEM pipeline for any child is their parent's attitude towards it.

**Outreach should emphasize that youth development experts can facilitate co-inquiry.** Outreach to after-school programs, schools and other stakeholders should aim to build public understanding that anyone can implement ISE, not just science experts. Successful ISE programs draw upon the youth development expertise of after-school leaders and adopt a co-inquiry approach, which supports group leaders as a learner alongside the students. Broadening the understanding of who can deliver after-school ISE helps to build the case for after-school as a natural place to teach and engage young people in science. Through its multimedia communications strategy, TASC is working to expand the public's perception of who can deliver science by broadcasting a wide range of after-school educators implementing ISE in after-school.

**Coordinating entities play a key role in building quality ISE systems.** A lead coordinating agency, such as an intermediary, helps broker partnerships and has a birds-eye view on all the resources in a community to support informal science education. In line with their core functions, intermediaries can provide professional development, leverage resources, convene stakeholders, and conduct research to expand and sustain after-school systems that promote ISE.

# PROMISING STEM MODELS

Through a scan of CBASS jurisdictions, promising strategies to advance science through after-school are taking shape. We found that the intermediaries are building on their existing after-school infrastructure, such as training modules and program models, to infuse ISE into after-school. Two strategies emerged and seem to be successful in exposing kids to high-quality ISE experiences.

1. Partnering with community science resources
2. Intentional alignment between after-school and school day STEM curricula and professional development

## Partnering with community science resources

### Fostering volunteerism through STEM Mentors

Recognizing the wealth of ISE experts in the community, The After-School Institute (TASI) in Baltimore partnered with a range of institutions, organizations and public agencies, including the local police department, Morgan State University and local engineering firms to recruit STEM professionals.[8] TASI developed the "STEM Mentors" model, which connects these ISE specialists and students majoring in STEM disciplines with after-school programs that are implementing STEM activities. Over the past two years, more than 30 STEM Mentors have been recruited.

STEM Mentors interact with programs in a variety of ways. Some of them lead activities from existing curricula, some facilitate discussions on STEM careers and pathways, some bring in activities of their own creation, and some connect after-school programs with ISE resources in Baltimore.

### SNAPSHOT: Baltimore

This year, a group of graduate students from Johns Hopkins University's Chemical and Biomolecular Engineering department are serving as STEM Mentors and sharing their knowledge and experience with the youth in a Great Science for Girls program at a downtown recreation center.

The volunteers have developed and implemented new activities for the youth, based on their own research areas and interests. Together the graduate students and after-school participants have launched rockets, made lightning bolts, extracted DNA, and examined the properties of flowers dipped in liquid nitrogen. The graduate students have sought funding from their university to purchase supplies and to take the students on field trips.

Together, STEM Mentors are increasing the delivery of ISE in after-school across the city. As a result, ISE has become a central part of after-school in TASI-partner sites. Programs have been able to formalize their schedules to include ISE, hold regular ISE activities, and engage more students in STEM. Students are not only exposed to STEM content, but also have the opportunity to develop relationships with young adults in STEM fields who are caring, exciting, and serve as role models.

[8] The After-School Institute (TASI) is a Baltimore-based capacity-building organization. TASI provides after-school programs with the training and support they need to offer children and youth quality after-school and out-of-school opportunities.

### Brokering relationships through STEM Enhancements

Prime Time Palm Beach County works with local school-based and community-based after-school programs to broker partnerships between these programs and community providers to offer an array of program enhancements, including arts, sports, literacy, media arts, financial literacy, and STEM.[9] Through partnerships with local ISE experts and education leaders, Prime Time provides more than 3,000 youth in Palm Beach County with STEM learning opportunities through the following program enhancements:

- **South Florida Science Museum**
  The South Florida Science Museum has offered fun and creative ways to expose youth to chemistry and biology. Lessons include *Crime Scene Sleuths, Star Labs, Exciting Electrons, Squid Dissection, and Shark Tooth*. After the youth participate in all four offerings at their after-school sites, they travel to the museum itself for hands-on learning at the facility.
- **Florida Atlantic University's Pine Jog Environmental Education Center**
  The Pine Jog Environmental Education Center opens its nature center to about 600 youth in 17 after-school programs, instilling in youth through curricula and hands-on activities (1) an awareness and appreciation of the natural world; (2) understanding of environmental concepts; and (3) sense of responsibility and stewardship for the earth.
- **Palm Beach Zoo**
  The Palm Beach Zoo delivers a series of four, one-hour outreach programs to after-school programs that offer a positive and enriching animal science education experience while covering the benchmarks of Florida's Sunshine State Standards. Elementary school-aged children are exposed to lessons such as *Animal Habitats, Florida Wildlife, Rain Forest Rescue and Edging Toward Extinction*, and middle school-aged youth receive A*nimal Adaptations, Classification Connections, Florida Wildlife and Wetlands, and Tropical Rain Forest.*
- **Green Mouse Academy**
  Green Mouse Academy educates youth in digital media including engineering/robotics; computer programming in the form of video game design; and computer animation that use digital art and math skills.

#### SNAPSHOT: Palm Beach County

This year, Prime Time is partnering with the South Florida Museum of Science to launch *Health Science in Motion*, which will bring an eight-week inquiry-based curriculum to 1,750 elementary and middle school youth.

Students will have the opportunity to engage in a range of hands-on activities that build their knowledge of health, including crafting a stethoscope, monitoring heart rates, and using bioengineering-type materials to build an artificial heart. Staff will receive training on how to deliver these activities and engage students in inquiry-based, hands-on learning activities.

Through a youth survey Prime Time found that the enhancement providers were successful in delivering ISE content and appropriately challenging youth based on their abilities and interests. Next year, Prime Time will evaluate youth knowledge of STEM content and interest in STEM activities.

[9] Prime Time Palm Beach County (Prime Time) is a non-profit organization that serves afterschool programs and practitioners. Prime Time provides supports and resources that increase program quality to positively impact school-age youth.

### Building a STEM pipeline through apprenticeships

After School Matters (ASM) in Chicago partners with local organizations, businesses, and individual instructors to offer STEM-focused apprenticeships after-school and over the summer.[10] Through apprenticeships teens receive stipends while learning marketable skills in a professional atmosphere from industry experts. ASM's STEM-focused apprenticeships include:

- **science37**
  ASM science37 programming is designed to actively nurture intellectual curiosity, connect Chicago teens with the city's growing science sectors, and introduce teens to the excitement of scientific exploration and discovery. Teens develop and demonstrate a greater understanding of the principles behind a wide array of scientific subjects from ecology to physics to bioscience and beyond.
- **tech37**
  ASM partners with technology entrepreneurs to deliver tech37. High school teens in tech37 programs work with industry professionals on authentic projects in areas such as Web design, manufacturing, engineering, media production, robotics, and computer technology. These programs enable skill-building through hands-on activities and spark teens' interest in technology for personal and professional development. They also afford teens the opportunity to refine their critical workplace skills, including problem solving, teamwork, and communication. With practice, teens become more adept at using these skills, which they will take with them to the job market and their future academic endeavors.

#### SNAPSHOT: Chicago

ASM's *Eco Landscaping and Restoration* apprenticeship aims to teach teens about the basics of horticulture and its relationship to science and technology.

This year, apprentices were responsible for planning and implementing a comprehensive landscape design for the Bowen high school campus on the South Side of Chicago.

As part of the planning process, apprentices met with professional landscapers and traveled to gardens around the city to build their knowledge of gardening styles and elements. Collaboratively, the apprentices developed a design for the flower and vegetable garden at the Bowen campus and prepared a power point presentation to share the plan with stakeholders.

Early results indicate that ASM's ISE apprenticeships are having a positive impact on student attitudes towards science and science careers:[11]

- Students' interest in pursuing a career in science grew from 33% to 78% from pre- to post-surveys.
- Students' sense of whether "it will be important for me to know about science for my daily life" increased from 47% to 89% over the course of the program.

Participants in the most recent session of science37 reported significantly increased interest in taking additional biology and chemistry courses in school.

[10] After School Matters (ASM) is a nonprofit organization that offers Chicago teens innovative out-of-school activities through its science37, sports37, tech37, words37 and nationally-recognized gallery37 programs.
[11] 2007, consultant David Heil for Abbott-funded science37 program

# Intentional alignment between after-school and school day STEM curricula and professional development

## Expanded Learning Time

The Providence After School Alliance (PASA), [12] in partnership with the Providence Public School Department, is working to align existing ISE activities more deliberately with the school day.

Through the Summer AfterZone[13] program, PASA pairs district school teachers and after-school providers to plan and implement summer programming in hands-on learning sites such as the environmental education center at Save the Bay, Natural History Museum, Botanic Garden and a new environmental/sustainable living organization. Together, teachers and community educators lead 4-week hands-on STEM programs that integrate science, mathematics, and English-language arts elements to provide a robust experiential learning opportunity for participating youth. During the school year, PASA works with a range of ISE providers to deliver high-quality science programs to middle school youth participating in their AfterZone network of after school programs.

PASA is also working with after-school providers to help better connect their program content to the science education goals outlined in the Providence Public Schools' newly adopted district-wide core science curriculum. PASA recently held a workshop for after-school providers to discuss the revisions of the middle school science curriculum and of the inquiry-based science education focus of the curriculum. PASA has been working with District staff to develop an "expanded learning" strategy for middle schools, which includes offering professional development opportunities for community-based experiential science learning programs to strengthen their programs' alignment to school curriculum standards.

### SNAPSHOT: Providence

This spring, through PASA's AfterZone program, the lead science teacher at a local middle school, Woonasquatucket River Watershed Council and the Department of Environmental Management (DEM) are partnering to introduce an after-school program that aligns with the School District's new standardized science curriculum.

*River Adventurers* will learn about the life cycle of the American Shad, a herring-like fish, by building a tank in their school-day classroom, and when the Shad run in late May, DEM will drop eggs into the system. Youth will get a chance to observe the initial part of the life cycle up close, watch them hatch and then stock the tiny fry into the river with the hopes that one day they will grow and return to the stream where they were released.

This program will provide hands-on, project-based learning experience for the participants. The lead science teacher will have the opportunity to use the tank as a visual tool in the classroom, and River Adventurers will actively contribute to restoring life to the River that is in their backyard.

Preliminary results from the pilot Summer AfterZone program have been positive. Evaluation by the Education Alliance at Brown University found that teachers and community providers reported valuing the opportunity to engage in professional development with one another. The school day teachers learned important youth development strategies, such as empowering youth to lead activities, which they brought back to their classrooms during the school year.

[12] The Providence After School Alliance (PASA) aims to expand and improve after-school opportunities for the youth of Providence by organizing a system to ensure all youth access to high-quality after-school programs and learning opportunities.

[13] Through the campus-based AfterZones, PASA partners with local community organizations and individual instructors to offer a menu of options that provide high-quality learning experiences after school and during the summer.

In evaluating the pilot Summer AfterZone program, PASA took away several key lessons, which informed the 2010 AfterZone "Summer Scholars" program:

1. Teachers and community members require additional joint planning time to plan and implement curriculum-aligned programming.
2. Teacher and community member partnerships must form organically for greater efficiency and outcomes.
3. Students enjoy targeted “intensive” activities that focus on a particular subject for an extended period of time.

## Environmental literacy

Through the Boston Youth Environmental Network (BYEN), Boston After School & Beyond (Boston Beyond)[14] is helping to develop and strengthen alignment between Boston Public Schools’ (BPS) science content and after-school programs. BYEN’s *Get Out And Learn* (GOAL) Initiative seeks to advance environmental literacy through science-based field experiences that draw on school-day content, but extend into the after-school hours. BYEN provides grants to partnerships of BPS school teachers and environmental community partners, including institutions of higher education, government agencies and non-profit organizations, to develop and implement project-based learning experiences in the environmental sciences that build on the BPS science curriculum.

This year, twenty-eight environmental education professionals received training in the Boston Public School Science (BPS) curriculum to more closely align their program offerings to BPS Science content and enrich science learning. Through the GOAL initiative, Boston environmental education professionals were also invited to attend BPS Science Kit trainings to further enhance knowledge and skills, and build relationships with BPS teachers. Since the program began in 2009, GOAL teachers and environmental education partners have engaged nearly 5,000 BPS students in meaningful field experiences connected to the science curriculum.

[14] Boston After School & Beyond (Boston Beyond) is a public-private partnership dedicated to supporting, strengthening, and expanding Boston's out-of-school time (OST) system.

# CURRICULUM

When TASC set out to increase the delivery of ISE in after-school in NYC, rather than creating its own curriculum, it built on existing high-quality curricula and adapted it to meet the needs of the after-school sites. TASC identified several ISE curricula based on its selection criteria, which represented a broad range of STEM content and grade levels. TASC worked with sites to identify appropriate curricula and augment the delivery of the activities based on each site's STEM readiness and goals. The following are examples of high-quality ISE curricula vetted by TASC:

## FUSE Frontline Staff Training Curriculum Offerings**

| Curriculum | Description | Target Grade Level | Training Hours | Estimated Technical Assistance Hours* |
|---|---|---|---|---|
| **After-School Conservation Club** http://www.dec.ny.gov/education/38184.html | The *After School Conservation Club* seeks to build an awareness of and instill a concern for the environment, in particular the urban environment and New York City's natural resources. Highlights: Stewardship projects that take kids outdoors for recycling and gardening. | 3-6 | 18 | 6 |
| **After-school Science Plus** http://www.edequity.org/programs/science-and-math-programs | Using everyday materials and a problem solving approach, *After-school Science Plus* participants engage in activities that are fun and informative. Participants receive a bin of hands-on materials, a set of children's literature aligned with the activities and a curriculum guide. Highlights: Parent letters in English and Spanish, role model biographies, literacy connections. | K-8 | 16 | 10 |
| **Mixing in Math** http://mixinginmath.terc.edu/ | *Mixing in Math* improves skills, confidence, and attitudes about math. Using games, sports, and other activities already present in after-school, students and staff join in fun math learning experiences. Highlights: Free downloadable extension activities, 20-minute warm-up math activities. | K-7 | 12 | 3 |
| **NASA: After-school Universe - Bringing Astronomy Down to Earth** http://universe.nasa.gov/au/ | *After-school Universe* is an astronomy program developed by NASA that explores astronomy concepts through engaging hands-on activities and takes participants on a journey through the Universe beyond the solar system. Highlights: free leader manual with required training, materials are low-cost and easily-acquired. | 6-8 | 12 | 3 |

| Curriculum | Description | Target Grade Level | Training Hours | Estimated Technical Assistance Hours* |
|---|---|---|---|---|
| **NASA: Out-of-School to Outer Space** http://sse.jpl.nasa.gov/educ/educators/index.cfm | This year-long program consists of three themes: *Exploring the Solar System; Reading, Writing, and Rings;* and *Design a Discover Mission.* Sites have access to several resources including NASA websites, and NASA posters and educational materials. Highlights: Additional NASA activities (free and downloadable), career connections, biographies of real NASA scientists. | 3-5 | 12 | 3 |
| **Wonderwise 4-H** http://wonderwise.unl.edu/ | *Wonderwise 4-H* combines the investigations and personal insights of a variety of scientists. The lessons promote hands-on inquiry, diversity and collaboration, encourage development of science skills, and provide role models in the field of science. Highlights: Videos of scientist and science activities, free downloadable activities. | 4-7 | 12 | 3 |

*TA hours were estimated by TASC's science team and reflect hours needed for successful implementation of the curriculum.
**Please refer to the *ISE Resources* section for additional information on after-school STEM curricula.

# EVALUATION

Evaluation is critical to inform continuous quality improvement and to ensure successful implementation of ISE in after-school. For example, pre- and post- surveys can help programs identify whether a particular curriculum is resonating with students and adjust programming accordingly. In addition, developing a strong, well-articulated ISE evaluation plan can help programs seek additional support from public and private funders, who want to see their investments lead to positive outcomes for both staff and students.

Fortunately, there is a wealth of resources to support the development of a comprehensive evaluation strategy for ISE, and programs can build on existing quality assessments to sharpen the focus on the delivery and impact of STEM activities.

## Evaluation strategies

The following strategies can help inform the development and implementation of an ISE evaluation plan:

**Develop a logic model for the evaluation**
Programs should start their evaluation planning by identifying their end goals. When identifying program and youth outcomes to be held accountable for, programs should be sure that the outcomes relate directly to the training that staff are receiving and the curriculum that is being implemented. Established, well-regarded frameworks, such as the National Science Foundation's ISE evaluation framework, provide programs with helpful tools to develop their logic models and guide them through the larger ISE evaluation process. NSF's evaluation framework can be found at: http://www.informalscience.org/evaluations/eval_framework.pdf

**Begin with program fidelity and move to youth outcomes**
The initial focus of evaluation efforts should be to assess and ensure program fidelity. If a program's logic model asserts that training staff will lead to better youth outcomes, program outcomes should including observations of trainings and interviews with staff who participate in the trainings. After ensuring that the training is delivered as planned, evaluation of the staff's readiness, engagement, and confidence to deliver ISE should be assessed. These indicators can be measured through staff surveys, interviews, focus groups and observations. Once it is clear that staff are delivering ISE as they were trained, programs can begin to assess youth outcomes. Evaluation of youth outcomes can range from outcomes that focus on the extent to which ISE activities contribute to their engagement, confidence and positive attitudes towards science to academic performance measures and career plans.

**Differentiate outcomes by grade/age level**
Outcomes, like activities, will vary among elementary, middle and high school students. Whereas elementary outcomes tend to focus on engagement in science and performance in science classes in school, outcomes for high school students look at the extent to which ISE contributes to students' pursuing STEM high school courses, college majors and/or careers.

**Build off existing quality assessment tools**
Fortunately, programs can draw upon existing resources when developing their own assessment tools. Programs may select from a range of tools that measure program quality and youth outcomes. Looking to resources like the website of the Program in Education, After-school and Resiliency (PEAR) at Harvard University, programs can draw on a variety of assessment tools and methods. PEAR's database of ISE evaluation tools can be found at: http://www.pearweb.org/atis/

# SUSTAINABILITY STRATEGIES

To ensure continued growth and long term sustainability of after-school ISE, programs must be intentional about identifying public and private funding. The following are potential sources of funding to consider when developing a sustainability plan.

## Private funding

STEM-focused businesses, including technology, engineering and telecommunications companies, are often seeking to invest in local youth projects. Local community foundations and national foundations with a focus on STEM, youth development, or workforce development are the most likely funders.

## Public funding

- **American Recovery and Reinvestment Act (ARRA)**
  Race to the Top (RTT), a federal funding opportunity through ARRA that provides $4.35 billion in education funding, encourages and rewards states that are creating the conditions for education innovation and reform, lists STEM learning as a priority and emphasizes the integration of STEM content across grades and disciplines. For more information on Race to the Top, visit: http://www2.ed.gov/programs/racetothetop/index.html
- **National Aeronautics and Space Administration (NASA)**
  NASA issues annual calls for proposals to advance STEM learning opportunities in higher education, elementary and secondary education, and informal education. In addition, each NASA Science Mission Directorate has separate funding to support STEM education. These funds can be used to advance STEM learning in after-school. In June 2010, NASA is launching the Summer of Innovation program aimed at engaging middle school students, particularly those who are underrepresented and underperforming in STEM, in stimulating STEM education programs over the summer. More information on funding opportunities through NASA can be found at: http://nspires.nasaprs.com
- **National Institute of Health (NIH)**
  Through the Science Education Partnership Awards (SEPA) program, supported by the Division for Clinical Research Resources, NIH seeks to improve life science literacy throughout the nation through innovative educational programs. SEPA-supported projects create partnerships among researchers, schools, museums and science centers, media experts, and other educational organizations. More information on SEPA can be found at: http://www.ncrrsepa.org/
- **National Oceanic and Atmospheric Administration (NOAA)**
  Through education, NOAA aims to advance environmental literacy and promote a diverse workforce in ocean, coastal, Great Lakes, weather, and climate sciences, encouraging stewardship and increasing informed decision making for the Nation. NOAA has ongoing funding opportunities to support formal and informal science education. More information on funding opportunities through NOAA can be found at: http://www.oesd.noaa.gov/funding_opps.html
- **National Science Foundation (NSF)**
  NSF is an independent federal agency that promotes science and engineering through research programs and education projects. There are several opportunities to support after-school STEM programs through NSF including a specific *ISE program*, which funds programs that promote STEM learning in a wide range of informal settings. NSF also funds the *Innovative Technology Experiences for Students and Teachers (ITEST) program*, NSF aimed at advancing the STEM workforce. NSF also seeks to advance research on STEM learning, education and evaluation

through the *Research and Evaluation on Education in Science and Engineering (REESE) program*. More information on current funding opportunities through NSF can be found at: http://www.nsf.gov/funding/

- **21st Century Community Learning Centers (21stCCLC)**
  21stCCLC is the primary funding stream to support after-school programs across the country. ISE after-school programs supported by 21stCCLC funds draw on partnerships with local schools and STEM institutions, including museums and science centers, to implement engaging, inquiry-based activities. More information on 21stCCLC can be found at: http://www2.ed.gov/programs/21stcclc/index.html

## Partnerships

- **Convening stakeholders**
  Sustainability of ISE after-school programs relies on strong and diverse partnerships. Leveraging resources from local museums, aquaria, and zoos can enhance ISE delivery and expose students to new environments. These groups are interested in developing local partnerships and often have their own curricula and materials, which after-school programs can build upon to expand ISE activities. Institutions of higher education can also be vital partners, providing access to STEM professionals, equipment and other resources to enhance ISE in after-school. Formalizing partnerships among these stakeholders enables after-school programs to expand and deepen ISE learning experiences and is an effective strategy to attract funders who are looking for the biggest impact from their investment.
- **Building ISE systems through coordinating entities**
  Real sustainability requires systemic efforts to create an after-school ISE infrastructure at scale. Intermediaries, such as the CBASS partners, can help bolster support for after-school ISE by leveraging public and private resources and brokering relationships with key stakeholders. Intermediaries can help build public will so that STEM is considered an expectation in after-school, not an extra. Intermediaries can also help support this culture shift by convincing funders and policymakers that investments in high-quality ISE experiences are critical to young peoples' future success.
- **Educate to Innovate Campaign**
  In 2009, President Obama launched the "Educate to Innovate" campaign, a nationwide effort to improve STEM participation and achievement in the US over the next decade. Through public-private partnerships among the Federal Government, leading companies, universities, foundations, non-profits and organizations, the campaign will connect young people to STEM experiences, increase STEM literacy, and help prepare and inspire the next generation of STEM professionals. Partnerships through the campaign present an opportunity to help build a stronger system to support STEM learning both in- and out-of school. Examples of current partnerships include:
  - ***"Connect a Million Minds" Campaign*** is designed to connect over one million students to highly-engaging after-school STEM activities using Time Warner Cable's media platform, Public Service Announcements, employees, and"connectamillionminds.com" website.
  - ***"National Lab Day," Bringing Hands-on Learning to Every Student*** is a grassroots effort, online at nationallabday.org, to bring hands-on learning to 10 million students by upgrading science labs, supporting project-based learning, and building communities of support for STEM teachers.

  For more information on the Educate to Innovate campaign, visit: http://www.whitehouse.gov/issues/education/educate-innovate

> **Open Innovation Portal**
In 2010, through the Federal Invest in Innovation (i3) program, the Department of Education launched an online portal to connect education stakeholders and funders to accelerate the development and implementation of innovative ideas to improve education in the US. For more information on the open innovation portal, visit: https://innovation.ed.gov/

# ISE RESOURCES

## After-school publications

**Afterschool programs: At the STEM of learning**
*Afterschool Alliance Issue Brief, January 2008*
This brief explains the ways in which afterschool can engage kids in the STEM fields.
http://www.afterschoolalliance.org/issue_briefs/issue_STEM_26.pdf

**Engagement, Capacity and Continuity: An Overview of A Trilogy for Student Success**
*September 2004*
This paper introduces a system to analyze what is needed for individual students to be successful in mathematics and science.
http://www.smm.org/static/about/ecc_paper.pdf

**Learning Science in Informal Environments: People, Places, Pursuits**
*Board on Science Education, Center for Education, 2009*
This report examines the state of science learning and articulates a common framework for the next generation of research on learning science in informal environments across a life span.
http://www.nap.edu/openbook.php?record_id=12190&page=1

**Making Science Matter**
*CAISE Inquiry Group, March 2010*
This report draws on theoretical perspectives and case-studies to highlight ways in which formal and informal settings can be combined and leveraged to create engaging STEM experiences.
http://caise.insci.org/news/97/51/Making-Science-Matter-Collaborations-Between-Informal-Science-Education-Organizations-and-Schools/d,resources-page-item-detail

**NASA and After-School Programs: Connecting to the Future**
*American Museum of Natural History, 2005*
This report argues that afterschool is uniquely suited for implementing science learning experiences that engage young people, build their capacity to succeed, and provide a continuity of opportunities to prepare them to participate in STEM careers.
http://education.nasa.gov/divisions/informal/overview/R_NASA_and_Afterschool_Programs.html

**Planning Early for Careers in Science**
*Science Magazine, 2006*
This article examines the effects of early encouragement on young adolescents' expectations to pursue a science degree and career.
http://www.sciencemag.org/cgi/content/summary/312/5777/1143

**Science by Stealth**
*Education Week, 2006*
An article drafted by TASC President Lucy Friedman and Assistant Executive Director of Community Schools at the Children's Aid Society regarding the value of science in after-school.
http://www.tascorp.org/content/document/detail/1478/

**Surrounded by Science: Learning Science in Informal Environments**
*Board on Science Education, Center for Education, 2010*
This book provides tools including case studies, illustrative examples and probing questions to support practitioners in informal science settings.
http://www.nap.edu/openbook.php?record_id=12614&page=1

**TASC Teens Take on Science**
*Connect Magazine, Jan/Feb 2009*
In this article, members of TASC's staff describe how high school students can be trained to effectively lead after-school science activities with younger children.
http://www.tascorp.org/content/document/detail/2320/

## Curriculum

**Coalition for Science After School**
This site provides links to resources and activities to support implementation of ISE in after-school.
http://afterschoolscience.org/resources/curricula-activities.php

**Science After School Consumers Guide**
This guide contains reviews of high-quality, hands-on science content for afterschool programs.
http://www.sedl.org/afterschool/guide/science/

**SEDL**
The Afterschool Curriculum Choice: Technology Resources collection is designed to help practitioners locate and make informed choices about high-quality technology resources to enrich their programs.
http://www.sedl.org/afterschool/guide/technology/

## Staff training

**Coalition for Science After School**
Resources to help support youth workers and other afterschool staff in leading fun and engaging science activities.
http://afterschoolscience.org/resources/staff_development/

**Great Science for Girls**
Resources to support successful staff development trainings for Great Science for Girls.
http://www.greatscienceforgirls.org/take-action/staff-development

**National Partnerships for AfterSchool Science to Scale (N-PASS)**
Guide to professional development for out-of-school time science activity leaders
http://npass2.edc.org/content/guide-pd-ost-science-activity-leaders

**National Partnership for Quality Afterschool Learning**
Toolkit for staff development in science and a resource guide for afterschool staff members
http://www.sedl.org/afterschool/toolkits/science/

**National 4-H**
On-line staff development resources provide professional development tools and opportunities for staff and volunteers.
http://4-h.org/resources/staff.html

**SEDL**
The Virtual Academy for Afterschool offers a series of online interactive courses designed to build the knowledge and skills of afterschool instructors to deliver content-based academic programming.
http://www.sedl.org/cpl/after-school.html

## Evaluation

**Assessment Tools in Informal Science**
Database of assessment tools to measure performance of informal and out-of-school science, technology, engineering and math programs.
http://www.pearweb.org/atis/

**Informal Science**
Website to share ISE project impacts and evaluation findings.
http://informalscience.org/evaluation

**National Girls Collaborative Project**
Links to evaluation resources and tools to advance gender equity in the STEM.
http://www.psctlt.org/ngcp/resources/eval_assessment.cfm

**Framework for Evaluating Impacts of Informal Science Education Projects**
*National Science Foundation, March 2008*
This document provides a detailed framework for evaluating ISE projects.
http://insci.org/resources/Eval_Framework.pdf

**Toward a Systematic Evidence-Base for Science in Out-of-School Time: The Role of Assessment**
*Program in Education, Afterschool & Resiliency, August 2008*
This report reviews the state of assessments in the informal science and out-of-school time fields.
http://www.pearweb.org/research/pdfs/Assessment%20of%20Science%20in%20OST.pdf

## Sustainability

**Coalition for Science After School**
This tool provides links to public and private funders that have demonstrated a commitment to funding science, technology, engineering and mathematics education in afterschool and informal settings.
http://afterschoolscience.org/tools/funders

**Educate to Innovate**
Information on the federal initiative to improve the participation and performance of America's students in STEM.
http://www.whitehouse.gov/issues/education/educate-innovate

**National Science Foundation, Innovative Technology Experiences for Students and Teachers (ITEST)**
ITEST is a funding opportunity through the National Science Foundation, which is aimed at advancing the STEM workforce.
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5467

### About TASC

The After-School Corporation created Frontiers in Urban Science Exploration (FUSE) to stimulate a culture shift that leads to greater opportunities for kids to experience informal science education after school, as well as in school and during summers. The TASC science team developed FUSE over three years and shared materials and findings to assist in the preparation of this resource guide. TASC is a nonprofit organization dedicated to giving all kids opportunities to grow through after-school and summer programs that support, educate and inspire them.

### About CBASS

The Collaborative for Building After-School Systems (CBASS) is a partnership of intermediary organizations dedicated to increasing the availability of quality after-school programming by building citywide after-school systems. The mission of CBASS is to make after-school a part of the system of essential services that support children and youth, and to promote the development of quality after-school service systems nationwide. Partner intermediaries include: The After-School Corporation, The After-School Institute, After School Matters, Baltimore's Safe and Sound Campaign, Bay Area Partnership for Children and Youth, Boston After School & Beyond, The DC Children and Youth Investment Trust Corporation, Providence After-School Alliance, and Prime Time Palm Beach County. CBASS was founded in 2006 with support from The Atlantic Philanthropies.

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