Afterschool STEM Learning: Supporting a Robust STEM Education System

Afterschool and summer learning programs are an effective avenue for enriching STEM learning and instruction, providing innovative spaces for teaching, professional development, curricula exploration, as well as hand-on and career connected learning opportunities for both students and educators. Informal STEM learning is more than an engagement strategy and should be considered a must-have component of any robust STEM learning continuum. Afterschool and summer STEM learning environments and educators have the potential to support advancement across current and future strategic plan priority areas. ***We encourage the integration of out-of-school time STEM learning programs and stakeholders throughout the next iteration of the nation's five-year STEM Strategic Plan.***

Afterschool programs support STEM learning

Afterschool programs reach a tremendous number of students. Nevertheless, for every student in an afterschool program—10.2 million in 2014—there are two awaiting access. In rural communities the number awaiting access increases to three, showing that demand for afterschool opportunities is high across the nation. 70 percent of parents whose children are enrolled in afterschool programs report that their kids have access to STEM learning through their afterschool program, meaning afterschool STEM experiences are reaching around 7 million kids; but the demand is for more than twice that number.[1]

Afterschool and summer programs are developed to be engaging, responsive, and connected. Grounded in youth development principles and fueled by enthusiastic educators, out-of-school time programs are a natural component of strong learning ecosystems. A robust learning ecosystem requires convergent approaches, including both formal and informal learning stakeholders. So valuable are these informal spaces that the American Innovation and Competitiveness Act (AICA) acknowledges the value of out-of-school and informal STEM education experts in guiding federal efforts around STEM learning and workforce development.[2] An effective system relies on multiple educational institutions—schools, afterschool and summer learning programs, museums and science centers, libraries, and other community organizations—to effectively engage and teach all students across the various times and settings in which learning occurs.[3,4,5]

Evidence from the learning sciences shows that for full engagement, youth must have content-relevant, interesting, and enjoyable curriculum and programming, while also seeing themselves and being seen by others as accomplished learners.[6,7] STEM interest, identity, and understanding are all fostered and reinforced in afterschool settings, making afterschool programs a critical tool of any learning ecosystem.[8] Furthermore, afterschool and summer programs add needed capacity and time to the formal school day, enhancing students' learning, personal development, and exploration of opportunities for the future, including postsecondary education and workforce pursuits. Students gain critical employability skills and access to postsecondary education preparation during out-of-school time programming.[9,10] Interest breeds interest, and students who participate in out-of-school time STEM programs seek more opportunities to engage in STEM learning, sparking life-long curiosity and persistence in STEM fields.[11,12]

The nation's guiding STEM education plan should reiterate that effective STEM learning occurs in both formal and informal learning spaces, including afterschool and summer learning programs, and affirm that providers and professionals of these programs are eligible and competitive collaborators, applicants, and participants in STEM learning research, training, and professional development opportunities.

Afterschool programs reach high needs populations

Afterschool programs disproportionately serve young people from low-income and racially marginalized communities, and can therefore play a key role in reaching the demographics often targeted by efforts to broaden participation in STEM fields, leading to opportunities in transformative employment sectors.[13] Combined with youth development approaches intended to be engaging and responsive to young people's needs and interests, afterschool and summer learning programs can be particularly powerful in ensuring that diverse groups of youth experience positive personal growth, increase their STEM career awareness, and have ample opportunity to develop in-demand employability skills.[14] It is important to not just improve achievement for high-need populations as defined by particular large-scale assessments, but rather improve the entirety of student learning, including positive identity growth and interest in and knowledge of STEM careers and pathways. Afterschool STEM engagement does that.

Afterschool programs help prepare tomorrow's teachers

Informal learning spaces, especially afterschool and summer learning programs, provide a valuable avenue to support both students and educators. The partnership between institutions of higher education and afterschool and summer learning programs brings advantages to both sectors, extending beyond the immediate advancement of the youth enrolled in afterschool and summer programs. Institutions of higher education and afterschool programs partner in myriad ways, including deploying college students serving as staff and near-peer mentors, evaluating afterschool programs, and providing technical assistance and discipline-specific content expertise.[15]

Afterschool programs can offer a rich environment for training pre- and in-service educators, contribute to teacher recruitment and retention, and enhance the diversity and quality of educators' learning and clinical training. Employment in afterschool programs is a powerful path to teacher recruitment and retention, leading many afterschool staff to pursue a career in education.[16] The California Teaching Fellows Foundation is one such example, using employment in afterschool programs as a method of apprenticeship for college students on STEM teaching career paths.[17]

Helping transition more afterschool and youth development professionals to formal education career paths can add much needed diversity to the education workforce. Afterschool and youth development professionals are often sourced from the local community, and as such are often reflective culturally, racially, and ethnically of the local community. Because staff of afterschool and summer programs typically work in their home communities, individual programs and summative studies report high diversity among afterschool and summer program staff, with high participation by African Americans and Hispanics, specifically.[18,19]

The evidence for STEM learning in afterschool is very strong

The evidence is now very strong that in addition to keeping kids safe when school is out, high-quality afterschool programs increase students' attendance in school, while also increasing their performance and engagement.[20] The evidence is based on new and improved ways to measure program quality and impacts on youth.

Program Quality

Although observational programs have been in use to measure instructional quality in schools for decades, it is a relatively new development for afterschool and summer programs. In 2005 the Youth Program Quality Assessment tool was developed after a study supported by the William T. Grant Foundation demonstrated that program quality could be assessed validly and reliably by trained observers. A STEM version of the tool was developed in 2008[21], and continues to be used by many program leaders today. More widely used is an observational instrument developed in 2010 specifically to measure the quality of STEM programs in afterschool and summer settings. The observation tool, known as Dimensions of Success (DoS), was developed by the Partnerships in Education and Resilience (PEAR) Institute at Harvard Medical School starting in 2010 with National Science Foundation support. The tool has since been refined and used to conduct many evaluations and research studies with further support from the Noyce Foundation, STEM Next Opportunity Fund, and the Charles Stewart Mott Foundation. Studies show that the tool is valid and highly reliable, whether used by professional researchers or local afterschool program leaders who complete a two-day training course.[22]

The DoS tool provides detailed "on the ground" information about program quality in four areas:

1) Features of the learning environment (including the organization of materials and space)
2) Activity engagement (the extent to which youth are engaged in purposeful activity)
3) STEM knowledge and practices (including STEM content, inquiry and design)
4) Youth development in STEM (including relationships among the youth and facilitators and the extent to which youth's ideas, concerns, and opinions are acknowledged)

Once a program quality assessment is completed, the results provide a clear roadmap for which aspects of the program need to be improved.

Youth Outcomes

An initial effort to determine which youth outcomes of informal science education were most important and measureable was undertaken with support from the National Science Foundation.[23] Although the recommendations were useful, a more specific set of outcomes focused on afterschool STEM programs was needed. With support from the Noyce Foundation and Stephen D. Bechtel Jr. Foundation, the Afterschool Alliance undertook a Delphi study, which is a method for developing consensus among a large number of practitioners. A panel of 55 afterschool leaders and facilitators and 25 supporters (funders and policy makers) participated in the extended process, which resulted in agreement on three major areas of outcomes:

1) Youth develop interest in STEM and STEM learning activities
2) Youth develop capacities to productively engage in STEM learning activities
3) Youth come to value the goals of STEM and STEM learning activities.[24]

Although agreement on a common set of key outcomes was helpful, as long as program evaluators used different instruments to measure achievement of those outcomes, the results from one evaluation or research study could not be compared with another. A major step forward was taken with the development of The Common Instrument Suite, a self-report survey consisting of just ten questions that was developed by a team of project leaders and evaluators with guidance by Gil Noam, Director of the PEAR Institute. In subsequent years, Dr. Noam developed Data Central, which

is a service to organizations to analyze data from the Common Instrument Suite (with appropriate privacy controls) and produce a report (in a fairly short period of time) that evaluators and leaders can use to improve their program and share with funders. Data Central also enabled comparison with a national data set, so program leaders could determine how well their programs compared with thousands of afterschool and summer programs nationwide.

Recent Findings

The DoS observation instrument and Common Instrument Suite were recently used in a major study of 1,600 children and youth in grades 4-12 enrolled in 160 programs in 11 states by Harvard's PEAR Institute and Texas Tech University. Not surprisingly, the findings showed that higher-quality STEM programs as measured by DoS resulted in more positive youth impacts as measured by the Common Instrument Suite. Overall, more than 70 percent of students across all states reported positive gains in areas of STEM interest, STEM identity, STEM career interest and career knowledge, and 21st-century skills, including perseverance and critical thinking. 80 percent said their STEM career knowledge increased because of their afterschool experience.[25]

A number of other studies have also shown important impacts from high quality afterschool programs. For example:

- Students who regularly participated in 21st Century Community Learning Centers in Wisconsin improved their school attendance, class participation and behavior, homework completion, and reading and math achievement scores and grades, according to responding teachers.[26,27]

- Regular participation in afterschool programs helps narrow the achievement gap between high- and low-income students in math, improved academic and behavioral outcomes, and reduced school absences.[28]

- A meta-analysis of nearly 70 afterschool program studies showed that compared to their non-participating peers, students who attended afterschool programs had increased school attendance and a 12 percent gain in grades and test scores.[29]

Afterschool programs are partnering to help prepare youth for the future

Afterschool programs across the nation partner with local, national, and global businesses to support programs that link youth with career development opportunities. For example, Girls Inc. and Lockheed Martin formed a partnership to develop and implement an interactive approach to STEM mentorship, which engages girls ages 9-12 with company professionals. Over the last five years, Lockheed Martin employees helped Girls Inc. reach more than 2,000 girls at ten sites in Lockheed Martin communities, engaging girls in hands-on STEM activities, mentorship from industry professionals, and increasing their understanding of the vast potential of STEM careers.

New evaluation data strongly demonstrate the lasting impact that afterschool STEM programs have on students' ability to connect the importance of STEM to their future success and their communities.

- Among alumni of The Clubhouse Network, 97 percent said that the Clubhouse was the most important source of support for setting high goals and expectations for themselves and 80 percent reported that the Clubhouse had been the most important source of support for pursuing a career.[30]

- After participating in Explore the Bay, an environmental and marine science afterschool program, 89 percent of students surveyed reported that they wanted to take better care of their environment.[31]

- The majority of participants in Science Action Club (86 percent) believe that learning about science can help them to better understand the natural world and 81 percent believe that the data they personally collect in the club is scientifically important.[32]

Supported by enthusiastic partners, trained educators and grounded in youth development principles such as student leadership, civic engagement, and positive adult relationships, out-of-school time programs are an essential component of workforce preparedness efforts. There are many examples of afterschool programs ushering kids into lucrative trades. For example, Colby from Alabama is pursuing a career as an electrician, an interest he discovered while installing solar panels on local homes through his work-based afterschool program. Colby is just one story of how afterschool works for workforce development.[33]

Afterschool programs can engage youth in computer science learning

It is critical that high-quality afterschool computing opportunities are available to all students. Currently, the majority of schools do not offer a rigorous computer science (CS) course (40 percent offer computer programing/coding), but a majority (67 percent) *do* offer CS through informal clubs and afterschool programs.[34] The importance of including afterschool, summer, and informal learning spaces in investments to increase and sustain access to computing education for all students, while also supporting curriculum, professional development, and policies that support CS learning, cannot be overstated. Given that 94 percent of surveyed afterschool programs are currently providing or are interested in providing CS opportunities, and 79 percent of parents whose kids attend programs with STEM offerings are satisfied with their child's STEM learning opportunities, there is an imperative to increase access to CS learning for all students through afterschool programs.[35] Expanding access for 10 million additional students to afterschool STEM and CS programs will require more afterschool educators who can facilitate high-quality STEM and CS programming. This is an opportunity to build bridges between formal, informal, and afterschool educators and institutions, as well as continuity and coherence across systems to the benefit of the country's youth and workforce.

Afterschool programs help youth build foundational skills

Connecting students to work experiences through activities such as internships and preparing students for the workplace through developing job-seeking skills are valuable opportunities afterschool and summer learning programs can provide to help students succeed in the workforce. They help students build familiarity with and capabilities in the workforce. Research has found that the benefits associated with early work experience include less time unemployed and higher hourly wages and annual earnings.[36,37] In a 21st century economy, more and more jobs are deeply technology-enabled and integrate historically discrete disciplines and skills. Almost all 113 CEOs surveyed for a Business Roundtable and Change the Equation report said that skills shortages was a problem for their companies and close to 4 in 10 companies said that at least half of their entry-level applicants lacked basic STEM skills.[38]

For more than a decade, employers have reported that communication, teamwork and collaboration, and critical thinking and problem solving are among the most important skills for their workforce, but are difficult to find in potential and current employees.[39] Afterschool programs provide a ladder of supports that help students reach their career aspirations. Many informal learning spaces across the country, such as science centers and museums, offer sustained skills development and pathways to STEM careers through youth enrichment-to-employment programs that serve students in their time outside the classroom. These programs result in participants achieving high levels of high-school graduation and college enrollment.

Building students' workforce competencies is typically associated with programming for older youth, especially by connecting them to internships and apprenticeships, but preparing students for the workforce begins much earlier. While workforce experience for older youth is at the top of the ladder of supports, there are intermediary rungs that students as early as elementary school can

reach. For instance, afterschool programs serving younger students often work with students on their communication and teamwork skills, the foundational skills employers' desire in their future hires. The flexible nature of afterschool programs also lend themselves to expose students to the wide spectrum of career fields, from introducing students to a potential new interest to taking students on field trips to local businesses to learn more about that field.

To date, there has been no comprehensive national study as to the prevalence of formal pre-apprenticeship partnerships between afterschool programs and their business allies. However, the Afterschool STEM Hub members and other afterschool and summer programs provide work-based learning and employability training opportunities for their students across the nation. Paid or unpaid, many prepare youth to receive industry-recognized credentials or high school or college credit and to enter the workforce with in-demand skills.

Professional development for afterschool facilitators is essential

We now know what high-quality STEM programs should look like in afterschool and summer. We also have agreement on what the outcomes of those programs should be and how to measure those outcomes. What we need now is a national commitment to provide the resources and training that program leaders and facilitators need to realize the vision in every city and state. Our nation's five-year STEM Strategic Plan has the potential to provide a large part of that essential support.

In order to provide the kind of assistance that federal agencies will need to ensure that their support of STEM outside of school time is appropriate and effective, a collaborative group of afterschool experts, led by the National AfterSchool Association, is developing a system that would provide professional credentials to afterschool facilitators as they develop and demonstrate their capabilities. Other collaborators include the Harvard PEAR Institute, the Maine Math and Science Alliance (which is developing a system of online professional development and coaching for providers in rural areas), and the University of Nebraska, Lincoln (which is developing a series of professional development videos, called Click2SciencePD). The credentialing system, which is still undergoing pilot testing, will advance afterschool STEM program quality by building and recognizing front line staff's STEM facilitation skills through a series of ten micro-credentials, or "digital badges," that are aligned with the Dimensions of Success (DoS) quality assessment observation instrument.

Supporting a robust STEM education system requires thinking beyond the school day

With students spending 80 percent of their time outside of school, it is imperative that efforts to support STEM learning include afterschool and summer opportunities. The research is clear that high-quality afterschool and summer learning programs are providing hands on STEM learning and opportunities to explore STEM career paths and readiness.

The nation's guiding STEM education plan can broaden the overall perception and delivery of STEM learning by emphasizing the importance of both formal and informal learning spaces, including afterschool and summer learning programs, and affirming that providers and professionals of these programs are eligible and competitive collaborators, applicants and participants throughout the plan.

Afterschool and summer STEM learning environments and educators are eager to work across sectors to support STEM learning and welcome the opportunity to be integrated throughout the next iteration of the nation's five-year STEM Strategic Plan.

A selection of high-quality afterschool STEM program profiles are available at the   pg. 6
Afterschool Alliance's website at http://www.afterschoolalliance.org/STEMprofiles.cfm.

Afterschool STEM Hub members' community reach

The Afterschool STEM Hub is a collaboration among a diverse set of national education leaders and stakeholders*, who are experts in learning, engagement, evaluation, and impact, and support cross-sector partnerships at the national, state, and local level. Connect with us for ideas, program examples, and research: stemhub@afterschoolalliance.org.

Organization	Geographic Reach	Estimated # of Youth Served	Programs Reached	Affiliate Networks
Afterschool Alliance	National	NA	>26,000	50
Association of Science-Technology Centers	National	59,000	100+	400
Boys & Girls Clubs of America	National	4.3 million	4,362	NA
Every Hour Counts	National	240,000	1,400	9
ExpandEd Schools	New York	1 million (1998–2017)	~86	NA
Girls Inc.	National	152,000	NA	83
National Network of Statewide Afterschool Networks	National	NA	NA	50
National 4-H Council	National	6 million	NA	NA
National AfterSchool Association	National	NA	NA	32
National Girls Collaborative	National	NA	36,000	33
National Summer Learning Association	National	NA	NA	34
Oregon ASK	Oregon	>6,600	>440	NA
Techbridge Girls	CA, WA, DC	14,055	17	
Vermont Afterschool	Vermont	12,000	300	50
YMCA of the USA	National	9 million	2,700	NA

*Not all Afterschool STEM Hub members directly serve youth or youth programs. Rather, they operate in the critical roles of funding, research, and coalition building. These members include the PEAR Institute at Harvard University, STEM Education Coalition, STEM Next Opportunity Fund, Cornell Lab of Ornithology, University of Washington – Dr. Brownyn Bevan, and University of Virginia – Dr. Robert Tai.

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