Examining the impact of afterschool STEM programs

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Executive summary

Recent years have seen a growing recognition that social and economic factors play a crucial role in influencing academic success and that young people require supports that extend beyond the school walls. The notion of a "learning ecosystem" is taking root, a concept that places students at the center, with resources and supports organized around them. In such a system, schools are extremely important but are just one of many influences in a young person's life. In addition to schools, the ecosystem includes the influence of families and peers; out-of-school-time offerings such as afterschool programs; and community resources such as science centers, libraries and media.

Afterschool programs have long aimed to positively influence students' personal development and support their social and emotional growth. Studies of high-quality afterschool programs have found that participating children see a significant improvement in their self-perception, increased positive social behavior and a decrease in problem behaviors—changes that ultimately extend to school-related behavior. Hence, afterschool programs are increasingly seen as a key social and academic support for youth.

Afterschool researchers and providers have recognized that hands-on, inquiry-driven science, technology, engineering and math (STEM) programs are in line with afterschool's overall approach to education and have increasingly begun to include STEM in their afterschool offerings. Afterschool programs that provide strong STEM learning experiences are making an impact on participating youth—youth not only become excited and engaged in these fields but develop STEM skills and proficiencies, come to value these fields and their contributions to society, and—significantly—begin to see themselves as potential contributors to the STEM enterprise.

For example:

- Program attendance and engagement in the 4-H Tech Wizards program is high—on average 95 percent of enrolled youth attend sessions regularly and 95 percent of participants stayed in the program for three years to build successively on their tech skills.

- Girlstart After School participants engage weekly in rigorous problem-solving. Using inquiry and iterative design, they generate predictions and hypotheses, document observations, and prototype solutions. At the end of the year, 91 percent of participants demonstrated mastery of scientific inquiry and the engineering design process.

- Every week at Science Club, an afterschool program run as a partnership between Northwestern University and the Boys & Girls Club of Chicago, youth work alongside scientist mentors on fun, challenge-based curricula. These units focus on health and biomedical careers and development of scientific skills: experimental design, variables, data analysis and evidence-based conclusions. As a result, 100 percent of


Photo courtesy of Techbridge

Science Club youth see science as important for their future careers, 30 percentage points higher than control youth. Two independent, well-controlled assessment methods reveal increases in participants' scientific skills ranging from 25-30 percent over non-participating students.

- Participants in Project GUTS, an afterschool computing program, come to understand that STEM is integral to everyday life and can be used to study and potentially solve local community problems. Project GUTS curriculum covers real-world topics of societal concern in fields such as ecology, biology, social sciences, resource management and public health. When youth were asked how they would investigate a community problem, 80 percent suggested using computer modeling and simulation as a technique to investigate the issue.

- Career exploration is a primary focus of the girl-focused Techbridge program; all activities integrate a career exploration component. Techbridge extensively uses professional female role models who visit programs and share their experiences with participants; students also go on worksite field trips. Eighty percent of participants planned to take on additional STEM learning opportunities by electing advanced math and/or science classes. Eighty-five percent reported they find engineering more interesting and 83 percent said they find science more interesting. Eighty-one percent of participants said they can see themselves working in technology, science or engineering.

While the afterschool field has made great strides toward offering strong afterschool STEM programming, much work remains to be done. Support systems are rapidly being assembled to support program providers, however assessing and documenting the impact of afterschool STEM experiences remains a challenge due to the diversity of programming. Efforts are being made to develop common frameworks for defining outcomes and assessments. Some common assessment tools have been developed to support the evaluation needs of many youth-serving organizations and to aggregate data across many programs.

As we move forward, it is vital that local, state, and federal education policies are inclusive of the various contributors to the learning ecosystem; distributing the educational burden and opportunity across a range of appropriate organizations so it does not rest so heavily on schools. Policies must incentivize partnerships and encourage data sharing between partners. Resources must be allocated to reflect an understanding that the system as a whole is accountable for success and individual players are accountable for their role in contributing to this success. Fortunately, good progress has been made in the past few years toward these goals, though much remains to be done to pursue this essential agenda.

Introduction

The last decade has seen growing interest in building the capacity of young people in science, technology, engineering and math (STEM) in the United States. The world has changed such that citizens require a greater level of STEM literacy to make decisions about complex issues such as global climate change, renewable energy sources and genetically modified foods. Increasingly, more and more jobs require proficiency in STEM and there is great concern that without access to adequate educational experiences, large segments of the population will be unable to participate effectively in the modern workplace. U.S. students are being outperformed in science and math by young people in many other industrialized countries[1], which has alerted many of the need to improve this country's K-12 STEM education.

Efforts to address the situation have primarily focused on education reform initiatives targeting schools. While schools and teachers are a critical part of young people's STEM education, increasingly they are seen as one part of a larger "learning ecosystem," one in which students are at the center of the system rather than a particular institution of learning taking center stage. In an ecosystem, the many components each have a differentiated and valuable role. The institutions that represent the components of a learning ecosystem work intentionally and collaboratively to create a rich educational world for children and youth as they grow into adults. The notion of a learning ecosystem, influenced by Bronfenbrenner's ecological theory of development (Bronfenbrenner, 1979), is not new. However, it is enjoying a renewed interest, particularly in the context of STEM learning (see the Research+Practice Collaboratory initiative[2]; Barron, 2006; Hedegaard, 2009; Traphagen & Traill, 2014).

Hence, as we consider redesigning learning to become more student-centered, we have to draw on our knowledge of **how** people learn and **where** people learn in order to design a system that more fully utilizes community assets, cultural institutions, and technological and media resources. The landmark 2009 study from the National Research Council, *Learning Science in Informal Environments*, highlighted this issue and examined informal learning settings and out-of-school-time (OST) programs. The report described an outcomes framework that included several strands of learning, two of which are particularly relevant for afterschool programs—one strand states that learners in informal environments will experience excitement, interest, and motivation to learn about phenomena in the natural and physical world; and the other states that learners will begin to think about themselves as science learners and develop identities as young people for whom science matters.

[1] 29 countries outperformed the U.S. in mathematics and 22 countries outperformed the U.S. in science, as measured by the 2012 Program for International Student Assessment, or PISA.

[2] The Research+Practice Collaboratory initiative seeks to engage researchers and practitioners to address gap between educational research and practice in STEM education. The initiative takes an explicitly ecological perspective on learning, and hence has a primary focus on furthering research and practice that address learning across settings. For more information see www.researchandpractice.org

Some of the hesitation to change current models of teaching and learning may arise from a lack of knowledge, trust, and perhaps a lack of centralized control of the various spaces that children and youth inhabit. And yet, spaces such as afterschool and summer programs, libraries, science centers, and other such OST settings offer great resources and capabilities as partners in providing STEM learning experiences for youth. Many of these partners are sophisticated and experienced in designing programs that not only engage young people in STEM fields, but also help them to develop tangible skills. It is vital to acknowledge afterschool and other OST settings as necessary partners to the formal education system, and not just a luxury.

The role of afterschool in STEM learning

Afterschool programs (used here to broadly refer to before-school, afterschool and summer learning programs) are an important and growing part of the STEM education ecosystem in the United States. Roughly 8.4 million children participate in these programs each year, many from populations that are under-represented in STEM fields and careers. Children from ethnic backgrounds historically underrepresented in STEM attend in higher numbers—24 percent of African-American, 21 percent of Hispanic and 16 percent of Native American children attend afterschool programs, compared to the national average of 15 percent (Afterschool Alliance, 2009). Data from the Department of Education's 21st Century Community Learning Centers program suggest that girls attend afterschool programs in equal numbers to boys. These programs serve an important role in providing a safe space for children while their parents are at work, but they are increasingly offering innovative learning opportunities.

Photo courtesy of The After-School Corporation (TASC)

As schools have focused on measureable academic results in recent years, other aspects of schooling like music, art, learning healthy behaviors and engaging in physical activity are reduced or cut out of the school day due to budget pressures. These subjects, often considered 'enrichment' programming, are not seen as key aspects in preparing children for success. Afterschool programs have stepped up their efforts, anchored in a holistic youth development approach, to offer arts, sports and other learning programs that offer youth a voice, choice and control over their own learning.

Youth-serving organizations such as 4-H, Girls Inc., and Girl Scouts have long embraced STEM in their program models. And in the past few years, the larger afterschool field has begun to recognize STEM as an important area of enrichment. Historically, afterschool educators have experimented with a learning approach that links school-day academic science and math with enriched learning in the afterschool hours.

Often these connections were established through homework support, but increasingly STEM activities in the afterschool space are hands-on or project-based, serving to simultaneously engage young people in STEM topics, teach them scientific reasoning and apply concepts learned during the school day. Today, many afterschool and summer programs are including STEM education as a standard part of their comprehensive programming. Thus, STEM has become an important element in a learning ecosystem rich in exploration, fun and hands-on activities that can lead to greater knowledge and interest in STEM coursework and careers.

Does afterschool STEM have an impact?

Practitioners closest to students typically answer this question affirmatively—they see youth engaged in and excited about STEM activities, asking significant questions, and wanting to learn more. However, funders and policy makers often seek data that substantiates such claims and demonstrates positive changes in a variety of outcomes—interest and engagement in science, greater knowledge of STEM careers, election of school science classes, and, sometimes, improved test scores in science and math. While some programs are able to achieve these outcomes and document their successes, it is unrealistic to expect that the afterschool field, in aggregate, will be able deliver on *all* of these outcomes *immediately*. Investments in afterschool STEM programs are still growing, as is the infrastructure that supports programs to offer more and higher-quality STEM opportunities. We can get a glimpse at the potential for what high-quality afterschool and summer STEM programs can offer by taking a look at what outcomes strong afterschool STEM programs are currently delivering.

This paper begins by presenting some of the research findings about the importance of afterschool and other OST experiences for STEM learning. It then proceeds to summarize evaluation data from a selection of strong afterschool STEM programs and describes the types of substantive impacts these programs are having on participating youth. The paper concludes with recommendations for how we can construct an integrated approach to education that includes in-school and OST experiences. Appendices provide details of the programs whose outcomes are featured in the narrative.

Research on afterschool and out-of-school-time learning

A well-established research base indicates the importance of cross-sector learning and underscores the importance of such experiences and activities outside of the classroom, especially for under-privileged populations (e.g., see Posner & Vandell, 1999; Bransford et al., 2006; Covay & Carbonaro, 2011).

The capability of OST learning experiences, such as afterschool programs, to support the social and emotional growth of students, and the genesis of these programs as initiatives to positively influence students' personal development, is often overlooked in an educational culture that devotes significant attention to test scores and academic achievement. There are many studies that document the myriad ways afterschool programs impact youth. An oft-cited meta-analysis (Durlak & Weissberg, 2007) by the Collaborative for Academic, Social and Emotional Learning (CASEL), found that children participating in afterschool programs saw a significant improvement in their perceptions of themselves, improved positive social behavior and a decrease in problem behaviors. Vandell, Reisner and Pierce (2007) looked at 35 quality afterschool programs and found that students regularly participating in the programs improved their work habits; demonstrated higher levels of persistence; and saw reductions in reports of misconduct, such as skipping school.


Photo courtesy of Tech Reach

In addition to supporting a child's development and sense of worth, building social skills, and igniting his or her passion for learning, afterschool programs do have the ability to positively impact a child's academic performance. Both the CASEL meta-analysis and the Vandell et al. (2007) study found that, on average, students participating in quality afterschool programs show gains in their school-day performance. Several additional evaluation studies (see Afterschool Alliance, 2013b) also demonstrate the ability of afterschool programs to support the learning that takes place during the school day and help boost students' academic performance, and increase the likelihood of graduating from high school—especially for students who have fallen behind in school and need extra support and mentoring.

New research by Deborah Vandell and colleagues (Auger, Pierce, & Vandell, 2013) finds that not only do students in afterschool programs see academic gains, but afterschool programs are also helping to close the achievement gap. The disparity in academic performance that has been documented between high- and low-income students disappears when low-income elementary school students have high levels of participation in afterschool programs. The findings[3] also show that students participating in afterschool programs, especially those who regularly participate, see gains in their math achievement and other academic performance, improve their work habits, and have better school day attendance.

More specifically, **the math achievement gap between low- and high-income students narrows when low-income students attend afterschool programs with greater frequency**. Conversely, the less often low-income students participate in afterschool programs, the larger the math achievement gap between them and their higher-income peers. This has significant implications for STEM education, as math proficiency is often the gatekeeper for many STEM fields.

Research on the role of STEM in afterschool

Lack of a STEM "identity" is often cited as one of the main reasons that young people do not pursue STEM fields, an issue highlighted in a recent study from King's College London (ASPIRES Project, 2014). The ASPIRES study found that most of the participating young people held relatively high career aspirations, but a very small percentage of the study sample (15 percent) aspired to be scientists. They reported liking science[4], having positive views of science and scientists, and doing well in school in those subjects—but imagined scientists to be mostly white, middle-class, male and "brainy" and thus was not something they could imagine for their own lives. Most of these students and their families also did not understand that science could lead them to a diverse range of promising careers. This result is in keeping with the findings of an important paper by Tai et al. (2006), which showed that for students with average achievement in math, an early interest in pursuing physical science or engineering careers was a better predictor of whether they would follow through on that interest compared to their peers who had higher achievement in math but did not express a desire for such careers.

Generating interest and engagement in STEM is a stated goal of many afterschool STEM programs. The focus is thus on nurturing curiosity and engagement with certain topics or fields (Krapp et al., 1992; Noam & Shah, 2013), and not necessarily on increased academic achievement. Of course, the theory of change implicit in much of the work is that increased interest and engagement will translate into improved achievement. Many afterschool providers do not see it as their direct goal to improve test score results, but instead they strive to increase involvement and exploration with STEM, decrease anxiety around STEM, and energize motivation.

The approach taken by these program providers is supported by theory and research. Hidi & Renninger (2006) have described how curiosity and enjoyment are not only critical first steps, but integral to increased and continued

[3] The full report is forthcoming, however findings are summarized in "*The achievement gap is real: New research shows afterschool is a real solution linked to closing the gap*" retrieved from www.expandinglearning.org/docs/The%20Achievement%20Gap%20is%20Real.pdf.

[4] Historically, science interest and identity have been studied more extensively than the other fields in STEM. Although research is now catching up in engineering and technology education, science continues to be used as a proxy for STEM.


Photo courtesy of Science Action Club

engagement with STEM activities and are part of a cycle where interest and proficiency feed and build on each other. The National Research Council's framework (discussed previously; 2009) begins with interest and engagement and progresses to a science identity. Development of a science or STEM identity involves multiple pieces: getting young people interested in STEM topics and professions; developing competence and a sense of confidence; and getting youth to envision themselves as contributors and participants in this enterprise.

Such studies highlight the importance of providing young people with opportunities to engage in STEM fields and with professionals on their own terms and in ways that may not always be possible during the school day: to design open-ended projects that are not guaranteed to succeed, to work on hands-on projects that build STEM skills and hence confidence in their abilities, and to interact with STEM professionals so that young people can update their ideas about the types of people who work in these fields.

A study by Dabney et al. (2011) supports this hypothesis: they conducted a retrospective examination of the association between university students' current interest in STEM careers and their participation in secondary OST STEM activities. The investigators found a strong positive correlation that showed participation in OST STEM activities was associated with STEM career interests, for both young men and young women, and by a similar amount. The ability of OST programs to engage young girls in STEM has been noted in other studies as well. For example, a study by Tan et al. (2013), which examined middle school girls' experiences in school-day science classes and OST science clubs, suggests that the positive science identity development that takes place within OST environments may impact girls' science trajectories and career goals.

In the course of leading an afterschool STEM program for middle school youth, Barton and Tan (2010) investigated the relationship between science learning, science identity, and student agency (which refers to the ability of individuals to engage in a field or practice as they choose). Their study underscores the need to provide opportunities for young people to exercise STEM agency in a socially appropriate context so they develop a sense of identity linked to the STEM enterprise.


Photo courtesy of Science Club

The importance of increased STEM "dosage" (or duration of exposure) was studied by Wai et al. (2010), who found that added exposure to opportunities for STEM engagement and learning, through individualized experiences such as competitions, led mathematically talented students to greater STEM achievement than their counterparts who lacked such opportunities. The results from the 2009 National Assessment of Educational Progress (NAEP) in science also showed that 4th graders who participated in "hands-on science activities" and 8th and 12th graders who did "science-related activities outside of school" showed a significant increase in test scores compared to those who did not. Further, it appears that the dosage mattered. Students involved almost daily in hands-on science, both in- and out-of-school, scored better on the 4th grade assessment than those who only participated once or twice a month. Afterschool programs offer an important opportunity to increase the dosage of STEM experiences for young people.

Noam et al. (2014) have taken this one step further and studied the impact of higher doses of STEM opportunities within afterschool programs[5]. Program dosage (hours per week and number of weeks) was consistently found, across multiple large datasets and analyses, to correlate with science interest scores. On average, children who spent more time involved in science activities reported significantly higher science scores than children with less participation. Additionally, self-reported interest in science and improved skills, like critical thinking, increased in youth program participants.

[5] For this study, Noam et al. (2014) used the assessment tool, the Common Instrument of Interest in Science, which is a survey used to assess student interest and engagement in science. For more information, see www.pearweb.org/tools/commoninstrument.html.

What impacts do strong afterschool STEM programs have on youth?

Afterschool programs that offer high-quality STEM learning experiences have a significant impact on participating youth—they cultivate students' interest in STEM and build STEM skills and proficiencies among diverse groups of young people. Specifically in relationship to interest, students in a recent study (Robertson & Noam, 2014) reported significantly greater science interest in afterschool and summer programs rated high in quality compared to programs rated average or low in quality. Program quality in these two studies was measured by the Dimensions of Success (DoS) tool[6], a program quality assessment rubric. This parallels findings about the effect of quality programming in relationship to other, non-STEM outcomes.

However, there is no widely-adopted measure of program quality or of related outcomes used in afterschool and summer programs. So in order to examine the potential range of the impacts and outcomes afterschool STEM programs can have, we gathered outcomes data from a sample of programs that have a *reputation for excellence*. This is not intended as a representative sample of the afterschool field as a whole, but it does allow for an understanding of what strong programs can achieve. This is especially important because the OST STEM field is relatively young, and strong outcomes should only be expected from strong programs (Noam & Shah, in press). Table 1 presents brief descriptions of the featured programs. More extensive descriptions can be found in Appendix 2.

Table 1. Brief descriptions of the programs featured in this paper.

Program	Brief description
4-H Tech Wizards *Multiple states*	A 4-H afterschool program that provides targeted student groups with technology training. It is delivered in partnership with schools, volunteers, libraries, nonprofits and other community partners.
Build IT *U.S. and Canada*	An afterschool and summer curriculum for middle school youth offered by Girls Inc. to develop information technology (IT) fluency, interest in mathematics and knowledge of IT careers.
Computer Clubhouse *International*	An OST program in which youth from underserved communities work with adult mentors to explore their own ideas, develop new skills and build self-confidence through the use of technology.
FUSE (Frontiers in Urban Science Exploration)	A strategy used in seven cities to institutionalize engaging, inquiry-based informal STEM education nationally. FUSE is a project of Every Hour Counts and The After-School Corporation.

[6] Read more about the Dimensions of Success (DoS) tool here www.pearweb.org/tools/dos.html

Table 1, continued. Brief descriptions of the programs featured in this paper.

Program	Brief description
Girlstart *Austin, Texas*	An intensive afterschool and summer program for girls that provides free STEM programming every week throughout the school year at partner schools.
Project GUTS *Santa Fe, New Mexico*	An afterschool program in which middle school students learn cutting-edge computing methods to solve modern-day problems.
Science Action Club *San Francisco, California*	An afterschool program that offers hands-on science investigations and participation in citizen science projects all in a fun, club-like environment.
Science Club *Chicago, Illinois*	An afterschool program run in partnership between Northwestern University and the Boys & Girls Club of Chicago in which graduate student mentors lead small groups of students through designing and running hands-on science experiments.
Science Minors Club *Chicago, Illinois*	An outreach initiative of the Museum of Science and Industry aimed at increasing interest in science in underserved neighborhoods by engaging students in places where they already spend their time after school, such as community-based organizations and schools.
Tech Reach *Austin, Texas*	An outreach program of the Thinkery, a hybrid science and technology center/children's museum, focused on creative computing.
Techbridge *Bay Area, California*	An afterschool and summer program focusing on hands-on projects and career exploration to inspire girls in science, technology and engineering.

Each program had its own methodology for collecting data on outcomes and impacts, however we have organized the findings of their evaluation results according to a framework of youth outcomes for STEM learning in afterschool that was developed in a recent consensus study (Afterschool Alliance, 2013a), representing the opinions of expert afterschool practitioners and other stakeholders.

The consensus study concluded that afterschool STEM programs can help young people to: (a) develop an interest in STEM and STEM learning activities; (b) develop a capacity to productively engage in STEM learning activities; and (c) come to value the goals of STEM and STEM learning activities. The indicators of progress toward such outcomes include:

1. Actively participating in STEM learning activities;
2. Demonstrating curiosity about STEM topics, concepts or practices;
3. Developing abilities to productively engage in STEM processes of investigation;
4. Developing abilities to exercise STEM-relevant life and career skills;
5. Coming to understand the role that STEM plays in solving societal issues; and
6. Developing an increased awareness of STEM professions.

Next, we summarize the main findings with respect to these six indicators.

Summary of impacts and outcomes

Despite the specific nature of each of the afterschool programs and their evaluations, there were several themes that emerged that help us better understand the impacts of OST STEM in general.

1. The programs are **successful in engaging and retaining** large numbers of students from **diverse populations** in STEM.

All programs featured in this paper focus on engaging underserved youth in high-need communities. On average, 75 percent of students served are eligible for free or reduced price lunch[7]. High percentages of minority students are enrolled; an average of 82.5 percent of youth are of Latino, African-American, Native American or Asian/Pacific Islander[8] ethnic background[9]. Youth have many options for what they do after school, and young people consistently choose to attend these programs. They participate in high numbers and return regularly, reflecting a keen interest in the hands-on STEM learning they're being exposed to.

For example:

- Program attendance and engagement in the 4-H Tech Wizards is high: on average 95 percent of enrolled youth attend sessions regularly and 95 percent of participants stayed in the program for three years to complete all three skill levels.
- Across more than 100 drop-in based Computer Clubhouse sites, 83 percent of participants visited their clubhouse at least weekly, and 47 percent every day. Ninety-one percent visited for at least one hour and 37 percent of youth visited their clubhouse for more than three hours at a time.
- In Project GUTS, middle school students are presented with a challenging computing curriculum and 82 percent persist in the program to complete a working computer simulation model (22 to 26 weeks).

2. Young people in these programs **express curiosity and interest in STEM subjects**, in ways that extended that interest in school and out of school.

For example:

- Participation in Girlstart resulted in the extension of interest in science outside the program. Eighty-six percent of participants agreed with the statement "I want to try more science activities." Eighty-four percent reported interest in taking further STEM classes in middle or high school. In 2012, 58 percent attended Girlstart's *Girls in STEM* conference.
- Sixty-five percent of students in Project GUTS strongly agreed that participating in the program made them more excited to do and learn science and technology in school.

[7] 7 of 11 programs reported data on the eligibility status for free or reduced price lunch of their participants.

[8] While Asian-Americans overall are not underrepresented in STEM, we chose to include Asian/Pacific Islander in this calculation because students in these programs came from such high-poverty backgrounds. The National Center for Science and Engineering Statistics at the National Science Foundation places Pacific Islanders in the "Other" category, which is underrepresented.

[9] 8 of 11 programs reported data on the ethnic background of participants.

Photo courtesy of Science Action Club

- Seventy-seven percent of youth in Science Action Club reported that "being in Science Action Club makes me want to learn more about science outside of school."

3. As they participate in these programs, young people **gain real skills** and the **ability to productively engage in STEM processes of investigation**.

Participants in these programs become familiar with concepts such as the engineering design process, scientific enquiry and problem solving. They apply these ideas to hands-on projects that include computer coding; Web development; designing hovercraft and solar cars; and building robots, geographic information systems (GIS) and other such technologies.

For example:

- Observations of Science Minors Club's staff revealed that 80 percent encouraged youth to formulate testable questions and 93 percent fostered the collection of data and recording of observations. At 93 percent of sites, staff was observed providing opportunities for youth to use tools like a hand lens, calorimeter and rulers to make observations, take measurements or collect data.

- Science Club's curriculum strongly emphasizes teaching scientific skills through the scientific method and engineering design process. Youth design their own experiments each week and collect data to make evidence-based conclusions. As a result, Science Club youth outperform their matched peers in Chicago Public Schools' annual science fair. Youth are assigned an initial aptitude category (low/middle/high) and the effect of Science Club participation is equivalent to raising youth scores by a full aptitude category (e.g. scores for Science Club youth in the middle aptitude category are statistically indistinguishable from non-participating high aptitude youth).

- Youth in 4-H Tech Wizards are closely mentored by professionals specializing in emerging technologies and spend three years progressively developing their technology skills. As a result, 95 percent of 4-H Tech Wizards participants demonstrate mastery of skills in website development, video and podcast productions, GIS and GPS technologies, and LEGO robotics.

- Techbridge girls consistently utilize the engineering design process. For example, they brainstorm on how to make a device to assist a disabled person, design a prototype and redesign the model based on use. Ninety-five percent of participants said they understand it can take many tries to solve a problem; 91 percent said they try harder to overcome a challenge; and 81 percent said they are better at problem-solving. More than 93 percent said they know more about how things work, like circuits and simple machines, and 80 percent said they are better at using new computer programs.

4. Youth **learn essential STEM-relevant life and career skills,** such as working in teams and collaborating effectively, as well as making presentations to audiences.

Youth become demonstrably more confident about their abilities to work on complex tasks and projects as well as persistence in the face of initial failures. For example, 90 percent of Girlstart participants responded positively to the statement "I understand that it is okay if my Girlstart activity does not work on the first try." Youth in these programs also start to use scientific terminology appropriately, consider multiple perspectives, and even begin to understand the importance of peer-review in scientific research.

Other examples:

- All programs observed in FUSE received a top score (5/5) in an observation-based evaluation tool for providing opportunities to practice group process skills, such as actively listening, contributing ideas or actions to a group, doing a task with others, or taking responsibility for a part of the project.

- Observations of Science Minors Club staff indicated that 100 percent utilized cooperative groups and individual roles to promote collaboration between youth participants. Eighty percent of observed sites provided opportunities for youth to report out their findings and communicate their ideas to the broader group and 86 percent supported youth in making connections between their work and their everyday lives.

- Tech Reach students made statistically significant improvements in communication, collaboration and computing skills on an assessment of 21st century problem solving skills. Participants improved their confidence with technology—90.6 percent of students reported that "I am good at computers" and more than 88 percent said "I like to figure out how something works."

- Computer Clubhouse youth who visited more frequently and stayed longer exhibited higher levels of collaboration. Ninety-two percent of youth plan to use skills acquired in the clubhouse in their future careers. Eighty-two percent of alumni say they are currently using the tools and technologies they learned at the clubhouse professionally and/or personally.

5. Equally importantly, participants in many of these programs come to **understand the value of STEM** in contributing to society and solving global and local problems**.** They begin to see how STEM intimately connects to their everyday lives.

Other examples:

- In observations of Science Minors Club sites, 86 percent of facilitators supported youth in making connections to their everyday lives and 78 percent of participating youth indicated that they use science in their everyday lives.

- Project GUTS curriculum covers real-world topics of societal concern in fields such as ecology, biology, social sciences, resource management and public health. Participants demonstrate their understanding that STEM relates to everyday life and can be used to study and potentially solve local community problems through their individual projects and presentations. When asked how they would investigate a new community issue, 80 percent suggested using computer modeling and simulation as a technique to investigate the issue.

- Science Action Club youth are engaged with increasing scientific understanding of their local environments by contributing to authentic science in citizen science projects. Seventy-five percent of youth respondents agreed that "in Science Action Club, I do activities that contribute to real science research." Sixty-two percent agreed that "Science Action Club makes me wonder and ask questions about the natural world."

6. Students in these programs display an **increased awareness of career options**, as well as a nuanced understanding of those careers.

The Build IT curriculum, delivered through Girls, Inc., gives a powerful demonstration of the impact afterschool programs can have on young people's choice of careers. Girls in the program showed statistically significant improvement on the survey items related to knowing what classes to take in high school for an IT career. Interviews with female participants as well as afterschool staff document that participating in Build IT has made a noticeable difference in how girls view technology careers, including having a more positive image of technology careers, a more nuanced understanding of the types of careers that require knowledge and skills in technology and math, and—for many girls—a clearer picture of the coursework involved in training for an IT-influenced career. Results from the other featured programs echo these outcomes. Youth not only develop an interest in STEM topics, but also gain an understanding of what related careers might involve.


Photo courtesy of Girlstart

Other examples:

- Science Club participants are exposed to a wide array of STEM professions through curricular units covering topics ranging from neuroscience to food science. Graduate student mentors, who lead these curricular units, similarly come from diverse scientific disciplines. Youth participants often ask their mentors questions about their career path, life in the lab, and their lives outside of school. Participants regularly describe their favorite school subject, their dream jobs and their hobbies in program surveys. One hundred percent of students felt science was relevant to their future careers after participation in Science Club, up from 70 percent before participation. Students could also more specifically describe STEM careers.

- Each Girlstart After School lesson includes a discussion of a STEM career, including educational prerequisites and how to enter that career. Ninety-four percent of participants demonstrated awareness that success in STEM can broaden their career options. Sixty-eight percent expressed strong interest and 93 percent indicated at least moderate interest in entering a STEM career. Almost all participants—97 percent—expressed an intent to attend college after high school, which is notable among a population in which 55 percent are first generation college aspirants.

- A key component of Techbridge is its use of STEM professionals as role models, which provides opportunities for youth participants to engage in career exploration. As a result, 94 percent knew more about different kinds of jobs. Eighty-one percent of girls said that because they engaged with role models and participated in field trips, they were more interested working in technology, science or engineering.

- High numbers of FUSE participants believe the program contributed to their science career aspirations—79.5 percent reported that participating in their afterschool science program(s) "made the idea of a job in science when I am older seem *more possible*"; 73.2 percent reported that it "made me *more interested* in a science job when I am older"; and 69 percent reported that it "made me feel *more sure* that I want a job in science when I am older." Eighty-eight percent of students reported that participating in FUSE "made me more confident that I could do well in science classes in college."

7. Finally, afterschool STEM programs can have an **impact on academic performance**.

A select number of programs have been able to track their students longitudinally. An evaluation of Project Exploration, a Chicago afterschool and summer STEM program, found that high-school graduation rates for participants are higher compared their peers, and their aspirations to attend college and major in a STEM field are higher (Chi et. al., 2010). An evaluation of Techbridge focused on long-term educational outcomes (2006-2012) found that participation helped girls achieve greater academic success. In comparisons made between girls who participated in Techbridge and those who did not (at the same school), findings indicated that:

- Techbridge girls have a higher weighted total cumulative GPA at high school graduation (3.32) than girls who have not participated in Techbridge (2.94).

- Techbridge girls scored an average of 26 points higher (321 vs. 295) than non-Techbridge girls on the California Standards Algebra II test, and an average of 43 points higher (365 vs. 322) on the California Standards Biology test.

- Girls who participated in Techbridge are 12 percent more likely to enroll in Advanced Placement (AP) Calculus (AB or BC) than girls who have not. Furthermore, Techbridge participants have a higher average grade in calculus than non-participants (87 percent vs. 82 percent).

Recently, Girlstart released an analysis of the impact of their programs (Bussiere & Hudgins, 2014). The primary questions for the analysis were: (1) Does Girlstart help girls perform better on standardized math and science tests? (2) Do Girlstart participants choose advanced STEM classes and electives at higher rates than non-participating peers?

- Girlstart After School participant test scores show that Girlstart girls are doing better than their non-participant peers in both math and science.
  - In spring 2013, 76 percent of Austin Independent School District (AISD) Girlstart After School participants passed the 5th grade State of Texas Assessments of Academic Readiness (STAAR) science test, while only 41 percent of comparison group members passed (64 percent of all students AISD partner schools passed–including both boys and girls).
  - Over a two-year period, 71 percent of AISD Girlstart participants passed the 5th grade STAAR science test, while only 48 percent of comparison group members (and 62 percent of all students) passed.
  - On the STAAR math test, 85 percent of Girlstart participants passed, compared to 70 percent of comparison group members (and 73 percent of all students at AISD partner schools).
- This impact is not limited to AISD. In 2013, 87 percent of Girlstart After School participants at the Georgetown Independent School District (GISD) partner schools passed 5th grade math, compared to 77 percent of students overall at partner schools. Over a two-year period, 82 percent of Girlstart participants passed the 5th grade STAAR test in science compared to 77 percent of students overall at GISD partner schools.
- Girlstart participants are also more likely to enroll in advanced and pre-AP math and science—1.58 advanced courses per girl, compared to 1.00 per non-participant girl. In conjunction with Techbridge's findings, this provides strong evidence that participation in OST STEM programs can be a significant factor in encouraging girls to pursue advanced math and science classes in school.

Many other programs observe that student impacts extend to academics or the school day. However, such measures are difficult to capture due to the lack of resources available for longitudinal tracking of students and the difficulty in having school districts share student-level data. The most critical limitation in evaluation efforts of afterschool and other OST STEM programs is the availability of validated tools (Noam and Shah, 2013), as well as the amount of time and resources available for planning and implementing evaluation.

As a final note, the featured programs had chosen, prior to the writing of this paper, which outcomes to assess and evaluate based on their defined programmatic goals and funder requirements. Additionally, they did not form their evaluation plans around the youth outcomes framework discussed above. The goal of this section was not to describe a representative sample of programs and students, but a nominated collection of strong programs and their impacts. Appendix 3 presents additional evaluation data from these programs set within the youth outcomes framework.

Conclusions

Afterschool programs present a great opportunity to engage a diverse group of young people in the STEM fields. It may be tempting to view such programs as compensating for needs not currently met via formal education, but it is crucial to remember that these programs serve a unique role. Afterschool programs complement the learning that occurs during the school day with experiences rooted in youth development principles and have many impacts that go beyond STEM-specific outcomes. As discussed here, in-school and OST programs are one set of components in a learning ecosystem that includes family, media, and cultural institutions.

Afterschool providers have embraced STEM in part because the hands-on learning it affords fits well with the core tenets of youth development, such as offering youth a voice and affording them opportunities to discover and grow their own interests. STEM programming in afterschool has grown at an extremely rapid pace in the past few years. Several support systems are now in place to aid both the growth in the number of programs offering STEM, as well as the quality of such programs. City-based intermediaries and statewide afterschool networks are able to coordinate resources and support programs; blended professional development models such as Click2Science PD[10] are helping to meet the professional development needs of afterschool educators; and investments in developing outcomes frameworks and assessment tools are greatly helping the field to set appropriate goals and document successes and challenges more systematically.

The program evaluations and studies that are included in this paper point to important contributions afterschool STEM programs can make. However, the sample of programs described here is not representative of the afterschool field as a whole, but instead serves as a glimpse of the potential outcomes possible if the afterschool field is further engaged and strengthened. Leading youth-serving organizations such as 4-H, Big Brothers Big Sisters, Boys & Girls Clubs of America, Girls Inc., and the YMCA of the USA have recently joined forces to make STEM a priority. This initiative has the potential to bring quality curricula, activities and mentoring to millions of children and youth.

It is difficult to isolate various environmental factors and attribute cause and effect specifically to afterschool interventions. Hence, there is a need to conduct further research to better understand these issues, specifically research that uses control groups in order to strengthen the evidence that positive changes can be attributed to the learning experience, and not simply a difference in interest among students who choose to participate in afterschool STEM. Absent such efforts, it will always be difficult to understand the selection bias of students who join programs and how it may differ from those who do not. In addition, these groups have to be studied within the same schools and districts in

[10] Click2Science is an online STEM professional development tool for out-of-school-time professionals and is available at www.click2sciencepd.org

order to distinguish effects that come from schools and those that are related to afterschool programs and other parts of the learning ecosystem.

Nonetheless, the consistent findings across increasing numbers of afterschool programs give us confidence that we are seeing a real phenomenon: students participating in OST programs have immediate and long-term gains on a number of STEM-related dimensions.

As the idea of cultivating learning ecosystems gains ground and afterschool programs are increasingly included as a key strategy in STEM education improvement, it is necessary to remain vigilant about the roles and values assigned to the components of an ecosystem. A true ecosystem assigns different roles to the different players, only some of which are duplicative. Local, state and federal policies and resource allocation must reflect an understanding that the system as a whole is accountable for success and all of the various players are accountable for their role in contributing to this success. The educational burden and opportunity cannot rest solely on schools; it must be distributed across a range of appropriate organizations. Policies must also incentivize partnerships between these organizations and encourage data to be shared among partners. Resources must be allocated for professional development to support program providers. Finally, there is a tremendous need to develop assessment instruments that can measure the impacts and outcomes of the system and the individual players appropriately. Progress has been made toward this goal, though much remains to be done to pursue this essential agenda.

Photo courtesy of Project GUTS

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Appendix I: Framework of Youth Outcomes

The youth outcomes framework for afterschool STEM was developed in a consensus study by expert afterschool practitioners and stakeholders (Afterschool Alliance, 2013a).

Outcome Through afterschool STEM programs, children and youth:	**Indicators** You know or can see that children and youth demonstrate:	**Sub-Indicators** If you had appropriate tools, you could document the following types of evidence:
A. Develop an interest in STEM and STEM learning activities. "I like to do this."	**Active participation in STEM learning opportunities**	**Active engagement and focus in STEM learning activities** *Persisting in a task or program; sharing knowledge and ideas; expressing enthusiasm, joy, etc.* **Pursuit of other out-of-school-time STEM learning opportunities** *Enrolling in programs; attending programs regularly; reporting performing STEM-related activities at home* **Pursuit of school STEM learning opportunities** *Participating more actively in school STEM activities; enrolling in courses; selecting special programs or schools; improving academic achievement*
	Curiosity about STEM topics, concepts or practices	**Active inquiries into STEM topics, concepts or practices** *Exploring ideas verbally or physically; questioning, hypothesizing, testing* **Active information-seeking about mechanical or natural phenomena or objects** *Conducting internet searches for more information; getting books/journals about STEM; watching TV programs on science, etc.*
B. Develop a capacity to productively engage in STEM learning activities. "I can do this."	**Ability to productively engage in STEM processes of investigation**	**Demonstration of STEM knowledge** *Demonstrating increase in knowledge in specific content areas; making connections with everyday world; using scientific terminology* **Demonstration of STEM skills** *Formulating questions; testing, exploring, predicting, observing, collecting and analyzing data* **Demonstration of an understanding of STEM methods of investigation** *Demonstrating understanding of the nature of science; using evidence-based reasoning and argumentation; demonstrating engineering design practices*
	Ability to exercise STEM-relevant life and career skills	**Demonstration of mastery of technologies and tools that can assist in STEM investigations** *Developing capacity to use measurement and other scientific instruments; running computer programs for data analysis; developing effective methods to communicate findings* **Demonstration of ability to work in teams to conduct STEM investigations** **C***ommunicating effectively with team members; collaborating effectively with team members; demonstrating leadership on the team* **Demonstration of applied problem-solving abilities to conduct STEM investigations** *Engaging in critical thinking; questioning, sequencing, reasoning*
C. Come to value the goals of STEM and STEM learning activities. "This is important to me."	**Understanding of value of STEM in society**	**Demonstration of an understanding of relevance of STEM to everyday life, including personal life** *Referencing examples of STEM in everyday life: everyday problems* **Demonstration of knowledge of important civic, global and local problems that can be addressed by STEM** *Contributing to projects that address a community need; developing awareness of how STEM is implicated in larger societal issues* **Demonstration of awareness of opportunities to contribute to society through STEM** *Engaging in a service-learning project*
	Awareness of STEM professions	**Development of an understanding of the variety of STEM careers related to different fields of study** *Gaining knowledge about relevant professions; gaining knowledge of where such jobs and careers exist* **Demonstration of knowledge of how to pursue STEM careers** *Acquiring knowledge of what courses are needed to prepare for or pursue STEM degrees; declaring STEM interests or majors* **Demonstration of awareness that STEM is accessible to all** *Expressing a desire to meet role models; declaring STEM interests and majors; desiring to become a role model to pave the way for others*

Appendix II: Descriptions of selected afterschool STEM programs with strong youth outcomes

	4-H Tech Wizards	Build IT	Computer Clubhouse
Location	Originally in Oregon; now in 26 states	U.S. and Canada	International (100 locations in 20 countries), headquartered at Museum of Science, Boston
Description	4-H Tech Wizards is an afterschool, small-group mentoring program that trains youth on various technologies within a bilingual, bicultural learning environment. The program is implemented through the 4-H National Mentoring Program, a partnership between National 4-H Council and the Office of Juvenile Justice and Delinquency Prevention.	Build IT is an afterschool and summer curriculum for middle school youth to develop IT (information technology) fluency, interest in mathematics, and knowledge of IT careers. The program—co-developed by SRI International and the Girls Inc. of Alameda County—is designed to engage girls and African-American and Latino/a youth.	The Computer Clubhouse provides a creative, safe out-of-school learning environment in which youth from underserved communities work with adult mentors to explore their own ideas, develop new skills, and build self-confidence through the use of technology.
Age Level	Ages 8-18; older youth involved as teen teachers	Middle school	Ages 10-18
Students Served	8,623	3,500	25,000
Demographics	Open to all, but focus is on Hispanic and other under-served, high-need youth.	95% girls; more than 80% are African-American and Latina and the majority are from low-income households.	Demographics depend on the local community. All clubhouses focus on reaching under-served communities and youth.
Evaluation Methods	Outcome data is collected by a variety of methods, including formal skill assessment tools; surveys; service logs; observations; and interviews with youth, mentors, staff and family members.	Staff collects ongoing outcomes data through performance tasks, concept surveys and attitude surveys. Evaluation data is collected during specific research projects and includes participant, facilitator, staff and parent surveys, as well as interviews and observations with youth and facilitators.	As a drop-in program, the clubhouse's first measure of success is participation. A sign-in system collects data about participants and attendance. An annual survey gathers demographic data; clubhouse visiting patterns; and attitudes related to technological competence, academic engagement, social-emotional well-being, and aspirations for the future.

	FUSE	Girlstart	Project GUTS Santa Fe Institute
Location	New York, New York; Providence, Rhode Island; Oakland, California; Baltimore, Maryland; Boston, Massachusetts; Chicago, Illinois; and Palm Beach County, Florida	Austin, Texas, and other high-need communities	Santa Fe, New Mexico
Description	FUSE is a strategy to institutionalize engaging, inquiry-based, informal STEM education nationally. The goal is to stimulate a culture shift among afterschool leaders and staff to increase the demand for and capacity to deliver high-quality informal STEM education.	Girlstart After School is an intensive intervention program providing free weekly STEM programming throughout the year at partner schools. Girlstart programs are designed to promote girls' early engagement and academic success in STEM, encourage their aspirations and persistence in STEM education and careers, and incubate a talented and diverse STEM workforce.	Project GUTS (Growing Up Thinking Scientifically) is an afterschool program in which middle school students learn cutting-edge computing methods to solve modern-day problems. Participants design, create and test computer models to simulate "what if" scenarios for real-world questions of community and societal concern.
Age Level	Grades K-12	Ages 8-13; Grades 4-8	Ages 11-13; Grades 6-8
Students Served	32,000	1,000	2,000
Demographics	Varies by city	100% girls; 70% qualify for federal free or reduced price lunch; 33% are Limited English Proficient; 5% have special needs or disabilities; 12% African-American, 5% Asian-American/Pacific Islander, 17% Caucasian, 63% Latina, 4% identify as multiracial; 55% first-generation college aspirants.	35% qualify for federal free or reduced price lunch; 7% are Limited English Proficient; 5% have special needs or disabilities; 1% African-American, 2% Asian-American, 24% Caucasian, 58% Hispanic/Latino, 2% Native American, 13% Other.
Evaluation Methods	The FUSE initiative is evaluated by TASC (The After School Corporation), which conducts interviews with stakeholders; collects surveys from staff, students and intermediaries' partners; and observes science activities using the STEM Program Quality Assessment (PQA). Staff confidence is examined via the Science Teaching Efficacy Belief Instrument (STEBI), and youth science attitudes via the Science Attitude Change Tool and Common Instrument.	Girlstart uses a system of pre- and post-surveys to assess girls' STEM skills and knowledge; self-reported attitudes toward Girlstart; and interest and confidence in undertaking future STEM activities, courses, majors and careers. A framework for tracking program alumnae's academic progress assesses long-term impact.	Project GUTS measures student demographics and attendance; collects pre- and post-surveys of knowledge, skills and self-efficacy; teacher participation in professional development; growth and self-efficacy of teachers as GUTS club leaders; and partnerships developed.

	Science Action Club California Academy of Sciences	Science Club	Science Minors Clubs Museum of Science and Industry
Location	San Francisco, California	Chicago, Illinois	Chicago, Illinois
Description	In Science Action Club (SAC), youth conduct dynamic and authentic investigations by exploring their local environment, making observations about the natural world, and contributing data to real scientific research. SAC also provides resources for other afterschool partners to implement the program.	Science Club is a partnership between Northwestern University and the Boys & Girls Club of Chicago, utilizing long-term mentoring relationships to engage low-income urban youth in science. Every week, Northwestern graduate students lead small groups of students through designing and running hands-on science experiments.	Science Minors Clubs is an outreach initiative of the Museum of Science and Industry aimed at increasing interest in science in underserved neighborhoods by engaging students in places where they already spend their time after school, such as community-based organizations and schools. Participants work together on STEM projects and activities that build curiosity and encourage teamwork.
Age Level	Ages 11-14; Grades 6-8	Grades 6-8	Ages 8-12
Students Served	430 (expansion planned for fall 2014)	60	6,370
Demographics	66% qualify for federal free or reduced price lunch; 25% are Limited English Proficient; 18% have special needs or disabilities; 15% African-American, 50% Asian-American/ Pacific Islander, 13% Caucasian, 13% Hispanic/Latino, 9% Other.	97% qualify for federal free or reduced price lunch; 35% are Limited English Proficient; 15% have special needs or disabilities; 40% Asian-American/Pacific Islander, 33% African-American, 5% Caucasian, 22% Hispanic/Latino.	87% qualify for federal free or reduced price lunch; 48% African-American, 6% Asian-American/Pacific Islander, 8% Caucasian, 36% Hispanic/Latino.
Evaluation Methods	SAC has partnered with a professional evaluation firm to assess programmatic impact on participating youth and activity leaders. Outcome data is collected through pre- and post-session surveys, site visits, interviews and focus groups. In addition to developing original assessment strategies, the program employs validated evaluation tools.	Using a case-control methodology, Science Club measures changes in youth skills with a scenario-based skills interview and science fair scores. Youth attendance, interviews and surveys are also collected. Mentors participate in focus groups and self-report on changes in communication and teaching skills as well as attitudes toward science outreach.	The museum's in-house research and evaluation team leads the design of the evaluation plan. Data sources include student intake forms, weekly attendance reporting, surveys, facilitator reflections and site observations. Program implementation across diverse sites, effectiveness and usability of the curriculum and pedagogical approaches, impact of the professional development trainings, and community perceptions of the museum have also been evaluated.

	Tech Reach The Thinkery	**Techbridge**
Location	Austin, Texas	Bay Area, California; expanding to Seattle in fall 2014 and two additional cities by 2016
Description	Tech Reach is an outreach program of the Thinkery, a hybrid science and technology center/children's museum formerly known as the Austin Children's Museum. Tech Reach engages students through a concept called "creative computing"—where the bridge to computing concepts is achieved through projects and challenges that tap into young students' creativity and inventiveness.	Techbridge offers afterschool and summer programs with hands-on projects and career exploration to inspire girls in science, technology and engineering. Curricula are developed with girls in mind, and designed to spark and sustain an interest in these fields as well as to make a connection with STEM careers. Career exploration is facilitated through STEM role model visits and field trips to local engineering and technology companies.
Age Level	Grades 3-5	Grades 5-12
Students Served	150	400
Demographics	95% qualify for federal free or reduced price lunch; 10% are Limited English Proficient; 15% have special needs or disabilities; 10% African-American, 2% Asian-American/Pacific Islander, 5% Caucasian, 80% Hispanic/Latino.	100% girls; 94% of school partners receive Title I funding; 75% of students are eligible for free or reduced price lunch; 40% Limited English Proficient; 10% African-American, 30% Asian-American/Pacific Islander, 8% Caucasian, 42% Hispanic/Latino, 2% Native American, 8% Other.
Evaluation Methods	An external evaluator designs pre- and post-program assessments, embedded assessments, and surveys for students to measure attitudes toward STEM and the program. Focus groups are convened for participating teachers to help determine program strengths in design and implementation and identify areas for improvement.	Techbridge uses quantitative and qualitative evaluation methods that include pre- and post-surveys; focus groups with girls, teachers, and families; and program observations and coaching. Surveys examine technical and scientific ability, career awareness, aspirations, teamwork and adult influence. Comparison groups are utilized to evaluate outcomes with groups not participating in Techbridge. In addition, an observation rubric is used to ensure fidelity of implementation and identify areas for program improvement.

Appendix III: Selected evaluation results of afterschool STEM programs with strong youth outcomes

Each afterschool program utilized the youth outcomes framework (Afterschool Alliance, 2013a; also shown in Appendix I) to describe their youth-level impacts. Programs collected a variety of evaluation data, however only data that fit the framework is shown here. Additionally, many programs found anecdotal evidence supporting the outcomes and indicators, but did not collect data on all of them. This evidence is not reflected in the following tables.

Outcome A: Develop an interest in STEM and STEM learning activities "I like to do this."		
Indicators:	**Active participation in STEM learning opportunities**	**Curiosity about STEM topics, concepts or practices**
4-H Tech Wizards	Program attendance is high and consistent—on average, 95% of enrolled youth attend 4-H Tech Wizard sessions and 95% of participants have stayed in the program for three years to complete all three skill levels.	Youth report that they are attracted to 4-H Tech Wizards because of the opportunities to work with cutting edge technology and the mentors.
Build IT	Retention was often 100% at sites that had girls and parents commit to girls' active participation in Build IT. Girls reported a statistically significant increase in their confidence in math, belief in its usefulness, and plans to take computer courses.	
Computer Clubhouse	83% of participants visited their clubhouses at least weekly, and 47% every day. 37% of youth visited their clubhouse for more than three hours at a time, and 91% visited for at least one hour.	Clubhouse alumni reported that they initially started attending to learn about technology (61%) and work on interesting projects (45%). Continued participation gave them the opportunity to work on projects of their own (38%), learn important skills (34%), and gave them access to valuable technology (31%).
FUSE	FUSE students participated in additional science-related opportunities—43.6% played a math or science game at home; 42% participated in discussions about science topics with friends; 55% watched TV, movies or online videos related to science topics; and 30% read a book about a science topic.	Student attitudes toward science increased significantly in terms of agreement with the following statements: "I get excited to find out that I will be doing a science activity"; "Science is something I get excited about"; "I like to work on science activities"; "I like to participate in science projects"; and "I am curious to learn more about science, computers, or technology."

Outcome A: Develop an interest in STEM and STEM learning activities “I like to do this.”		
Indicators:	**Active participation in STEM learning opportunities**	**Curiosity about STEM topics, concepts or practices**
Girlstart	Participation resulted in the extension of interest in science outside the program—86% agree with the statement “I want to try more science activities.” 84% reported interest in taking further STEM classes in middle or high school. In 2012, 58% attended Girlstart’s *Girls in STEM Conference.*	87% report enjoying science, and particularly the scientific activities they did at Girlstart.
Project GUTS	82% of Project GUTS youth persist in the program to successfully complete a working computer model. 65% of students strongly believed that participating in Project GUTS made them more excited to do and learn science and technology in school.	
Science Action Club	69% of participants attend the program regularly and 86% indicated that they would recommend it to a friend. More than 60% of youth who enrolled in two sessions also participated in a third session. 77% of youth reported that “Being in Science Action Club makes me want to learn more about science outside of school.”	74% agree that “I get excited to find out that I will be doing a science activity in afterschool.” 63% agree that “science is one of my favorite subjects in afterschool.”
Science Club	Youth choose to go to Science Club among an array of options at a Boys & Girls Club—84% of participants attend weekly, participating for 1.5 years on average, with a 92% retention rate.	94% of youth prefer learning hands-on science with Science Club over school-based science classes. 82% of youth express a desire to continue in the program after as a high school mentor.
Science Minors Club	87% of youth surveyed indicated that they enjoy science and 92% expressed interest in doing more science activities. Family engagement is strong—on average, 1266 participant family members attend Museum of Science and Industry Family Days.	85% of site facilitators reported an interest in additional STEM topics to meet youth participant demand. 57% of site facilitators accessed additional curriculum kits to expand offerings for their club participants.
Tech Reach		After participating in Tech Reach, 88% of students believed that science was fun and 86% said that math was fun.
Techbridge	After participation, 80% of girls planned to pursue additional STEM learning opportunities by taking advanced math and/or science classes.	85% of girls reported they find engineering more interesting and 83% said they find science more interesting after participating in Techbridge.

Outcome B: Develop a capacity to productively engage in STEM learning activities "I can do this."		
Indicators:	**Ability to productively engage in STEM processes of investigation**	**Ability to exercise STEM-relevant life and career skills**
4-H Tech Wizards	95% of 4-H Tech Wizards participants demonstrate mastery of skills in website development, video and podcast productions, GIS and GPS technologies, and LEGO robotics.	
Build IT	The computer engineering design process is embedded in every curriculum unit as a method of problem solving. Girls showed statistically significant improvements in their understanding and use of the design process.	Build IT motivates girls to use technology to strengthen and build their technology fluency. The project achieved statistically significant improvements in frequency of computer use, computer skills, and conceptual understanding of computing.
Computer Clubhouse	Youth who visited more frequently showed higher levels of problem-solving competence and technology competence. Of students in that group, 61% of girls and 55% of boys scored above the median on "technology competence."	Clubhouse youth who visit more frequently and stay longer show higher levels of collaboration. 92% of youth plan to use skills acquired in the clubhouse in their future careers. 82% of alumni say they are currently using the tools and technologies they learned at the clubhouse professionally and/or personally.
FUSE	Youth saw gains in science knowledge, motivation and confidence across all FUSE sites participating in the evaluation. At least 85% of youth reported that participating in their afterschool science program: "Improved my understanding of science"; "Helped me learn things that I need to answer science questions"; and "Gave me experience that will help me in the future with science projects and activities."	FUSE received a top score (5/5) on an observation-based evaluation for providing opportunities to practice group process skills, which includes actively listening, contributing ideas or actions to a group, doing a task with others, or taking responsibility for a part of a project.
Girlstart	100% engage weekly in iterative design and scientific inquiry to solve problems, including generating observations, predictions and hypotheses, and tracking experiments and outcomes. As a result, 91% of participants demonstrated mastery of scientific inquiry and the engineering design process.	100% participate in weekly collaborative problem-solving challenges that require critical thinking. 90% respond positively to the statement "I understand that it is okay if my Girlstart activity does not work on the first try." All participants present their experiments and results to parents, teachers and others in an end-of-semester showcase.
Project GUTS	64% of youth agreed they had learned how to use computer models to conduct scientific investigations—a skill that requires following an iterative problem solving process to design, implement, test and debug computer models.	

Outcome B: Develop a capacity to productively engage in STEM learning activities "I can do this."		
Indicators:	**Ability to productively engage in STEM processes of investigation**	**Ability to exercise STEM-relevant life and career skills**
Science Action Club	100% of participants contribute directly to a national citizen science project by making observations, collecting data and considering the implications of their findings. 72% of youth report that "The data I collect in Science Action Club is scientifically relevant."	The SAC environment emphasizes teamwork and leadership, and evaluations show gains in youth self-perception and leadership. As a result of an emphasis on using technology for data collection, 89% of participants agreed that, "I feel confident using technology to do science activities in SAC."
Science Club	The Science Club curriculum emphasizes the scientific method and the engineering design process. Science Club youth significantly outperform their aptitude-matched peers in two independent, well-controlled oral assessments of science skills. These assessments include constructs of experimental design, use of variables, and data analysis. Science Club youth are also more confident conducting experiments than non-participating youth (56% vs. 32%).	Twice as many Science Club students described experiments as a way to help them learn and find out new things compared to youth not in the program (64% vs. 33%). 81% of Science Club youth described using science outside of school compared to the control group.
Science Minors Club	Site observations revealed that 80% of facilitators encouraged youth to formulate testable questions and 93% fostered the collection of data and recording of observations. 93% of observed sites provided opportunities for youth to use STEM tools such as a hand lens, calorimeter and rulers to make observations, take measurements or collect data.	Observations indicated that 100% of program sites utilized cooperative groups and individual roles to promote collaboration between youth participants. 80% of sites observed provided opportunities for youth to report out their findings and communicate their ideas to the broader group.
Tech Reach	All students must use critical thinking and creative problem solving needed to design, program and build technology in Tech Reach—77% of students report "I am good at building things using technology."	Students made statistically significant improvements in communication, collaboration and computing skills on an assessment of 21st century problem solving skills. 90.6% of students reported that "I am good at computers" and more than 88% percent said "I like to figure out how something works.
Techbridge	95% of girls say they understand it can take many tries to solve a problem. 93.5% said they know more about how things work, like circuits and simple machines. 80% said they are better at using new computer programs.	70% said they are more comfortable speaking in front of a group of people. 91% said they try harder to overcome a challenge. 81% said they are better at problem-solving. 92% said they feel more confident using technology. 89% said they feel more confident in science.

Outcome C: Come to value the goals of STEM and STEM learning activities "This is important to me."		
Indicators:	**Understanding the value of STEM in society**	**Awareness of STEM professions**
4-H Tech Wizards	85% of 4-H Tech Wizards participants completed 15 hours of community service learning by teaching technology to others.	Evaluators report that 70% of graduating 4-H Tech Wizards participants pursued post-high school education and careers in science, technology, engineering or math.
Build IT		Interviews document that participation has made a noticeable difference in how girls view technology careers. Many who initially reported IT as solitary and boring later reported that they found IT to be collaborative, fun, intellectually stimulating and a possible career. Girls showed statistically significant improvements in knowing what classes to take in high school to prepare for an IT career.
Computer Clubhouse	74% of alumni give back to their communities through continued interaction with clubhouse staff and youth.	Among alumni, 80% reported that the clubhouse had been the most important source of support for pursuing a career. 97% of alumni said that it was also the most important source of support for setting high goals and expectations for themselves.
FUSE	After participating in FUSE, student attitudes increased significantly in terms of agreement with the statement: "I pay attention when people talk about recycling to protect our environment."	79.5% reported that participating in FUSE "made the idea of a job in science when I am older seem *more possible*"; 73% reported that it "made me *more interested* in a science job when I am older"; and 69% reported that it "made me feel *more sure* that I want a job in science when I am older." 88.6% reported that participating in FUSE "made me more confident that I could do well in science classes in college."
Girlstart	After participating in Girlstart, 70% report that they believe their ideas can solve problems in their own neighborhoods. 87% realize that they use science frequently outside of Girlstart. 91% agree with the statement, "If I do well in STEM in college, I am more likely to get a better job."	94% of participants demonstrate awareness that success in STEM can broaden their career options. 68% express strong interest and 93% indicate at least moderate interest in entering a STEM career. In a population in which 55% of participants are first generation college aspirants, 97% expressed intent to attend college after high school.

Outcome C: Come to value the goals of STEM and STEM learning activities "This is important to me."		
Indicators:	**Understanding the value of STEM in society**	**Awareness of STEM professions**
Project GUTS	When asked how they would investigate a new community issue, 80% of Project GUTS participants suggested using computer modeling and simulation.	
Science Action Club	In SAC, youth are engaged with increasing scientific understanding of their local environments. 75% of youth agreed that "In [SAC], I do activities that contribute to real science research." 62% agreed that "[SAC] makes me wonder and ask questions about the natural world." 68% agree that "I care about the topics we learn about in [SAC]."	SAC is central to the California Academy of Science's pathway of youth programs, which fosters an awareness of STEM professions. 40% of survey respondents agreed that "Being in SAC makes me think about getting a science job when I am older."
Science Club	Science Club youth are better able to describe how science is used in everyday life in comparison to their non-participating peers.	100% of students felt science was relevant to their careers after participation in Science Club, up from 70% at the start of the program. Students could also more specifically describe science careers.
Science Minors Club	In site observations, 86% of facilitators supported youth in making connections to their everyday lives and 78% of participating youth indicated that they use science in their everyday lives. Of the sites implementing the "Green Energy" curriculum, 100% of facilitators reported participation in a recycling program.	An average of 1,350 youth and family members participated in Museum of Science and Industry STEM career fairs. 100% of youth attending the fairs completed a STEM career journal, which guided their interviews of STEM professionals and encouraged them to describe STEM careers of personal interest.
Tech Reach		Thinkery staff members promote awareness of STEM careers and futures by routinely encouraging students to imagine themselves as engineers solving problems. 76% of participants reported "Someday I would like a job where I can use math and science."
Techbridge		Techbridge provides extensive opportunities to engage in career exploration. As a result, 94% of participants knew more about different kinds of jobs. 81% said they can see themselves working in technology, science or engineering.

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The Afterschool Alliance is a nonprofit public awareness and advocacy organization working to ensure that all children and youth have access to quality afterschool programs. More information is available at **www.afterschoolalliance.org**.

PEAR's mission is to create and foster school and afterschool settings in which all young people can be successful. Dedicated to "the whole child; the whole day; the whole year," PEAR continuously integrates research, theory, and practice for lasting connections between youth development, school reform and mental health. For more information, visit **www.pearweb.org.**