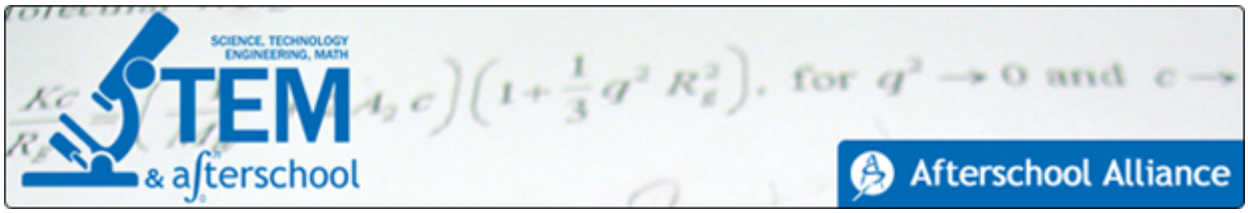

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STEM Learning in Afterschool: An Analysis of Impact and Outcomes

There is a widely acknowledged, urgent need for improving and increasing science, technology, engineering and math (STEM) skills among our citizenry and students to navigate the modern world and access the opportunities it affords. The need for a more STEM literate workforce has been discussed in respected reports such as "Rising Above the Gathering Storm" from the National Academies, and data on the workforce show clear benefits of a STEM-related post secondary education in the current job market.[1,2]

A critical factor in this issue is the need to improve access to STEM fields and careers among populations that are currently underrepresented. According to the U.S. Department of Commerce Report *Education Supports Racial and Ethnic Equality in STEM, "*Non-Hispanic Blacks and Hispanics each account for six percent of all STEM workers, but 11 percent and 14 percent, respectively, of overall employment."[3] In another report by the Department of Commerce, focused on the gender gap, it is noted that women make up 48 percent of the workforce but only 24 percent of STEM jobs. [4] These data make it very clear that women and minorities are greatly underrepresented in the STEM fields. Increasing access to and representation of these populations in STEM fields is necessary to increase their opportunities to participate in the modern economy; the nation would also benefit greatly if a larger and more diverse talent pool was to participate in the STEM workforce.

Given a need to improve STEM education in America and increase access to STEM learning opportunities, what steps can be taken to get there? While improvements in formal K-12 education are necessary, children spend less than 20 percent of their waking hours in school. Opportunities lie in all aspects of their education, including enrichment programs that take place during the afterschool hours and the summer.[5]

Afterschool programs[*] are especially well-placed to help close the opportunity gap that many children and youth from underserved and underrepresented communities face. Of the 8.4 million children in afterschool programs, ethnic minority children are more likely than others to participate.[6] 25 percent of Asian, 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. Furthermore, girls attend afterschool programs in equal numbers to boys. These participation data provide evidence that the afterschool setting reaches students from populations that are underrepresented in STEM fields and provides enrichment opportunities that can bring STEM alive for them.

[*] The term "afterschool" is used in this paper to refer broadly to before school, afterschool and summer learning opportunities.

Among students who are fortunate enough to have access to afterschool enrichment opportunities, the benefits of afterschool programs in general are well documented, showing positive impacts on both academic and behavioral development.[7] In addition, outcome and impact data are now emerging from studies of afterschool programs that offer STEM learning and this recent research highlights the unique benefits for youth participating in these afterschool and summer programs.

This document summarizes evaluation reports from afterschool STEM programs across the United States and identifies common trends and strengths that afterschool learning brings to STEM education. Like many programs nationwide, several of the programs highlighted in this paper were designed specifically to provide services to underrepresented populations in STEM fields, and many also focus on providing girls with exposure to science and female role models. Thus they are reaching some of the very children and youth we need to better engage in STEM fields and careers.

Evaluations presented here were collected by casting a wide net to solicit reports from afterschool programs across the country through various communication channels as well as searching through evaluation databases. Several of the programs used pre- and post-program surveys and focus groups to measure change in students while a few continued to track their students after they left the programs. There were also some that measured academic achievement through administering pre- and post-program tests as well as recording grades and standardized test scores. Some evaluation studies also surveyed parents and program staff.

Our review of evaluations found that attending high-quality STEM afterschool programs yields STEM-specific benefits that can be organized under three broad categories: improved attitudes toward STEM fields and careers; increased STEM knowledge and skills; and higher likelihood of graduation and pursuing a STEM career. Below is a brief overview of these three types of outcomes, followed by specific findings that were common across a number of the evaluations.

1. <u>Improved attitudes toward STEM fields and careers</u>
    a) Increased enrollment and interest in STEM-related courses in school [11,16,21]
    b) Continued participation in STEM programs [9,11,13,15]
    c) Increased self-confidence in tackling science classes and projects [10,15,22]
    d) Shift in attitude about careers in STEM [12]

2. <u>Increased STEM knowledge and skills</u>
    a) Increased test scores as compared to non-participants [19,23]
    b) Gains in knowledge about STEM careers [22,18,23]
    c) Gains in computer and technology skills [20,22]
    d) Increased general knowledge of science [17,24]
    e) Gains in 21st century skills, including communication, teamwork and analytical thinking [17, 18, 19, 20, 22]

3. <u>Higher likelihood of graduation and pursuing a STEM career</u>
    a) High rate of high school graduation among participants [18,28,27,29]
    b) Pursuit of college and intention of majoring in STEM fields [22,28,27]

Improved Attitudes Towards STEM Fields and Careers

Researchers have shown that an early interest in pursuing science and engineering is a better indicator of whether a student will pursue a career in these fields than a student's grades in school.[8] Increasing interest early on is critical so that students are motivated to develop the knowledge and skills required to pursue more rigorous math and science courses in high school. The following programs have documented increased interest, self-confidence or positive attitudes towards STEM fields among their participants as seen from pre- and post-program surveys. Increased interest in STEM is also evidenced by increased enrollment in advanced math and science classes as well as continued participation in STEM programs and clubs outside of the school day.

- *Communication, Science ,Technology, Engineering and Math (CSTEM)* started in Houston, TX, operates both in the formal classroom and out-of-school-time setting and spans K-12. CSTEM seeks to eliminate barriers to the STEM disciplines as well as communication for under-represented populations and currently operates in six states (Louisiana, Michigan, Maryland, Mississippi, Tennessee and Texas) and the Dominican Republic. The school year culminates with a CSTEM challenge that includes a robotics competition and presentation of work done throughout the year. CSTEM focuses on professional development for teachers who are leading the robotics teams, most often in the afterschool time. Each team consists of participants from one high school, middle school and elementary school. Each school team completes a section of a larger end product. The different components of the competition include robotics, creative writing, a "green" challenge, sculpture and Geographical Information System (GIS) mapping.

  Highlights from its 2010-2011 community impact reports show that many students participating in CSTEM had not previously been exposed to similar topics and that there was a high interest among students:
  - 94 percent of students reported that they want to continue in the CSTEM program.
  - 100 percent indicated that CSTEM provided their first STEM enrichment experience. 75 percent spent three hours per week or more on their CSTEM project, and 20 percent spent 10 or more hours per week.[9]

- *For Inspiration and Recognition of Science and Technology (FIRST)* provides several leagues in which student teams compete in robotics competitions. The program is open to all K-12 youth. Within the teams, students spend six weeks planning and designing a robot to compete in local, regional and national competitions. *FIRST* Robotics Competition and *FIRST* Tech Challenge are designed for high school students while *FIRST* LEGO League is for 9-14-year-olds and Junior *FIRST* LEGO League is for youth aged 6-9.

  A retrospective study of *FIRST* alumni was conducted by researchers at Brandeis University who surveyed participants who graduated from the program between 1999-2003 in New York City and Detroit. The study found that:
  - 80 percent of respondents reported an increased understanding of the role of science and technology in everyday life.
  - 86 percent reported an increased interest in science and technology generally and 69 percent had an increased interest in STEM careers.
  - 89 percent reported increased self-confidence and 70 percent had an increased motivation to do well in school.[10]

Several national organizations host *FIRST* teams, including the Girl Scouts. A survey of Girl Scouts *FIRST* Lego League (FLL) and *FIRST* Tech Challenge (FTC) teams at the world championship in 2010 highlighted the following findings:

- 66 percent stated that they enjoy math and science projects in school more than before their participation in FLL.
- 56 percent stated they were more interested in their science classes than before participating in FLL.
- 92 percent of respondents stated that they "want to learn more about science and technology" as a result of their participation in FLL. [11]

- *Operation SMART*® is a national program offered by Girls Inc. and provides K-12 participants an opportunity to explore STEM careers through afterschool and summer programs. Students spend time working on science experiments, designing projects and having discussions about careers in STEM with professional mentors.

  Participants from a Girls Inc. site in Harrisburg, PA, were asked particular questions about their attitudes towards math, science and learning before and after their experiences in the program. They responded as below:[12]

	Percent who answered YES	
Survey item	**Before**	**After**
I know what a scientist does	45%	99%
I am good in math	90%	100%
I am smart (intelligent)	91%	100%
I like to discover things (or invent things)	54%	97%
Not having science would be okay with me	40%	3%

- *Science Club for Girls (SCFG)* operates out of Cambridge, MA, at school sites throughout the state. Girls in 8th-12th grades build leadership skills by serving as mentors to younger girls (K-7). Students interact with STEM professionals, do science activities and take field trips to local museums.

  A survey given to Cambridge Public School students who participated in SCFG for at least one year and girls who did not participate found:

  - Those who participated in SCFG scored 4.9 points (out of 48 points) higher than those who did not on a survey that measured attitudes towards science.
  - SCFG members had more confidence in themselves as science students than their non-participating counterparts.

- *Student Science Enrichment Program (SSEP)* was established by the Burroughs Wellcome Foundation in 1996 to fund innovative programs in the state of North Carolina that work during out-of-school-time (OST) on science enrichment. The monetary awards are granted to programs that provide hands-on science learning and inquiry-based exploration. The programs are also required to align with the school-day curriculum. Since its inception, SESP has worked with 69 programs across North Carolina.

Evaluation of the OST programs began with the inception of the award in 1996 using an external evaluator. The evaluation tools included student feedback surveys, project profiles, observations and annual reports by program directors. From the feedback survey conducted during 2008-09:

- 72 percent stated that they are more interested in learning science since being part of the program.
- 76 percent stated they are more excited about science because of the program.
- 81 percent stated they want to participate in a similar program.[13]

- *TechBridge* works exclusively with girls in grades 5-12 and operates as an afterschool program located on school campuses in Oakland, CA. The program provides participants with an opportunity to work on projects organized by discipline (computer science, chemistry, biology). Activities include learning about chemical properties by making bouncy balls or the principles of programming by creating Scratch[†] animations. Youth also have an opportunity to visit tech companies and participate in career exploration activities.

  Evaluation data from its annual report in 2010 showed that there was increased interest in STEM among participating girls:

  - 95 percent believed engineering is a good career for women.
  - 85 percent were more interested in working in technology, science or engineering because of role models and field trips.
  - 82 percent could see themselves working in technology, science or engineering.[14]

- *Tech Corps* programs include Student Tech Corps, Techie Club, Techie Club: Girl and Techie Camp, and can be found in Ohio and Texas. Techie Club is designed to expose elementary school youth to STEM. The curriculum includes computer programming with LEGO Mindstorm NXT[‡] and Scratch as well as work on digital media and Web tools.

  An evaluation of 10 Techie Clubs in Ohio during the 2009-2010 school year included pre- and post-program attitude surveys from students, mid-year surveys from site coordinators, student impact surveys from homeroom teachers and program impact surveys from parents. Site coordinators as well as homeroom teachers observed a significant increase in confidence using technology among Techie Club participants:

  - 67 percent of those surveyed stated that participating in Techie Clubs allowed them to be more confident about how a computer works.
  - 17 percent said they were more excited to be an engineer at the end of the program.
  - 89 percent of students said they would recommend Techie Club to their friends.
  - 97 percent of students said they would want to participate in Techie Club next year.[15]

- *TechREACH*, based in Washington state, provides afterschool clubs for middle school students at several school sites. The curriculum includes 3D design, creating podcasts, learning and building small-scale wind turbines, and designing arcade games. Club mentors are brought in to talk about

[†] Scratch is a platform in which users can create programs by manipulating visual icons that represent program code. It was created as an educational tool by researchers at the Media Lab at MIT.

[‡] LEGO Mindstorm NXT is a kit of LEGO bricks with a central microcontroller with which participants can build and program a robot to move autonomously.

their careers in STEM fields. The program also has a teacher training component to equip teachers with the resources to implement curriculum. The clubs are separated between boys and girls.

Evaluations done by an external reviewer in 2008 through surveys, focus groups and interviews showed that participants had increased interest in science and math and increased confidence in their ability to pursue these subjects.[16] Highlights from the report include:

- More than 73 percent agreed or strongly agreed that it made them want to take more technology classes in high school.
- 62 percent said it increased their interest in a career in technology.
- 49 percent said it increased their interest in a career as a computer scientist.
- 49 percent said it made them want to take more math classes in high school.

All of these programs have found ways to increase interest in STEM by providing youth with engaging curriculum that sparks their curiosity. All the programs promote teamwork and provide an element of problem solving that puts students in control of what they are learning. Many of the programs highlighted here have a strong mentorship component that exposes youth to various career opportunities through interaction with STEM professionals. In addition, several evaluations noted that the staff and parents of participants reported an increase in confidence among their youth. This increase in confidence, especially among young girls, is key to taking the next steps to pursue STEM education and careers.

Increased STEM Knowledge and Skills

While engagement and developing positive attitudes towards STEM fields is the first step, afterschool programs also provide an opportunity for participants to gain knowledge, further their interest in the topic and gain the skills necessary for STEM careers. Problem solving, critical thinking, communication and collaboration are all part of the skill set required for the knowledge-based jobs of the present and future. These skills are being cultivated in the afterschool space.

- *4-H* Science Initiative is offered by 4-H clubs across the U.S. Program curriculum ranges from animal and plant biology to renewable energy. The educational materials are created by 4-H members and are reviewed and evaluated. 4-H afterschool and summer programs are run through land grant universities and colleges which have liaisons for the surrounding community.

  Evaluation of the Science Initiative was done in 2010 through the 4-H Science Youth Engagement, Attitudes and Knowledge (YEAK) survey which measures interest in science as well as probable pursuit of a STEM career from participation in the Science Initiative. On the survey, students reported gains in the skills and knowledge they learned:

  - Recording data accurately (76 percent of students).
  - Using data to create graphs (75 percent of students).
  - Using results of an investigation to answer questions (73 percent of students).[17]

  Other highlights of the evaluation include 4-H participants' increased interest and participation in science activities outside of school as compared to the national sample. A high percentage of participants planned to go on to college and higher education in pursuit of STEM fields.

- *ACE Mentor Program* is a national program that partners high school youth with local mentors in the architectural, construction and engineering (ACE) industries to work on a real-life design problem. The students work as a team to develop a design proposal, learning to use drafting tools, budgeting and planning for material acquisition as they design the proposed infrastructure and present their plan at an end of the year showcase.

  Evaluations of program alumni were conducted in 2010 in which 933 alumni completed a Web survey of their experiences in ACE Mentor Program and current status as it relates to ACE careers. Nearly half of the respondents completed the program in 2009.
    - More than 90 percent of participants said that they gained valuable life/work skills by participating in the ACE Mentor Program.
    - More than 95 percent of alumni said that they gained valuable knowledge about ACE careers and about how the industry works.[18]

- *After-School MathPlus* is implemented in afterschool programs nationally to highlight the importance of math skills for future career options. The curriculum is designed to help students identify and learn math in everyday experiences.

  Evaluation data was collected from two sites where museums collaborated with local afterschool programs. The New York Hall of Science worked with the Chinese American Planning Council, and the St. Louis Science Museum worked with Adams Park Community Center and Adams Elementary to provide programming for third through eighth-grade students and their parents, including creating math exhibits that were showcased to a larger audience. Participants showed significant increases in math test scores as compared to students who did not participate in the program.[19]

- *Build IT* is administered through Girls Inc. of Alameda County, CA, and co-developed by SRI International. Designed for middle school-aged girls, the program provides participants with an opportunity to learn about careers in information technology (IT) and to work on design projects with mentors.

  Evaluations conducted through self-assessments show that the girls gained technical skills and knowledge:
    - 80 percent of participants stated they were able to tell someone how to use a computer program, explaining specific functions to accomplish a task.
    - 77 percent stated they could troubleshoot a computer problem.
    - 78 percent stated they could easily learn new computer programs and describe how information travels through the Internet.[20]

- *Design Team* is run through the Kitty Anderson Youth Science Center at the Science Museum of Minnesota in Saint Paul, MN. Design Teams provide middle school participants the opportunity to work on design projects in groups.

  Summative and formative evaluation methods included observations of the teams, documentation of work on an online group site, interviews and surveys. A 2009 report summarizing exit surveys of participants showed that a significant number of students became more comfortable in programming the tools used and gained significant communication and teamwork skills:

- 70 percent stated that they used what they learned in Design Team in school.
- 57 percent stated that participating in the program influenced them to take engineering courses in high school.[21]

- *Project IT Girl* is a three-year program offered by GirlStart in Austin, TX. Female high school students explored various aspects of information technology, including programming and design principles, culminating in an internship with a local tech company. A group-based, mentored design project required them to use problem solving skills, teamwork and presentation skills.

  A review of the program after its third year (2008-2009) revealed positive impacts on participants' interest level, knowledge and skills, and desire to pursue STEM careers:
  - 82 percent of participants stated that they were more confident in gaining high-tech skills.
  - 79 percent stated they have a better understanding of technology-related careers.
  - 71 percent of participants stated they can code HTML to create a website as compared to the 19 percent who came into the program with this skill.
  - 85 percent stated they are more confident in their business communication skills.[22]

  The study also found that while the students participated in IT-related projects, their new skills in project management, design and communication—including business skills, teamwork and confidence working with IT professionals--could be applied to a wide range of career pursuits. One of the participants noted, "I learned about databases' organization, but more than that, I gained valuable experience on how the workplace works and improved my teamwork skills."

- *SHINE 21st Century After-School Program* operates in schools in Carbon and Schuylkill counties in Pennsylvania. Participants are referred to the program based on academic performance. SHINE began a pilot Career Camp in 2009 for fifth and sixth-grade students who had previously participated but were currently ineligible to return to the program. The Career Camp had a STEM focus that exposed students to health services, manufacturing and business. The students engaged in hands-on problems solving activities and visited local businesses and community colleges.

  Data collected from report cards of program participants in the three school districts from the third marking period to the fourth marking period showed:
  - Gains in overall academic performance as measured by school grades (67 percent)
  - Improvements in their science grades (62 percent)
  - Improvements in classroom conduct (54 percent)

  Furthermore, students reported an increased knowledge of job possibilities, understanding of the importance of reading and mathematics for future careers, and gained insight into high priority fields such as health services, business and finance, logistics, and advanced manufacturing.[23]

- *The After-School Corporation (TASC)*'s initiative to increase STEM learning in the afterschool space, *Frontiers in Urban Science Exploration 2.5*, was designed in 2007 to provide afterschool staff with professional development training to implement STEM curriculum in their programs. TASC evaluated 19 of these programs during the 2009-2010 school year to gauge the program's effectiveness. Programs were given materials and training on various curricula including After-School Science Plus, After-School Conservation Club, Afterschool Universe, 4-H Wonderwise, Mixing in Math, NASA: The Planetary Neighborhood and Tech After-School.

  The evaluators surveyed both staff and students to better understand the impact of training on staff development as well as student learning.
  - 72 percent of students reported that the program made science more fun for them.
  - 76 percent of students reported that the program allowed them to learn things about science that they did not know before.[24]

- *YMCA of Central Maryland* used the Let's Go STEM curriculum at six Y of Central Maryland sites during the fall of 2010 in which participants worked on LEGO Mindstorm NXT robotics kits over a 10-week period.

  Evaluations were done through pre- and post-program surveys of participants, teachers and parents that included questions which measured student interest as well as how much the program changed their perception of science. The first section of the pre- and post surveys included expectations and motivations for joining the program and the second part measured their attitudes using the *Modified Attitudes towards Science Inventory (mATSI)* to create the tool. A section of the post-participation survey also measured what students learned from the program about specific content and robotics skills. The evaluation showed that there was increased perceived knowledge of robotics among the participants after completing the program.[25]

These examples show how afterschool programs can help develop career-relevant knowledge and skills prior to graduation. The STEM skills and knowledge acquired through afterschool programs are essential to future success in the job market. In addition to providing content knowledge, afterschool programs teach and strengthen 21st century skills such as teamwork and communication, which are invaluable to the participants regardless of their post-graduation plans. Participants also explore careers and identify mentors and role models who can provide guidance on pursuing STEM careers if students choose to follow that path.

Graduation and Next Steps

Evaluations of afterschool programs have shown a link between afterschool participation and decreased high school dropout rates.[26] Evaluations of STEM programs offered in afterschool are also showing that participants are more likely to pursue higher education and study STEM fields. Although tracking students is a resource-intensive approach to evaluation that only a few programs can afford, some programs have been able to track their alumni, providing a rare glimpse into how many have pursued STEM careers.

- *ACE Mentor Program* partners high school youth with local mentors in the architectural, construction, and engineering (ACE) industries to work on a real-life design problem. The

students work as a team to develop a design proposal learning to use the tools of the trade along the way.

Results from a survey of program alumni showed that:

- ACE students who were seniors in high school in 2009 graduated at a rate of 97 percent compared to the 73 percent national graduation rate as reported by the National Center for Education Statistics.
- 66 percent of alumni from the ACE program are studying architecture, engineering, construction and the skilled trades, or are already working in one of these fields.[18]

- *For Inspiration and Recognition of Science and Technology (FIRST)* provides several leagues in which student teams compete in robotics competitions. The program is open to all K-12 aged youth. Within the teams, students spend six weeks planning and designing a robot to compete in local, regional and national competitions.

  A retrospective study of *FIRST* alumni who graduated from the program between 1999-2003 in New York City and Detroit was conducted by researchers at Brandeis University. The study found that:

  - 99 percent graduated from high school.
  - 89 percent went on to college.
  - Of those in college reporting a major, 41 percent reported that they had selected engineering. [11]

- *Project Exploration*, based in Chicago, IL, started in 1999 and provides out-of-school-time programs for youth to explore science through a strong mentor component. Seventy-four percent of participants are girls and 85 percent come from low-income families (predominantly African-American and Latino). Scientist mentors work with youth in their respective fields to spark their curiosity in science. The Junior Paleontologist programs take participants out to dig sites where they work with professional paleontologists to learn about geology. Sisters4Science is an all-female afterschool program in which students go on field trips and work on science activities with female scientists. Project Exploration staff maintains a relationship with its participants even after they become alumni of the program, which gave them access to report on the impacts of their efforts over time.

  A 10 year retrospective study that surveyed 30 percent of an estimated 259 alumni showed that:

  - 95 percent have graduated or are on track to graduate from high school, nearly double the rate of other Chicago Public School students.
  - 60 percent of those who are enrolled in a four year college are pursuing a degree in a STEM-related field.
  - 60 percent of those who graduated from college did so with a degree in a STEM-related field.[27]

As stated before, tracking students long term is a very resource-intensive process that few programs are able to afford. More commonly, evaluations have asked students about their intentions for the future, and many students reported that they planned to graduate from high school and pursue STEM fields in college.

- *Digital Wave* at the Miami Science Museum in Florida introduces students in 9th-12th grades to climate change, digital technologies and related careers. Participants learned 3-D design and animation to create educational simulations about climate change.

  Evaluation of the second cohort in 2010 showed a strong number of participants graduating high school with plans to pursue STEM education:
  - 96 percent of program alumni planned to attend college.
  - 77 percent planned to major in a science or technology field in college (an increase of 9 percent compared to the start of the program).
  - 96 percent of students who completed the Digital WAVE Design Studio program expressed plans to take Advanced Placement classes in STEM subjects in high school (an increase of 20 percent compared to the start of the program).[28]

- *Science Club for Girls (SCFG)*, a program based in Cambridge, Massachusetts, provides girls with an opportunity to interact with STEM professionals, do science activities and take field trips to local museums. It also provides girls in 8th-12th grades an opportunity to serve as mentors to the younger girls and build leadership skills.

  A survey given to Cambridge Public School students who participated in SCFG for at least one year and girls who did not participate found that:
  - When asked about their future plans, 99 percent of participating students stated that they plan to attend college as compared to 91 percent of non-SCFG students.
  - 46 percent of SCFG members stated they wanted a STEM-related career as compared to 35 percent of non-SCFG students.[29]

Several other programs can also point to a high percentage of participants that graduate from high school and plan on pursuing careers in STEM fields:
- 87 percent of participants of Project IT Girl enrolled in a four-year university and 80 percent stated they will pursue a STEM major.
- 93 percent of Design Team participants plan on pursuing education after graduating from high school.
- 75 percent of CSTEM participants plan to attend college.
- 68 percent of Girl Scouts FLL participants surveyed stated they wanted to pursue careers in design.

The high percentage of high school graduates among afterschool STEM program participants clearly indicates that the benefits of STEM in afterschool extend beyond sparking interest and capturing students' imagination in the short term. Students are also more motivated to pursue higher education and careers in STEM fields; and select studies are beginning to show that they follow through on these intentions.

Conclusion

This report highlights just a handful of afterschool programs across the nation that provide engaging opportunities for STEM learning. While individual programs have collected data on their participants' outcomes to refine and support their local models, patterns in the findings across multiple studies begin to reveal the potential of STEM programming in afterschool as a means to engage students in STEM fields and careers and nurture that interest.

The evaluation results collected here offer a sample of the positive impacts of these programs on youth: Afterschool programs can not only inspire youth, but provide them with the confidence to pursue STEM fields both academically and professionally. Yet the skills and knowledge gained through these programs are not exclusive to STEM career aspirations, as outcomes such as increased communication skills and the ability to work in groups are essential skills in any career. More outcome studies and impact data from afterschool and summer programs that provide STEM enrichment will help to clarify the promising trends noted in this paper. However, data from these programs already show that afterschool is playing a key role in supporting STEM learning. To maximize potential impact, future STEM education policy should support afterschool and summer opportunities for STEM engagement.

The table below provides additional detail on the afterschool evaluations included in this analysis, including demographic information and specific outcomes organized into the three main trend categories from the various afterschool program evaluations described above.

Program	Description	Demographics	Improved Attitudes Towards STEM Fields and Careers	Increased STEM Knowledge and Skills	Graduation and Next Steps
4-H (Nationwide)	4-H Science Initiative creates science curriculum for 4-H chapters to use in their afterschool and summer programs. The curriculum looks holistically at science topics ranging from biology to renewable energy.		59% would like to have a job related to science when they graduate from school. 71% of 4-H Science Initiative participants said science is one of their favorite subjects. 68% do science-related activities that are not for school work.		More than 80% of respondents intend to finish college or continue to pursue more education after college.
ACE Mentor Program (Nationwide)	ACE Mentor Program works with middle and high school students to partner them with members of the community in the **a**rchitecture, **c**onstruction, and **e**ngineering (ACE) fields. Mentors at partnering firms are paired with project teams at schools and work with them throughout the year on a design project that is presented at the end of the year.	61% minorities in the program in 2008-09		95% of ACE Mentor Program alumni agreed that they gained valuable knowledge about ACE careers and about how the industry works. 90% of ACE Mentor Program alumni agreed that they gained valuable work/life skills to use in a career and gained an edge over their peers studying ACE in college as a result of the ACE Mentor Program.	90% of ACE Mentor Program participants enrolled in post-secondary institutions. 66% of ACE Mentor Program alumni are studying architecture, engineering, construction and the skilled trades, or are already working in one of these fields. ACE Mentor Program attracts a high percentage of African-American and Hispanic college freshmen into engineering.

Program	Description	Demographics	Improved Attitudes Towards STEM Fields and Careers	Increased STEM Knowledge and Skills	Graduation and Next Steps
After-School MathPlus (NY, MO)	This program is a collaboration with museums, including New York Hall of Science, to provide programming for youth and their parents. Participants worked on math exhibits that were showcased to a larger audience.	The NYC site served mostly Asian-American students while the St. Louis and Louisville sites served mostly African-Americans.		Participants showed a significant increase in math test scores as compared to students who did not participate in the program.	
Build IT (Alameda County, CA)	Build IT is an out-of-school, project-based program administered through Girls Inc. in Alameda County to get middle school girls interested in information technology (IT) careers.	100% girls	Girls expressed more interest in mathematics and computer science after participation. Many of the girls expressed interest in IT careers and can articulate the responsibilities of specific IT jobs.	80% stated they can tell someone how to use a computer program, explaining specific functions to accomplish a task. 77% stated they can troubleshoot a computer problem. 78% stated they can easily learn new computer programs and describe how information travels through the Internet.	
CSTEM (LA, MD, MI, MS, TN, TX, Dominican Republic)	CSTEM operates both in the formal classroom and the out-of-school-time setting depending on implementation at each school and spans grades K-12. The year culminates with a CSTEM challenge, which includes a robotics competition and presentation of work done throughout the year.	91% African-American and Hispanic students 45% girls Participating schools serve 80-100% economically disadvantaged students.	94% of students reported that they want to continue in the CSTEM program. 75% spend three hrs/week or more on CSTEM projects (2% spending 10 or more hrs/week).	100% of participants passed math and science state tests. 100% indicated that CSTEM provided their first STEM enrichment experience (i.e. robotics, GIS, digital fabrication, etc.).	82% plan to attend a college or a four-year university. More than 53% of CSTEM participants that have graduated high school are in college or university pursuing a STEM-related degree.

Program	Description	Demographics	Improved Attitudes Towards STEM Fields and Careers	Increased STEM Knowledge and Skills	Graduation and Next Steps
Design Team (Science Museum of Minnesota)	Design Team participants are middle school-aged students who work on design projects. The program runs afterschool and weekends at the Science Museum of Minnesota.			70% of participants said Design Team helped them in school.	93% of participants plan on pursuing education after high school graduation.
Digital WAVE Summer Design Studio (Miami Science Museum)	Digital Wave is a yearlong program offered by the Miami Science Museum to high school students to learn more about climate science, digital technologies and related careers.	100% enrolled in the free and reduced lunch program. Nearly 75% spoke languages other than English at home.		Participants reported that they had learned 3-D modeling skills through the program.	96% plan to attend college. 77% plan to major in a science or technology field in college.
FIRST (Nationwide)	*FIRST* is a robotics competition with various leagues for K-12 students. Participants work in teams to build robots for competition.	55% non-white 41% girls 37% neither parent attended college.	Four times as likely to expect to pursue a career in engineering. Ten times as likely to have had an apprenticeship, internship, or co-op job in their first year of college.	73% reported learning how to make a presentation in front of people they did not know and how to gather and analyze information. 68% reported learning how to use computers to retrieve and analyze data.	99% reported graduating high school. 89% went on to college.
Girls Inc. Operation SMART (Nationwide)	Operation SMART provides K-12 participants an opportunity to explore STEM and related careers through afterschool and summer programs.	100% girls	Participants demonstrated an increase in their confidence, competence and comfort in STEM. Participation lessened girls' stereotyped views of scientists and whether men or women should have certain jobs.		

Program	Description	Demographics	Improved Attitudes Towards STEM Fields and Careers	Increased STEM Knowledge and Skills	Graduation and Next Steps
Project Exploration (PE) (Chicago, IL)	PE provides youth programming that focuses on different science disciplines and interaction with mentors in the field. Programs vary in length and operate both afterschool and during summer. PE works in the Chicago area with predominantly minority and female middle and high school students.	85% from low-income families, primarily African-American and Latino 74% girls	94% of those surveyed responded that PE increased their interest in science outside of school. 93% responded that PE sparked their sense of curiosity about science. 84% responded that PE motivated them to find other science-related opportunities.	95% of those surveyed reported that they learned "science in ways that was different from school." 90% responded they learned "how to ask scientific questions." 86% responded they learned "how to use evidence when making an argument."	95% of those surveyed have graduated high school or are on track to graduate—nearly double the overall rate of Chicago Public Schools. 60% of those enrolled in a four year college are pursuing a degree in a STEM-related field. 60% of those who graduated from college did so with a degree in a STEM-related field.
Project IT Girl (Austin, TX)	Project IT Girl worked with girls in 10th through 12th grade afterschool and during summers. The program curriculum focused on information technology (Web design and programming) as well as an internship component in which they worked on project teams with mentors. There was also a cohort of middle school girls.	100% girls 93% Hispanic or African-American among the middle school cohort 42% spoke Spanish as their primary language at home. 91% qualified for free or reduced lunches.		Participants increased knowledge in Web design and learned about business, communication and teamwork skills.	87% of participants enrolled in a four year university. 80% plan to pursue a STEM major in college.

Program	Description	Demographics	Improved Attitudes Towards STEM Fields and Careers	Increased STEM Knowledge and Skills	Graduation and Next Steps
Science Club for Girls (SCFG) (Cambridge, MA)	SCFG operates as clubs on various school sites in Massachusetts in which girls are exposed to hands-on science activities. The club operates for one hour per week and is open to K-seventh-grade female students. Eighth through 12th-grade students have the opportunity to serve as mentors for younger girls and also get to work with adult mentors.	100% girls 32% African-American 24% Hispanic	SCFG members scored higher on science attitude surveys than their non-SCFG counterparts.		99% of SCFG members said they planned to attend college. 46% of SCFG members said they desired a STEM-related career.
SHINE 21st Century Afterschool Program (Carbon and Schuylkill County, PA)	SHINE offered a five-week career camp for fifth- and sixth-graders that exposed them to careers in health services, manufacturing and business. The students worked on hands-on problems solving activities and visited local businesses and community colleges.	100% from rural counties 82% low income		Students in three school districts showed gains in academic performance (67%), science grades (62%) and classroom conduct (54%) from the third to the fourth marking period on their report cards.	
Student Science Enrichment Program (SSEP) (North Carolina)	SSEP is a fund established by the Burroughs Wellcome foundation to support programs in North Carolina that promote hands-on science activities and inquiry-based learning outside of the regular school environment.		76% of the students surveyed said they are more interested in learning science because of the program. 81% stated that they wanted to participate in a similar program in the future.	43% of students said they learned specific content or developed skills. 80% of students said they are better able to learn science.	

Program	Description	Demographics	Improved Attitudes Towards STEM Fields and Careers	Increased STEM Knowledge and Skills	Graduation and Next Steps
TechBridge (Oakland, CA)	TechBridge works with girls in grades 5-12 and operates as an afterschool program located on school campuses. The program provides participants with an opportunity to work on projects, visit tech companies and explore career options.	100% girls 37% Hispanic 25% Asian 14% African-American	Participants became more aware of STEM career opportunities. Participants gained technical skills and learned to think/act like a scientist.	95% stated they know more about how things work (like circuits and simple machines). 82% stated they are better at using new computer programs. 91% stated they learned that teamwork is good for solving problems. 84% stated they are better at problem solving. 68% said they speak up more in classes at school than before.	96% said they know more about different kinds of jobs. 95% stated they believe engineering is a good career for women. 85% stated they are more interested in working in STEM fields because of role models and field trips.
TechCorps (Nationwide)	TECHie Club is designed for elementary school students and has a curriculum that includes programming through LEGO Mindstorms NXT and Scratch as well as the use of digital media tools.		Participating in TECHie Club increased the number of students who said that computer jobs are exciting.	Participants stated they were more confident in their knowledge of how computers work.	
TechREACH (Washington)	TechReach provides afterschool clubs for middle school students in which they participate in hands-on science and engineering curriculum. The program also has a teacher training component to equip teachers with the resources to implement curriculum. The clubs are separated between boys and girls.		Science and math teachers reported that girls were more engaged in science and math classes after participating in TechREACH. 73% of participants reported increased interest in science or math.	87% of survey respondents agreed that they learned about STEM careers.	

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The After-School Corporation (New York)	TASC provided professional development support in STEM to several afterschool programs as part of their initiative, Frontiers in Urban Science Exploration 2.5. They used available curriculum, including Afterschool Universe, 4-H Wonderwise and Mixing in Math.	50% Hispanic 26% African-American	72% of students reported that the program made science more fun for them.	76% of students reported that the program allowed them to learn things about science that they did not know before.	
YMCA of Maryland (Maryland)	Let's Go STEM is a curriculum used by the YMCA of Maryland to introduce participants to STEM through robotics.	43% African-American	There was an increase in STEM career aspiration after participating in the program.	There was a significant increase in self-reported knowledge gain of designing robots.	

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