Afterschool Alert ISSUE BRIEF

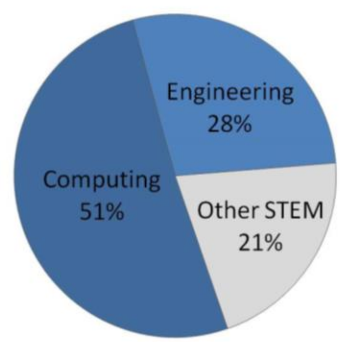
Issue Brief No. 62 December 2013

Computing and Engineering in Afterschool

The number of jobs requiring proficiency in science, technology, engineering and math (STEM) fields is projected to grow by 17 percent between 2008 and 2018, which is almost double the growth of non-STEM occupations.[1] Computing and engineering represent a majority of these STEM jobs—79 percent will be in these occupations alone.[i] The Bureau of Labor Statistics reports that there will be almost 1.5 million job openings in computing and more than 600,000 in engineering by 2020.[2] Job opportunities in the computing field will grow by 30 percent more than the national average and the computing-related industry is among the fastest growing.[ii] Not only is there great opportunity within these fields, but they are also high-paying jobs—both workers earn more than twice the average annual wage.[iii]

There is great concern that there will not be enough qualified workers to fill these jobs. The majority of occupations within these fields require a bachelor's degree and in 2010, only 40,000 students were awarded a bachelor's degree in computing. If this graduation rate stays the same, there will be a gap of almost one million computing jobs by 2020![3] While the numbers may not be as stark for engineering occupations, many of the engineering fields face a demographic challenge. Women and ethnic minorities are severely underrepresented in engineering jobs and much work remains to be done to increase the participation rates of these populations and to ensure equitable access to opportunities in these fields.

Where are the STEM jobs?



Source: Carnevale, A., et al. (2011). *STEM.* Georgetown University Center of Education and the Workforce.

Despite the availability of well-paid computing and engineering jobs, very few college freshmen are interested in these fields—only 1.5 percent intend to major in computer science and 10.3 percent intend to elect engineering.[iv] While there are many factors that influence what major college students choose, one of the key factors is a lack of exposure and experience during the K-12 years. Very few schools are able to offer computing and engineering courses. Although several of the more popular Advanced Placement (AP) exams are in science or math, less than 1 percent of tests taken are the computer science exam. Currently, there is no AP Engineering exam offered.

[1] Based on the Economics and Statistics Administration (ESA) calculations using Current Population Survey public-use microdata and estimates from the Bureau of Labor Statistics' employment projections. See http://meteorology.rutgers.edu/STEM.pdf.

[2] Other studies provide slightly different employment projections, however these studies all show the same growth trends within computing-related fields.

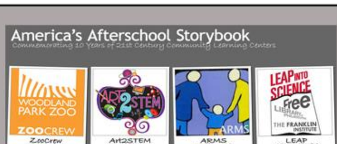
[3] Based on calculations from Code.org. See http://code.org/stats.

How can afterschool programs help?

While we know students need the academic background and skills necessary to be ready for college-level STEM courses, student interest is key to pursuing and persisting in further STEM opportunities. Research has found that 8th grade ***interest* in STEM careers is a better indicator than *academic achievement* of whether or not a student will graduate from college with a STEM degree**. [v]

Schools are under many constraints and pressures that might prevent them from offering courses in computing and engineering. However, out-of-school-time programs such as afterschool programs[4] represent an avenue to provide learning opportunities in computing and engineering. Afterschool programs have long engaged youth in STEM and several programs actively offer computing and engineering topics. Several features of the afterschool environment help reach the populations most in need and provide supports to keep kids interested and engaged:

- **Afterschool programs are not bound by curriculum requirements**. Schools struggle to fit computing and engineering into the core curriculum for several reasons, but afterschool programs are less pressured by these demands and can offer subjects outside of a district's set curriculum.
- **Afterschool programs are flexible, low-stakes environments.** [5] Students are able to tackle challenges and fail, without worry of being graded on this failure, reflecting the real experiences of scientists and engineers. Students are not tested on their knowledge in traditional ways, and so can take on challenging topics with less stress. Afterschool programs meet for several weeks, often throughout the course of the school year, which allows students to freely engage in project-based learning and/or follow the engineering design process through several iterations.
- **Afterschool programs can help to address equity and access issues in STEM.** Girls participate in equal numbers to boys and underrepresented minority populations participate at higher rates in afterschool programs.[vi]
- **Afterschool can leverage community resources and help to put a face to STEM occupations.** Afterschool programs often partner with community-based organizations and STEM-rich institutions like universities and science centers that can contribute additional expertise, tools and materials. [6] Many afterschool programs bring in STEM professionals as role models and mentors who can bridge student learning to careers and help break down stereotypes about who practices STEM. It is especially important to expose underrepresented groups to STEM role models and mentors.[vii viii]



Read more about the afterschool programs mentioned in this issue brief in our Afterschool STEM Storybook.

Visit www.afterschoolalliance.org/storybook/gallery.cfm.

Find out what makes these programs successful, as well as details on outcomes, curriculum and other program features.

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[4] The term "afterschool" is used to refer broadly to before school, afterschool and summer learning opportunities.

[5] For further discussion of how formal (school) and informal (out-of-school) learning environments differ see Bevan, B. et al. (2010). *Making Science Matter: Collaborations between Informal Science Education Organizations and Schools*. A CAISE Inquiry Group Report. Washington, D.C.: Center for Advancement of Informal Science Education. Retrieved from http://informalscience.org/images/research/MakingScienceMatter.pdf.

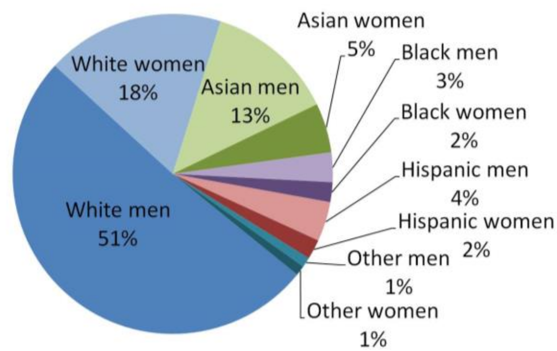
[6] The Afterschool Alliance recently released an issue brief, "Partnerships with STEM-Rich Institutions," that describes how afterschool programs are connecting with these types of organizations. See www.afterschoolalliance.org/issue_61_STEM.cfm.

Underrepresented populations in STEM

Women, African Americans, Latinos, Native Americans, and persons with disabilities are considered to be underrepresented in STEM as the number earning postsecondary STEM degrees and employed in the STEM fields is disproportionally less than their percentage of the U.S. population.

The vast majority of those who work in the STEM fields are Caucasian—white men make up 31 percent of the population yet represent half of the STEM workforce.[ix] Women of all races are underrepresented and all together make up only 26 percent of scientists and engineers. Hispanics and blacks represent 6 and 5 percent of the STEM workforce, despite being 16.3 and 12.2 percent of the population, respectively.

Demographic characteristics of scientists and engineers



Source: NSF & NCSES. (2013). *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*

In computing, the disparity between men and women is especially stark. Women earn half of all undergraduate math and science degrees, but only 18 percent of computer and information sciences degrees.[x] Among female college students, interest in computer science is low—only 0.3 percent of freshmen women are interested in majoring in it. There are several social and cultural obstacles girls face in becoming interested in and staying engaged in the STEM fields. The National Center for Women in Information Technology (NCWIT) recently released a synthesis report of existing research on girls' participation in computing explaining these obstacles in depth.[7]

Current state of K-12 computing and engineering education

The K-12 school system currently does not have a focus on computing and engineering education due to the many demands on time during the school day. While some schools do offer computing and engineering design courses, it is not the norm.

Computing in K-12

Despite its growing importance, computer science is only taught in a minority of American schools. Of the 42,000 high schools in the United States, only 3,249 offered AP Computer Science classes in 2013. A 2010 national study from the Association for Computing Machinery (ACM) and

What is Computing Education?

Computing is an inclusive term that reflects a wide range of computer-related pursuits, however within the context of K-12 education the goal of such activities is that students learn how to *create* technology, not just how to *use* it.

Creating Technology	Using Technology
In creating technology, students might program a robot or an animation, develop mobile apps or computer software, design hardware, or come up with technical solutions.	When learning to use technology, students might learn to use a word processor, edit an image in Photoshop, or post a blog.

[7] The NCWIT report is *Girls in IT: The Facts.* See www.ncwit.org/thefactsgirls.

the Computer Science Teachers Association (CSTA)[xi] examined states' adoption of K-12 computer science standards[8] and found there is much confusion as to what computer science is[9] and how it is differentiated from technology literacy and fluency, information technology, and educational technology.[10] While learning about all of these computer and technology-related fields is important, and all can map to future computing occupations,[11] most states focus on lower-level computing skills, such as teaching students how to use a computer and its applications or how to use other technologies.

Some high school students do have access to rigorous computing courses and over the past four years there has been a marked increase in these courses. According to a CSTA national survey of high school computer science teachers, the number of schools offering an introductory computer science course and AP Computer Science has increased by 27 percent and 90 percent respectively, from 2009 to 2013.[xii] However, the reach of these courses is small and disparities within underrepresented populations remain.[xiii] [xiv]

For the most part, computing not considered part of the "core" curriculum that students must take in order to graduate from high school. In thirty-six states, upper-level computing courses like AP Computer Science don't count as math, science or computing credits for graduation, only as electives.[xv] And as students have many demands in their course schedule to graduate, it can make it a tough choice to elect a computing course.

[8] CSTA and ACM have developed comprehensive standards for K-12 computer science education. Other national standards include some aspects of computing, like the International Society for Technology Education standards or the International Technology and Engineering Educators Association standards. However, these blend technology and engineering and do not address computing as a discipline.

[9] ACM describes computer science as "an academic discipline that encompasses the study of computers and algorithmic processes, including their principles, their hardware and software designs, their applications, and their impact on society". CSTA elaborates on this definition in their K-12 standards to say that computer scientists might work in several different application areas such as robotics or bioinformatics, but are primarily concerned with (1) designing and implementing software; (2) developing effective ways to solve computing problems; and (3) devising new ways to use computers.

[10] The CSTA report, *Running on Empty*, defines "technology literacy and fluency" as understanding how to use technology and the ability to express ideas creatively, reformulate knowledge, and synthesize new information and technology; "information technology" as the application of the computing knowledge to solve a business information problem, such as network or database administration; and "educational technology" as the integration of technology into teaching in order to advance student learning across academic disciplines.

[11] The Bureau of Labor Statistics defines 12 sub-categories of computing occupations, which include computer programmers, software engineers, information systems managers, and database and network systems administrators.

Engineering in K-12

Engineering education is even harder to find in schools than computing. Similar to computing, students and teachers are unclear as to what exactly engineering is.[xvi] Engineering is often viewed as too advanced for K-12 students and hence relegated to the domain of postsecondary education.[xvii] Only an estimated 10 percent of K-12 students are exposed to engineering-related coursework.[xviii] High school students might encounter engineering through a career and technology education (CTE) program. While there is currently no AP course for engineering, the College Board along with engineering education advocates are exploring the creation of an AP program in engineering design.[xix]

Getting a full picture of K-12 engineering education is difficult, as there is no central organization that collects data on student participation and performance. However, the 2014 National Assessment of Education Progress (NAEP) 8th grade assessments will include items that measure selected areas of engineering and technology,[xx] which should provide some data on students' related skills. The National Academy of Engineering and the National Research Council surveyed the landscape of K-12 engineering education in 2006-2008, looking at available curriculum and professional development opportunities. The resulting report outlined core learning concepts for K-12 engineering education since there are no stand-alone standards at the national or state level.[12] One promising finding is that there has been increase in engineering curricula from almost none 15 years ago to several dozen today.[13] Project Lead the Way and Engineering is Elementary are two prominent curriculum programs that have seen rapid growth,[14] however their overall reach is small compared to the total number of students in elementary and secondary schools.

The recently-released Next Generation Science Standards (NGSS) provides an opportunity for incorporating engineering education into the K-12 system in a broader and more systemic manner. The NGSS reflects years of advancements in the science fields and in science education—the last national science standards were released almost 20 years ago. The important conceptual shift within the standards is that students learn science through the same practices that professional scientists and engineers do—through scientific inquiry and engineering design. Engineering is regarded with the same importance as scientific inquiry and is taught in kindergarten through 12th grade.[15] Within the NGSS, engineering is defined as "a systematic practice for solving problems," meaning that students of all ages can engage in the design process of defining a problem, designing a solution and then improving upon their design.[16]

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[12] The International Technology and Engineering Educators Association (ITEEA) *Standards for Technological Literacy* contain a few standards on engineering design. See www.iteea.org/TAA/PDFs/xstnd.pdf.

[13] Appendix C of Katehi, et al.'s *Engineering in K-12 Education* provides a detailed analysis of several available engineering curricula for schools.

[14] Project Lead the Way's *Pathway to Engineering* curriculum is being offered in 2,760 U.S. high schools and Engineering is Elementary curricular units are used by more than 45,000 elementary teachers. See Erik Robelen's article "Engineering Building a Foundation in K-12 Curricula," *Education Week*, March 26, 2013. Retrieved from www.edweek.org/ew/articles/2013/03/27/26engineering_ep.h32.html?r=1912442951.

[15] A detailed description of how engineering practices are incorporated into NGSS can be found in Appendix F—*Science and Engineering Practices in the NGSS*. See www.nextgenscience.org/sites/ngss/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf.

[16] For a description of how engineering design is approached throughout the grade levels see Appendix I—*Engineering Design in the NGSS*. See www.nextgenscience.org/sites/ngss/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf.

Afterschool is a promising opportunity

While many education and advocacy organizations are working to improve both computing and engineering education in schools, these efforts will take time to gain traction and to implement. Afterschool programs present an immediate opportunity to tackle this issue and begin engaging a diverse group of young people in computing and engineering education. As described earlier, the attributes of afterschool programs allow for engaging a diverse group of students in hands-on projects that bring computing and engineering topics and careers to life.

Computing in afterschool

In national surveys led by CSTA, high school computer science teachers ranked lack of student interest as the greatest challenge in computer science education. Developing early interest in the STEM fields is key for youth to pursue undergraduate degrees in science or engineering. High-quality afterschool STEM programs have demonstrated success in cultivating youth interest in STEM fields and careers, as well as improving their likelihood of graduation and pursuit of a STEM career.[xxi]

Several afterschool programs are teaching computing and there is a great diversity in the types of projects young people can take on that spark their imagination and creativity. Many platforms for programming have been designed specifically for the K-12 ages to allow for early engagement in computing. Afterschool programs use applications like Scratch, Kodu, and Alice[17] that use graphical blocks instead of lines of code, so students don't have to learn a programming language before jumping into computing. With these applications, youth create animations, multimedia projects, video games and more. Afterschool programs are also able to connect students' computing projects to careers, help develop useful job skills, and allow youth to understand the relevance of computing to real life.

Youth solve real-world problems with afterschool computing

Project GUTS (Growing Up Thinking Scientifically) is an afterschool program based in Santa Fe, New Mexico, where 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—like the spread of contagious disease, how information spreads in a social network, or the population dynamics of an ecosystem. Using StarLogo TNG,[18] a programming platform specifically for modeling and simulation, students translate complex and abstract ideas into a computer model, incorporating real-life data as well as observations they have conducted in their schools and communities. For example, in the epidemiology unit to explore how a disease would spread, students input the layout and the number of students in their school, factoring in variables like the virulence of a disease, number of students initially infected, and the physical movement of people.

STEM & afterschool IMPACT AWARD

Project GUTS

2013 Winner of the Afterschool STEM Impact Award in computing and/or engineering

Project GUTS received a $10,000 award generously sponsored by the Noyce Foundation.

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[17] All of these applications are free graphical programming tools, accompanied by curriculum and teaching support, which make them a popular choice for afterschool and other out-of-school time programs. See http://scratch.mit.edu; http://research.microsoft.com/en-us/projects/kodu/; www.alice.org.

[18] StarLogo TNG is a free graphical programming tool developed at the MIT Scheller Teacher Education Program, who has also developed several other technology tools and games for use in both school and out-of-school time environments. More information can be found at http://education.mit.edu/projects/starlogo-tng.

In the 2012-2013 school year, 82 percent of participating students successfully completed a computer model. Despite tackling a tough topic, a majority of youth said they developed specific programming skills in Project GUTS. Roughly the same proportion also believed that they successfully learned how to use computer models for scientific inquiry. Sixty-five percent of students strongly felt their experiences in afterschool made them more excited to do and learn science and technology in school. However, Project GUTS' program evaluations revealed that girls struggled to persist in the program. In response to this finding, Project GUTS developed a girls-only program called Guts Y Girls[19] that offers day-long Saturday workshops, a summer camp, and incorporates mentorship from female computer science professionals. On average, participating girls attended more than 85 percent of the offered sessions and demonstrated significantly more knowledge of complex systems, computer models and networks than girls who did not participate in Guts Y Girls.

Read more about **Project GUTS** in the Afterschool Storybook.

Each of the 30 Projects GUTS afterschool clubs across New Mexico is led by a school-day teacher, assisted by a Project GUTS facilitator (generally with a background as a computer science professional), along with near-peer mentors (high school students who often are Project GUTS alumni). Teachers receive intensive professional development in the summer and throughout the year. Curricula are aligned to several national standards—the CSTA's K-12 Computer Science Standards, Common Core Math, and NGSS—which can help demonstrate how the program supports school day computing, science, and math education. Project GUTS is an education outreach initiative of the Santa Fe Institute, a research and education center pioneering work in complex adaptive systems. This close proximity to active research informs Project GUTS' programming, ensuring that it is relevant for participants.

Youth get creative with computing in afterschool

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 third- through fifth-grade 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. Participants learn how to build and program a working Lego NXT robot and create stories and animations using Scratch. Using Makey-Makey circuitry[20], students connect their computers to the physical world off-screen by turning everyday objects into touchpad to control object on-screen. Tech Reach utilizes innovative technologies to empower young students to be creators, rather than passive recipients, of a technology experience.

Read more about **Tech Reach** in the Afterschool Storybook.

[19] Guts Y Girls began with an NSF-ITEST (Innovative Technology Experiences for Students and Teachers) award and is going into its third year of implementation. View the project description (#1031421) here www.nsf.gov/awardsearch.

[20] Makey-Makey is a circuit board that turns conductive objects into touchpad controllers that can take over a computer's mouse or keyboard. Go to www.makeymakey.com for more information.

Students become deeply engaged and are able to express themselves through tangible projects. And they stick with the program, allowing Tech Reach to have a considerable impact. Participants demonstrate statistically significant improvements in three major areas: (1) technical knowledge (in programming computers or robots); (2) skill development (information communication and technology skills); and (3) attitudes toward STEM. One hundred percent of students in Tech Reach are able to successfully code and program working computer games and robots. Evaluation of the fall 2012 program demonstrated that students' individual computing scores rose from 24.5 percent to 80 percent after the program. Students consistently show improvements in critical thinking, creativity, communication and collaboration skills. Tech Reach's positive impacts extended to the school day—85 percent of teachers surveyed agreed that Tech Reach positively improved their students' academic performance and 75 percent of teachers reported improvements in students' classroom behavior. The program meets a high need in the greater Austin community for rich computing and technology education experiences—Tech Reach serves a population in which 95 percent of students are low-income and 90 percent are underrepresented in STEM (80 percent Latino, 10 percent African American).

Youth develop job skills and connect to computing careers

Digital Harbor, an afterschool program in Baltimore, Maryland, aims to prepare students for careers in key technology sectors such as Web development, mobile app development and digital fabrication using 3D printing. The program began as an innovative solution to the economic realities that many communities face. In 2011, the City of Baltimore announced it would close almost half of its recreation centers, and Digital Harbor Foundation decided to turn one of the centers into a tech center to serve inner city youth with afterschool and summer programs centered on computing and technology.

Students of all ages engage in projects appropriate for their grade level, gradually building on skills learned in previous years. For elementary- and middle-school students, the focus is on engendering a design-thinking mindset. Students engage in maker-style[21] activities that combine computing and engineering, taking them through an iterative process of creation and prototyping. Middle school students compete in a WebSlam—a "hack-a-thon" style event in which teams create and code a website for a real client.

Read more about **Digital Harbor** in the Afterschool Storybook.

High school students progress to working on paying projects from clients as they develop their skills. They can also become eligible for internships or job placement in local companies. Students earn digital badges and maintain a portfolio that includes the apps or products they have developed to keep track of their progress and accomplishments. To further bridge the connection to real life computing and tech jobs, volunteers from the local technology community regularly interact with Digital Harbor students as mentors, coaches and competition judges. Students are able to get a sense of what steps are required in becoming a professional in technology sectors.

[21] Projects or curriculum that incorporate "making" focus on invention and prototyping. While incorporating aspects of art and craft, "making" often uses technology as a primary component. Popular projects utilize electronics, robotics, 3D printers or CNC machines. When K-12 students engage in maker-style activities, they learn practical skills in these technologies but repurpose them in creative ways.

Engaging Girls in Computing

There are several high-profile afterschool and summer computing programs aimed specifically at girls.

Black Girls Code (national) www.blackgirlscode.com

Black Girls Code jump starts girls' interest in computing through one-day workshops held across seven U.S. cities. Girls of all ages learn core computing skills by completing a project in game design, mobile app development, robotics or Web design. Additionally, a 2012 evaluation reports that the program encourages young African American women to broaden their career goals and aspirations, and challenges stereotypes and misconceptions about African American participation in STEM fields.

Girls Who Code (national) www.girlswhocode.com

In summer 2013, Girls Who Code scaled up their intensive 8-week program to five U.S. cities. High school juniors receive intensive instruction and hands-on computing experiences, learning mobile phone development, robotics, and Web development and design. After participation in the Girls Who Code program, 95 percent of participants said they would seriously consider a major or minor in computer science. Ninety-nine percent of participants said they are considering pursuing a career in technology and 81 percent definitely intend to do so.

Engineering in Afterschool

Engineering isn't new to afterschool—*FIRST* Robotics Challenge, *FIRST* LEGO League (FLL), and many other such design challenges have been commonplace for several years. In 2012, more than 13,000 teams[22] competed in FLL and many of these teams were hosted by afterschool programs. The hands-on experience provided by engineering challenges is particularly attractive to youth as it allows them to apply science and math principles to build tangible products. The popularity of Maker[23] programs is a testament to the pent-up demand for project-based learning and construction.

An additional strength of engineering challenges is that the problems students solve can be chosen so that they are situated in a local or personal context and are therefore more meaningful to students.[xxii] Afterschool programs have the flexibility and space to make projects and lessons more connected to students' communities and interests. This offers particular potential for students who may be disengaged by classroom science or school in general. The integration of engineering education within the NGSS provides a tremendous opportunity for strong school-afterschool partnerships that can greatly strengthen K-12 engineering education.

Engineering Curriculum for Afterschool

The Museum of Science, Boston, creators of the school-day engineering curriculum Engineering is Elementary, recognizes afterschool as a critical space for engineering education. Recently they have developed Engineering Adventures, a free curriculum series designed specifically for the out-of-school-time environment.

As many afterschool programs may not have the capacity or mission to become a full-fledged engineering or STEM program, research-based curriculum like Engineering Adventures or Design Squad from PBS provide an entry point for programs to offer engineering. Activities rely less on deep content knowledge, focusing more on teaching the design process thus making it more accessible to those without a STEM background.

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[22] This number is for U.S. and Canadian teams. Retrieved from www.usfirst.org/uploadedFiles/Robotics_Programs/FLL/Communications_Resource_Center/Flyers/FLL_Growth_FNL.pdf.

[23] The Maker Education Initiative is leading the charge to create more opportunities for youth in making, primarily through their Maker Corps program which places maker experts in youth-serving organizations. Digital Harbor was one of the 34 sites in summer 2013. Visit www.makered.org for more information.

Afterschool addresses equity issues for girls in engineering

There are many afterschool programs that aim to reach girls with a program structure and curriculum designed specifically to engage them. Techbridge is a well-known program in Oakland, California, that offers both afterschool and summer programs for elementary- through high-school students focused on engineering and technology. For example, girls might design a prosthetic hand, build a gumball machine or construct a filter that cleans dirty water. Activities such as these are meaningful because they are relevant to girls' lives and have real-world impacts.

To connect what they are doing after school to real jobs, all activities integrate a career exploration component. Techbridge extensively uses professional female role models who visit programs and share their experiences with participants. This helps girls understand what it takes to pursue a career in STEM and how engineering and technology have an impact on their lives. Students also go on worksite field trips, furthering the connection to careers. This approach has been highly successful—in Techbridge's 2011-2012 evaluation results, 87 percent of participants said that because of their experiences with the role models and field trips, they were more interested in an engineering, technology or science career. Ninety-five percent came to believe that engineering is a good career for women.

Techbridge
Oakland, CA

Read more about **Techbridge** in the Afterschool Storybook.

Techbridge was also successful at improving participants' knowledge and skills—88 percent knew more about how things work and 85 percent felt more confident using technology. Girls extended their interest in STEM by participating in other STEM opportunities like attending summer programs, participating in competitions and applying for awards. Eighty-one percent planned to take advanced math and/or science classes in school. In addition to targeting a major population underrepresented in the STEM fields and particularly engineering, Techbridge serves schools in low-income areas. More than 75 percent of participants are eligible for free or reduced meals and 94 percent of partner school sites receive Title 1 funding. In Fall 2014, Techbridge will begin scaling up to several U.S. cities. Techbridge also plans to update curriculum and teaching to align with NGSS, which will only build on the strong relationships its partner schools and teachers.

Afterschool helps to bring engineering education to rural areas

The SHINE (Schools and Homes in Education) After-School Program is an example of how an afterschool program not situated in a major metropolitan area can provide quality engineering education using local resources and expertise. SHINE is part of a large community grassroots plan linking youth and family-serving organizations with school districts to improve outcomes for area youth. It is based at a local community college and serves an at-risk population in several rural Pennsylvania counties. All students in the kindergarten through 5th grade program are referred for academic reasons. Eighty-two percent come from low-income families and 73 percent have special or remedial needs. Engineering and STEM are just one component of this comprehensive afterschool program that operates three hours a day and four days a week, providing transportation, snacks and meals, tutoring and homework help, along with recreational activities.

SHINE
Jim Thorpe, PA

Read more about **SHINE** in the Afterschool Storybook.

SHINE's STEM programming is two-part—it first builds a foundation for 4th and 5th graders through hands-on activities focused on engineering, the health sciences and green energy. During these years, students gain familiarity with careers in those fields while improving their problem-solving and design-thinking skills. In 6th grade, students advance to a middle school program held at a local technical center where they have access to technology like Computer-Aided Design (CAD) and shop machinery. Working with college interns and high school mentors, middle school teams complete six intensive engineering projects over the course of the academic year. In one project, student teams build a "car of the future," first designing and re-designing the car in CAD, then with the help of the college interns, cutting precision machined parts, and constructing the life-size derby car.

Both the middle school academy and the 4th/5th grade program have significant impacts on students' skills, knowledge and connection to careers. In a 2011-2012 evaluation, parents of middle school students observed an improvement in their children's teamwork and problem-solving skills (84 percent), ability to use technology (86 percent), and math skills (68 percent). Ninety-five percent of students in the middle school academy were excited about STEM careers as a result of the program. Almost all of the 4th and 5th grade students, 97 percent, understood what an engineer does. Eighty-three percent came away with an understanding of jobs of the future. At the end of the year, the number who said they would like to study math or science in college increased by 14 percent.

Conclusion

The necessity for STEM proficiency will only increase in the coming years. As efforts to improve STEM education and increase access to these fields continue, it is important to recognize the particular sub-fields within the universe of "STEM" that deserve special attention. Computing and engineering education are two topics within STEM that have not traditionally received as much attention—even as they have become vital engines for the economy. The situation is changing slowly but much work remains to be done.

There are many education advocacy groups and technology companies that are leading the charge for K-12 computing education. The most significant boost for K-12 engineering education will come through the implementation of the Next Generation Science Standards. As states and school systems across the country adopt new standards and practices for teaching these fields, they can draw on partners in the afterschool field to achieve the goal of preparing our young people to access the jobs of the future.

Afterschool programs wishing to offer computing and engineering programs have a wealth of resources to draw upon. Several high-quality curricula and programs are now available for afterschool providers. The programs highlighted in this issue brief represent models to emulate and colleagues whose expertise can be tapped. Partnerships with businesses and other STEM-rich institutions will provide needed funding, equipment, as well as the expertise to design and implement robust and rigorous learning opportunities[24]. There is a great need for an "all-hands on deck" approach to prepare our students for careers in computing and engineering—and afterschool programs are well-positioned to play a major role in this effort.

[24] See the Afterschool Alliance issue brief, "Partnerships with STEM-Rich Institutions" for more on this topic www.afterschoolalliance.org/issue_61_STEM.cfm.

[i] Carnevale, A., Smith, N., & Melton, M. (2011). *STEM*. Washington, DC: Georgetown University Center of Education and the Workforce. Retrieved from www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stem-complete.pdf.

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