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Afterschool: Middle School and Science, Technology, Engineering and Math (STEM)

The Afterschool Alliance, in partnership with MetLife Foundation, is proud to present the second in a series of four issue briefs examining critical issues facing middle school youth and the vital role afterschool programs play in addressing these issues. These issue briefs feature: the multiple benefits of afterschool for middle school youth; STEM; pathways to higher education and careers; and health and wellness for preteens and teens. They examine just a few of the ways afterschool programs support middle school youth, families and communities.

The 21st Century's information economy has been creating more jobs that require not only a college education but also a fair amount of expertise in the fields of science, technology, engineering and math – collectively known as STEM. Science and technology underpin nearly every aspect of our society, making STEM skills necessary for all students, regardless of whether or not they eventually pursue careers in STEM. We need a STEM-literate citizenry to make informed decisions about energy sources, health care, transportation, communication, and even food development and nutrition.

The last several decades have seen the industrial- and manufacturing-based economy shift to a service economy fueled by information, knowledge and innovation. According to the U.S. Bureau of Labor Statistics, between 1996 and 2006, the United States lost three million manufacturing jobs. In that same timeframe, 17 million service sector jobs were created, specifically in the areas of health care, education, environment, security and energy.^{i,ii} From 2008 – 2018, many of the fastest-growing jobs in the service sector are and will be STEM-related, high-end occupations that include doctors, nurses, health technicians and engineers.ⁱⁱⁱ Industries projected to have the most employment growth are in scientific, technical and management consulting; computer systems design; and employment services.^{iv}

In order to help prepare youth for these careers, we need to think about STEM learning opportunities beyond the traditional school day. Afterschool programs are currently serving more than 1.3 million middle school students, with many programs providing engaging STEM content. Combining STEM learning with afterschool programming offers middle school students a fun, challenging, hands-on introduction to the skills they will need in high school, college and the workplace. This issue brief highlights afterschool programs that incorporate STEM activities, giving middle school students time to develop an interest in STEM and inspiring them to learn.

STEM Learning is a Critical Component of a 21st Century Education

To become the innovators, scientists, technologists and engineers of the future, youth must be exposed to and master STEM skills. There is a growing body of research suggesting Americans are falling behind in math and science education. U.S. students rank 25th in math and 21st in science skills internationally, according to a recent Organization for Economic Co-operation and Development report. Additionally, the 2007 ACT College Readiness Report states that only 43 percent of graduating seniors are ready for college math, and only 27 percent are ready for college science.^v Further, only 32 percent of U.S. college undergraduates are graduating with a bachelor's degree in science or engineering. Because of this, the U.S. faces a critical shortage of students and young adults pursuing science and technology majors and careers.^{vi}

Middle school is a “make or break” time for many young adolescents academically. In addition to facing more demanding academics, middle school youth are dealing with the challenge of meeting social and emotional benchmarks as they transition from elementary school to middle school and then high school. During this transition, middle school youth experience fluctuating emotions and motivation levels, and are exposed to new situations and experiences. Peer pressure, academic demands, exposure to new social environments, and physical changes are added distractions to an already new and sometimes overwhelming time in their lives. It is during middle school that many youth, especially girls, turn away from math and science. Once their young minds stop progressing in these subjects, it is difficult to catch up with peers later on.^{vii} It is therefore critical that these youth are adequately exposed to quality STEM programming before

The public is open to many different strategies for improving STEM education, and they're enthusiastic about the overall goal, but much more has to be done to help them understand what's needed for kids in their local schools to have a world-class science and math education. The problem is particularly acute in science. Many parents don't realize the importance of starting children in science early on. Many think it can easily wait until high school.
--**Jean Johnson, director of Education Insights at Public Agenda**

they reach high school.

Afterschool is the Perfect Platform to Build STEM Learning in Middle School

An article in Education Week, “Science by Stealth,” summed up the role of afterschool in STEM learning: “...afterschool programs offer an ideal setting for nurturing the potential scientist in every student, as well ...as reinforcing the science taught during the school hours. Compared to the school day, these programs’ smaller groups, longer time slots, and less formal settings provide opportunities for young people to visit museums, study neighborhood environments, cultivate gardens, perform laboratory experiments and have their love of discovery awakened in countless other ways.”^{viii} Further, a number of studies show that STEM learning during the school day is necessary, but not enough to support lifelong STEM literacy.^{ix} It is not surprising that 75 percent of Nobel Prize winners in the sciences report that their passion for science was first sparked in non-school environments.^x

“I got interested in science from a very early age; my parents took me to the American Museum of Natural History in New York when I was about 8, and they read out loud to me and my sister from biographies of Darwin and Galileo. Nothing in school at that age was nearly as interesting as the adventures I began to imagine doing science.”
--**John C. Mather, Astrophysicist and Winner of the Nobel Prize in Physics 2006**

The case for including STEM learning in afterschool is strong.^{xi}

- Supporting the STEM pipeline: Afterschool programs can play a key role in increasing the number of students following STEM academic and career paths at a time when the nation's economy is becoming increasingly dependent on a STEM-literate workforce.
- Fostering diversity: Enrollment, especially of youth from populations historically underrepresented in STEM fields, is dramatically increasing in afterschool programs.
- Generating awareness of the value of afterschool: There is increasing awareness of the importance of non-school learning experiences in generating interest, engagement, and capacity to know and do science, but we still have a long way to go. For STEM truly to thrive in the afterschool space, we need widespread recognition of the value of afterschool in contributing to STEM interest and learning.
- Responding to expectations from afterschool funders: Many supporters of afterschool programs are increasingly asking for evidence of academic achievement. STEM activities have the potential to support academic growth while being engaging and entertaining.

Beyond the big picture case for including STEM in afterschool, there are program-level benefits to providing STEM programming to middle school youth in the afterschool space. Program-level benefits include:^{xii}

- Engaging, hands-on curricula tailor-made for middle school youth in afterschool programs are available.
- Connecting with STEM professionals as mentors and volunteers to work with students and provide exposure to STEM careers.
- Involving community-based organizations and foundations to supplement learning and further engage students.
- Providing opportunities for students to work collaboratively and include student-directed subject matter.
- Offering experiential learning activities that require youth to plan, investigate and communicate.
- Creating strong linkages to the school day by engaging and inspiring youth, keeping them on the STEM path during the regular school day, and preparing them for high school STEM learning and beyond.

Multiple evaluations of STEM programming in afterschool show clear benefits for middle school youth:

- Participants have increased school attendance, improved grades, and raised graduation rates. Students also show significant improvements in school engagement, family support and parental support for education and behavioral expectations at school. (See **The Bridge Project**)
- Participants have a more positive attitude towards science, are more confident in themselves as science students and students in general and are more aware of careers in STEM. (See **The Science Club for Girls and C.E.L.L.S.**)
- Participants have higher rates of high school graduation and college attendance. Thirty-five percent of all female participants in one STEM program who graduated from high school went on to major in science in college. (See **Project Exploration/Sisters 4 Science**)
- Participants continue to pursue STEM-related topics in high school and beyond, and feel prepared for professional careers in STEM-related fields. (See **Woodcraft Rangers**)

Afterschool STEM programming offers middle school youth experiences with collaboration and innovation, while also learning about the relevant issues of the day. Youth also have the opportunity to combine subject areas and skills, making projects challenging, multi-dimensional and fun.

- At **The Bridge Project** in Denver, Colorado, middle school students learn about renewable energy through hands-on science experiments and then make short films explaining how different types of renewable energy work and about the benefits of sustainable living. The science curriculum on renewable energy, including the experiments, is provided by the National Renewable Energy Laboratory. Students enjoy hands-on experiments, like building a solar oven and wind turbine, which help them understand how renewable energy operates. For the technology component, students work with state-of-the-art movie-making and editing equipment to create a film, which is then shared with the wider community. This program allows students to learn about science and technology and gives them a tangible outcome that can be shared with others. A rigorous evaluation process shows that participants have increased school attendance, improved grades and increased graduation rates. Students also show significant improvements in school engagement, family support and parental support for education and behavioral expectations at school.

Offering STEM in afterschool allows groups of middle school youth who are typically underrepresented in the sciences to participate in and get excited about STEM, encouraging them to pursue a science education and consider a career in science.

- **The Science Club for Girls and C.E.L.L.S.** in Cambridge, Massachusetts seeks to increase the science literacy and self-confidence of girls. Middle school students participate in hands-on science clubs in 6th and 7th grades, and in the C.E.L.L.S. (Career Exploration, Leadership and Life Skills) program in the

second semester of 7th and 8th grade. The curricula encompass a range of STEM topics including astronomy, astronautics, climate change and oceans. These interdisciplinary curricula stress hands-on learning, and culminate in a final, collaborative project. Girls are exposed to a variety of STEM fields and the real-world applications of principles and tools related to these fields. The clubs are guided by undergraduate, graduate, and professional women in STEM, who serve as role models, mentors and sources of information on STEM careers. Internal outcomes evaluations find that participants have a more positive attitude towards science, are more confident in themselves as science students, and are more aware of careers in STEM.

When I think of a group of girls getting together, I don't think of it as productive—it's just getting together to be girls. But [in Science Club] everyone's there, helping each other, supporting each other—and at the end, something comes out of it.
--Louisa Irele, 19, a Science Club alumna

- **Project Exploration/Sisters 4 Science (S4S)** in Chicago, Illinois is a nonprofit science education organization that works to ensure communities traditionally overlooked by science education—particularly minority youth and girls—have access to personalized experiences with science and scientists. Their afterschool program includes hands-on activities, authentic fieldwork, leadership development and the chance to develop long-term relationships. The program merges research-based best practices for both youth development and science education into a model that gets middle school youth interested in science, keeps them interested, and builds their capacity to pursue science. Participants in the program have higher rates of high school graduation and college attendance than their non-participating peers. Further, 35 percent of all female participants who graduate from high school go on to major in science.

- *We get to learn new things that wouldn't come to you every day.*
 - *I feel that I am more interested in science because of S4S.*
 - *It's just girls and we can do things cooperatively together.*
 - *Having time away from my family and learning about science.*
 - *We get to answer questions and ask questions and we really learn stuff we didn't even know.*
- Sisters4Science participants on being asked what is the best part of being in S4S (Jafri 2007)**

Afterschool can employ a wide range of strategies for engaging youth in STEM learning. Because of the flexible nature of afterschool, STEM learning can be readily incorporated into appealing curricula, allowing middle school youth to get excited about STEM.

- **Woodcraft Rangers** in Los Angeles, California makes STEM education relevant and captivating for young people who would otherwise have little or no access to STEM activities. Participants are exposed to cutting-edge STEM activity options (using state-of-the-art technology) that motivate them not only to pursue post-secondary education, but also prepare them for vocational pursuits. The key to Woodcraft Rangers' success with middle school youth is its innovative approach to sparking students' imaginations so that they become and remain involved over time. Rather than relying on a static menu of activities, Woodcraft Rangers

afterschool STEM club themes are wide-ranging and selected by students, giving them ownership and increasing their engagement. Multifaceted evaluations find that participants show improvement in school attendance, academic achievement and behavior. The overarching goal of the program is to motivate youth to pursue related STEM topics in high school and beyond, and to prepare them for professional careers in STEM-related fields. Outcomes for participants consistently reflect these goals, with over 70 percent of participants achieving expected benefits.

Barriers Exist to Providing STEM in Afterschool

Despite robust data that show the benefits of high-quality STEM programming in afterschool for middle school youth, considerable barriers exist. High-quality STEM programming in afterschool includes the following components.^{xiii}

- Priority on STEM, materials and access to expertise
- Appropriate staff levels of STEM knowledge, pedagogy and relevance
- Hands-on, inquiry based learning opportunities
- Regularly scheduled STEM activities that encourage consistent attendance

For a wide variety of reasons, many programs lack the ability to provide these essentials in their STEM activities. These reasons include:

- **Capacity:** Many programs offer only limited opportunities for participants to engage in high-quality STEM learning opportunities. There may be issues with how often STEM is offered, the quality of the materials available, or appropriate staff development. Program leaders say they would like support from families, schools and communities to help them increase the quality and quantity of STEM activities.^{xiv}
- **Commitment:** Many providers are reluctant to tackle STEM due to lack of staff buy-in, comfort with science content and availability of training and materials. Programs must invest in materials and quality training to implement the curriculum, which requires resources that may already be scarce.^{xv}
- **Sustainability strategies:** To ensure continued growth and long-term sustainability of afterschool STEM, programs must be intentional about identifying public and private funding. Programs need to become aware of funding sources beyond traditional afterschool funding streams such as 21st CCLC. Public funding can be found in federal government agencies such as NASA, NIH, NOAA and NSF. Private funds can be obtained from STEM-focused businesses, including technology, engineering and telecommunication companies that often look to invest in local youth programs. Local and national foundations with a focus on STEM, youth development or workforce development are also potential funders.
- **Partnerships:** Strong partnerships are a hallmark of afterschool programs, but many of the typical afterschool partners do not bring the STEM expertise that is necessary for a high quality STEM learning experience. STEM programs must develop partnerships with organizations and personnel who bring scientific and technical content expertise. Museums, science centers, universities and teaching hospitals can provide programming assistance, mentoring opportunities and materials to make STEM learning in afterschool vibrant and relevant.^{xvi}
- **Perception:** Finally, for those outside of the afterschool community, the afterschool space is not currently seen as a vital partner in STEM learning. Consequently, policies are not in place to encourage and enhance participation and engagement of the afterschool sector in national STEM education initiatives.

Conclusion

STEM literacy is critical to the future success of the U.S. in a rapidly changing global marketplace. Engaging middle school youth in STEM learning after school teaches them the relevance of science in daily life, offers engaging hands-on curricula, presents a space to apply the concepts they are learning during the school day, and provides a safe place to experiment with science without fear of academic failure.

STEM learning is widespread in afterschool and currently engaging millions of children. However, the potential to do even more and reach more children with compelling programs is enormous. Many programs are not yet prepared to deliver the high-quality STEM programs that can inspire our middle school youth to be lifelong STEM learners, but could do so with additional support. The good news is that many programs contain the necessary elements of training, curriculum and structure to attain strong and engaging STEM programming if adequately supported. Strategic policy, funding, technical assistance/training and strong community partnerships are critical to grow and strengthen these programs that will in turn create an engaged and STEM-literate middle school youth population.^{xvii}

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