Students from a FIRST team from Virginia ("Team Tiki") show off their robots at the Afterschool Alliance's 2011 Afterschool for All Challenge conference. Photo by Herman Farrer

STEM Learning in Afterschool: Ready to Soar

By Anita Krishnamurthi and Ramya Sankar

There is a widely acknowledged, urgent need for improving science, technology, engineering, and math (STEM) skills among U.S. citizenry and students to navigate the modern world and access the opportunities it affords. Studies estimate that nearly 80% of future careers will require awareness of and facility with STEM. But without a stimulating STEM education, our children and youth will not develop an interest in these fields and the basic analytical, problem-solving, and critical thinking skills so central to academic achievement and workforce readiness in the 21st century. Other countries around the world face similar challenges.

What steps can be taken to improve U.S. STEM education and increase access to STEM learning opportunities? While improvements in formal K–12 education are necessary, children spend less than 20% of their waking hours in school. Afterschool programs—defined broadly as those programs serving students before school, after school, and during the summer—offer both additional time and the opportunity to diversify the ways that students experience STEM learning. Such programs complement and supplement school-day learning in an environment that feels very different from school. Children and youth can engage in innovative, hands-on STEM learning that feels relevant to their lives without the pressures of testing.

Afterschool networks and providers are becoming more and more sophisticated in their efforts to increase STEM learning opportunities and promote quality STEM learning.

In addition, the afterschool setting is well placed to close the opportunity gap that many children and youth from underserved communities face. Of some 8.4 million children in afterschool programs, children from ethnic minority backgrounds are more likely than others to participate: 25% of Asian-American, 24% of African-American, 21% of Latino, and 16% of Native American children attend afterschool programs, compared with the national average of 15%. Girls attend afterschool programs in equal numbers to boys.

This article presents some data and analysis by the Afterschool Alliance *(www.afterschoolalliance.org)* and our partners. It provides a brief overview of the current state of STEM in afterschool and also summarizes evaluation reports from afterschool STEM programs across the United States.

SUPPORTS FOR STEM IN AFTERSCHOOL

Afterschool programs are no strangers to STEM programming. National youth organizations such as 4-H, Girls Inc., and Girl Scouts; state and local afterschool providers; and informal science institutions including science centers and museums have been offering STEM programs for many decades. Many are deepening their commitment to STEM programming in the current environment. For example, 4-H has embarked on a new initiative to engage 1 million new young people in science programs by 2013, and the ASTC-led *Youth Inspired Challenge (youthinspiredchallenge.org)* has called on science centers and museums around the world to offer out-of-school time programs to engage at least 25,000 youth in a minimum of 2 million hours of science enrichment over a three-year period. (See Notes from ASTC, page 11.)

To enable growth and support STEM in afterschool, infrastructure is being assembled at a rapid pace. System-level intermediaries are working to increase quality and availability of afterschool and STEM in afterschool, and the 40 Mott Foundation–funded Statewide Afterschool Networks *(www.statewideafterschoolnetworks.net)* are increasingly becoming the brokers to coordinate afterschool STEM learning efforts in their states.

Afterschool networks and providers are becoming more and more sophisticated in their efforts to increase STEM learning opportunities and promote quality STEM learning. The (U.S.) National Science Foundation (NSF) has been a strong supporter of informal science education (ISE), including afterschool programs, for several decades. NSF gave ISE its name and shaped the existing ISE community into a more consciously educational enterprise. More recently, many private funders—including philanthropic foundations and corporations—have become engaged in this space. The Noyce Foundation, in particular, is investing heavily on a national level in afterschool and has recently partnered with the Mott Foundation to bolster the STEM efforts of the state afterschool networks. The U.S. Department of Education is also placing a priority on STEM in its 21st Century Community Learning Centers program, the only federal funding source exclusively devoted to afterschool.

NSF and these funders are also driving the development of assessment tools and research studies to study the impact of STEM learning in afterschool programs. These efforts are crucial to helping the afterschool community become effective partners in STEM learning as the nation considers sweeping education reform initiatives.

THE NATIONAL STATE OF STEM IN AFTERSCHOOL

The Afterschool Alliance teamed up with the National Afterschool Association (NAA) in December 2010–January 2011 to conduct a survey to assess the national state of STEM in afterschool in the United States. The survey was distributed

Afterschool providers view STEM as a vital component of their programming even if STEM is not the major focus of the majority of programs.

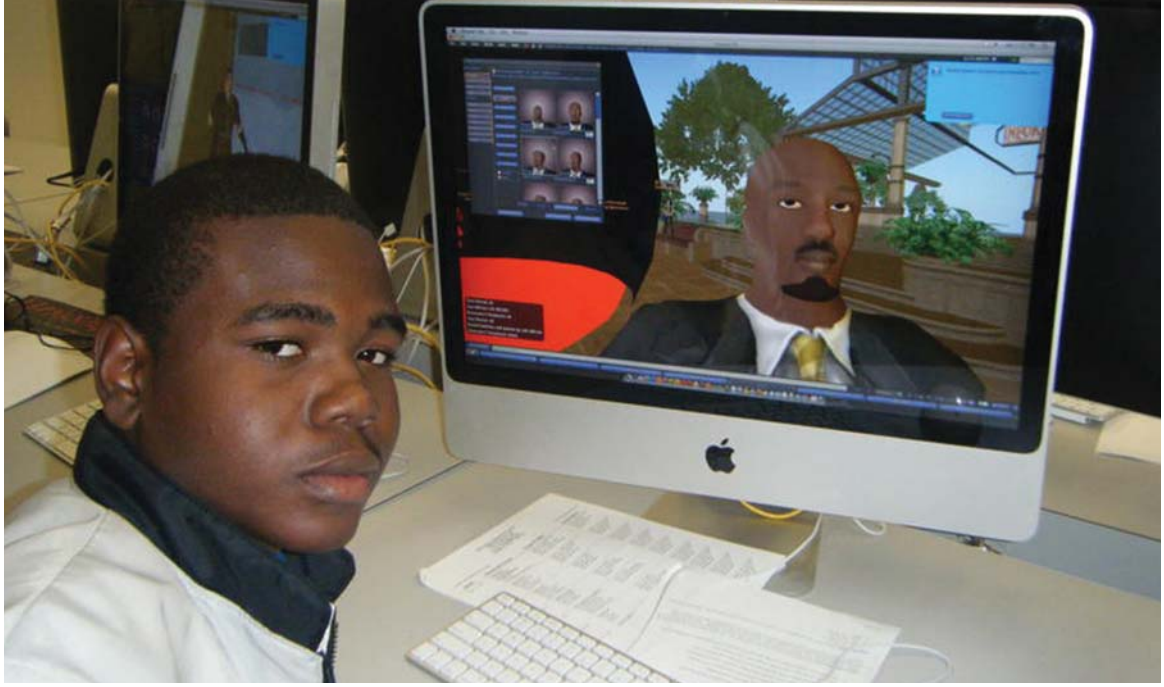
widely through a variety of listservs (including NAA, Statewide Afterschool Networks, Coalition for Science After School, and policy coalitions) to capture a broad group of stakeholders. More than 1,000 afterschool program directors and staff from every U.S. state except Alaska responded to the survey. The survey results highlight the current state of STEM education in afterschool and offer a glimpse into how STEM learning in this setting can improve, evolve, and become even more widespread and sustainable in coming years. Here are some of the major findings:

1. Afterschool providers view STEM as a vital component of their programming even if STEM is not the major focus of the majority of programs.
   - Nearly all survey respondents (99%) stated that they believe it is important to offer STEM programs afterschool and during the summer.
   - Only 33% of respondents considered STEM to be the primary focus of their afterschool program, and only 29% of respondents considered STEM the primary focus of their summer learning program.

2. STEM learning takes place in a variety of arenas and is being offered to all age groups, but even more children could get involved.
   - The majority of practitioners responding (81%) stated that they offered STEM learning opportunities after school, while 53% and 8% stated they offered STEM in the summer and before school respectively.
   - An analysis of the survey data found that 47% of all reported afterschool participants and 57% of all reported summer participants were engaged in their program's STEM offerings.
   - As in most afterschool programs, the majority of children benefitting from STEM offerings were in elementary school, yet many programs also served middle and high school students.

3. The meaning of STEM learning varies from program to program. It is difficult to easily categorize the types of STEM offerings in the afterschool space.
   - A majority of program providers (85%) responded that their program addressed math, with geology/Earth science (63%), engineering (53%), and biology (51%) appearing as other popular STEM fields. Environmental science, LEGO robotics clubs, rocketry, and computers were also very popular. (This highlights one of the positive aspects of the afterschool space in STEM learning: Engineering and technology do not often receive much attention during the school day, and afterschool programs offer an opportunity to facilitate learning in topics not often addressed by schools.)

4. Respondents face several significant challenges to their programs.
   - Of providers surveyed, 87% cited increased funding as a resource that would help them provide higher-quality STEM offerings, while nearly equal percentages of providers stated that curriculum materials (68%), professional development opportunities (67%), and expanded partnerships (71%) would help improve program quality.
   - Nearly a quarter of the programs surveyed offered no STEM content professional development for staff, and nearly half offered less than one hour per month. However, 68% of programs acknowledged that providing more



Digital WAVE participants at the Miami Science Museum create their own avatars, which they use to explore, build, and interact with others in virtual worlds. Photo courtesy the Miami Science Museum

professional development would be a major way to improve their STEM programming.

- Programs engaged a variety of partners to offer their STEM programming—school teachers (48%) and colleges (40%) were the top two, while science centers and businesses came in next (30%). Almost a quarter had no external partners for their STEM programs.

COMMON TRENDS AND STRENGTHS IN AFTERSCHOOL STEM PROGRAMS

Despite some challenges, high-quality STEM afterschool programs show tremendous promise for engaging and inspiring children and youth. In mid-2011, the Afterschool Alliance looked at evaluation reports from afterschool STEM programs across the United States and identified common trends and strengths that afterschool learning brings to STEM education. Many of these programs are aimed at girls and/or youth from underrepresented communities.

Several of the programs we evaluated 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. Some 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 trends. 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. Improved attitudes toward STEM fields and careers
   a) Increased enrollment and interest in STEM-related courses in school
   b) Continued participation in STEM programs
   c) Increased self-confidence in tackling science classes and projects
   d) Shift in attitude about careers in STEM.
2. Increased STEM knowledge and skills
   a) Increased test scores as compared with non-participants
   b) Gains in knowledge about STEM careers
   c) Gains in computer and technology skills
   d) Increased general knowledge of science
   e) Gains in 21st-century skills, including communication, teamwork, and analytical thinking.
3. Higher likelihood of graduation and pursuing a STEM career
   a) High rate of high school graduation among participants
   b) Pursuit of college and intention of majoring in STEM fields.

Middle school students from the Kitty Andersen Youth Science Center's Design Team at the Science Museum of Minnesota prepare to present their creative design work to visitors at the museum's first annual Asian Americans in Science event. Photo courtesy the Science Museum of Minnesota

The following examples—taken from afterschool programs in our evaluation review that involve science centers and museums—illustrate these types of outcomes:

- *FIRST (www.usfirst.org)* provides several leagues in which student teams, including some based at science centers and museums, compete in robotics competitions. A retrospective study of *FIRST* alumni, conducted by researchers at Brandeis University, surveyed participants who graduated from the program between 1999 and 2003 in New York City and Detroit. The study found that 86% reported an increased interest in science and technology generally, 69% had an increased interest in STEM careers, 89% reported increased self-confidence, and 70% had an increased motivation to do well in school. In addition, 99% graduated from high school, and 89% went on to college. Of those in college reporting a major, 41% said they had selected engineering.
- After-School MathPlus *(www.edequity.org/programs/science-and-math-programs/#24)* was developed by the Educational Equity Center at the Academy for Educational Development, in collaboration with the New York Hall of Science, Queens, and the Saint Louis Science Center, Missouri, with the participation of afterschool centers in their communities. Through the program, students in grades 3–8 and their parents created math exhibits that were showcased to a larger audience. Participants showed significant increases in math test scores as compared with students who did not participate in the program.
- Design Team, run through the Kitty Andersen Youth Science Center at the Science Museum of Minnesota, St. Paul, provides middle school participants with the opportunity to work on design projects in groups. In a 2009 report summarizing exit surveys of participants, 70% of respondents stated that they used what they learned in Design Team in school, and 57% said that participating in the program influenced them to take engineering courses in high school.
- Digital WAVE *(www.miamisci.org/wave)* at the Miami Science Museum, Florida, enables students in grades 9–12 to create educational simulations about climate change using 3D design and animation. A 2010 evaluation showed that 96% of program alumni planned to attend college, 77% planned to major in a science or technology field in college (an increase of 9% compared with the start of the program), and 96% 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% compared with the start of the program).

NEXT STEPS

One of the most common questions that policymakers ask the afterschool field is exactly what we are willing and able to deliver as outcomes for STEM learning in afterschool. While they acknowledge

Professional development of afterschool staff is often a major challenge facing providers who wish to offer more STEM programming. This may present a tremendous opportunity for science centers and museums to partner with afterschool programs in their communities.

Left: Youth participants at the Afterschool Alliance's 2011 Afterschool for All Challenge conference examine a robot built by a *FIRST* team from Virginia. Photo by Herman Farrer

Below: A *FIRST* participant tests his robot prior to exhibiting it at the Afterschool for All Challenge conference. Photo by Herman Farrer

that exciting and inspiring children and youth is essential, we are told that it is insufficient. To try and answer this question, the Afterschool Alliance has embarked on a Delphi study to survey two sets of stakeholders: afterschool practitioners who have to deliver on outcomes, and state education officials and funders who often define these outcomes. We hope this study will uncover consensus on some appropriate and feasible outcomes and indicators for STEM learning in afterschool and provide guidance to the field and external stakeholders. The results of this study will also inform a consensus study the (U.S.) National Research Council is undertaking on assessments in ISE.

The afterschool field has embraced STEM learning enthusiastically and has moved rapidly to incorporate it into its larger portfolio of programming. Professional development of afterschool staff is often a major challenge facing providers who wish to offer more STEM programming. This may present a tremendous opportunity for science centers and museums to partner with afterschool programs in their communities. Afterschool program providers have deep roots in their communities and are experts in youth development; both of these attributes may be useful to science centers. The two communities have very similar goals, and strong partnerships will help to highlight the role community partners and ISE play in the STEM education landscape. ■

Anita Krishnamurthi *(akrishnamurthi@afterschoolalliance.org) is director of STEM policy and* **Ramya Sankar** *is research assistant at the Afterschool Alliance, based in Washington, D.C. This article is adapted from two Afterschool Alliance reports published in 2011—*Afterschool: A Vital Partner in STEM Education *and* STEM Learning in Afterschool: An Analysis of Impact and Outcomes. *To read the full reports, and other reports on STEM and afterschool, visit* www.afterschoolalliance.org/stem-publications.cfm.