STEM READY AMERICA

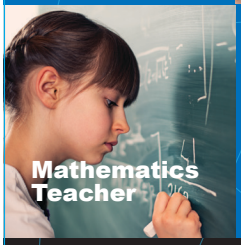
Inspiring and Preparing Students for Success With Afterschool and Summer Learning

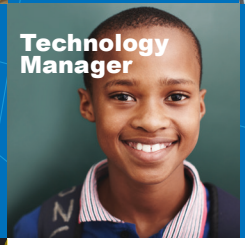
This collection of articles is excerpted from a new resource, *STEM Ready America: Inspiring and Preparing Students for Success with Afterschool and Summer Learning.* In this volume, Executive Editor Ron Ottinger and Contributing Editors Cary Sneider and Ian Hickox have collected expert perspectives on the state of the field of STEM learning—especially in afterschool and summer learning opportunities.

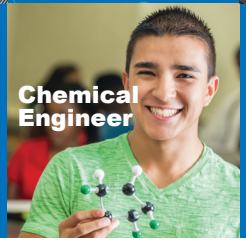
Collectively, these writings from more than 40 thought leaders highlight how young people are developing STEM knowledge and skills that will prepare them to be successful in school today and the workforce tomorrow.

The articles provide persuasive evidence and real-world examples to inform effective partnerships, policies, and actions to bring quality STEM learning to children and youth across the nation. This volume is focused in three key sections:

- **The Evidence for STEM**
- **Partnerships for STEM Learning**
- **Ensuring Access to Quality STEM Learning**







Developed by STEM Next with support from the Charles Stewart Mott Foundation, *STEM Ready America* builds on the award-winning 2013 publication *Expanding Minds and Opportunities: Leveraging the Power of Afterschool and Summer Learning for Student Success* edited by Terry K. Peterson, Ph.D., which made the definitive case for the power and effectiveness of afterschool programs and summer learning.

For more information about STEM Ready America and to download articles visit: www.stemreadyamerica.org.

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From Evidence to Policy: The Case for STEM in Afterschool

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In socially interactive environments like afterschool programs and summer camps, young people have the freedom to explore new ideas, take intellectual and creative risks, and stretch themselves and their understanding in ways that are not always supported in schools, particularly under-resourced schools serving low-income communities. Parents seem intuitively to understand the importance of out-of-school-time (OST) learning and, when they are able, invest in it accordingly. In fact, the wealthiest 20 percent of families devote almost seven times the resources to their children's enrichment activities outside school than do the poorest 20 percent (Duncan & Murname, 2011). By sixth grade, middle class children have spent 4,000 more hours in afterschool and summer learning programs than their low-income peers (ExpandED Schools, 2013). These inequitable inputs lead to the inequitable outcomes we see down the line, including in science, technology, engineering, and mathematics (STEM) fields.

In this article, we review the consensus understandings—firmly based on the syntheses of decades of studies in the Learning Sciences and other fields—about what makes for powerful and compelling STEM learning. We also identify policy directions that can build on the evidence base to address educational equity in STEM.

Why afterschool for STEM learning?

Research shows that hands-on, materials-based investigations by students are linked to higher levels of interest in STEM and lead to better STEM learning outcomes (Furtak, Seidel, Iverson, & Briggs, 2012). Schools often struggle to provide this kind of instruction, especially schools that are under-resourced and that serve low-income and racially marginalized communities (Oakes, 2005). Research shows that female, African-American, and Hispanic students are less likely to complete high-level STEM coursework in high school (Tyson, Lee, Borman, & Hanson, 2007), which is precisely the coursework most closely associated with the decision to pursue STEM majors in college (Maltese & Tai, 2010). As a result, students from these populations remain under-represented in STEM fields, an outcome that adversely impacts the quality, scope, and nature of the STEM enterprise in the United States (National Science Foundation, 2013).

Afterschool programs disproportionately serve young people from low-income and racially marginalized communities (Afterschool Alliance, 2014). Therefore, they can play a vital role in helping to level the playing field by expanding participants' opportunities to engage in compelling and productive STEM learning activities. Afterschool providers have embraced STEM in their programming, recognizing the importance of STEM learning for young people as well as the value of the opportunities they can provide for hands-on, engaging, and innovative learning in these settings. A study conducted with afterschool educators and stakeholders showed that they offered STEM learning activities to help young people develop their STEM interests, their capacities and skills to engage with STEM, and their commitments to exploring and valuing STEM as an enterprise (Krishnamurthi, Bevan, Colon, &

Rinehart, 2013). Additionally, a majority of parents with children in afterschool programs report that their child is receiving some form of STEM activity in their program (Afterschool Alliance, 2015). Thus, afterschool can serve as a key lever for preparing more students from diverse backgrounds to become interested in and identify with science, to succeed in school science, and to pursue STEM fields. It does this by providing elementary students with hands-on STEM learning, engaging older students in project-based STEM programs, and by helping a wide range of students across the country to identify with the STEM enterprise.

Research from the Learning Sciences

Over the last few decades, research on learning has established clear foundations and directions for the design and evaluation of STEM programs in afterschool. These findings have been synthesized in consensus reports, involving scores of individual studies, many conducted by the National Academy of Sciences:

1. **Learning develops across time and setting.** Research demonstrates that learning is a process that involves not just knowledge transmission and acquisition but also the development of interest, identity, and understanding (National Research Council, 2000, 2009, 2015). Learners activate their existing interests, current understandings, and prior experiences as resources or means for engagement and development of further knowledge, skills, and understanding.

   Although STEM interest, identity, and understanding certainly develop in school, they are also developed and reinforced in OST settings, where K–12 students spend 80 percent of their waking hours (Banks, 2007). Wai, Lubinski, Benbow, and Steiger (2010) found that successful postsecondary STEM students reported greater participation in pre-collegiate STEM learning experiences, including activities such as science fairs and math competitions. Interest feeds on itself; students who participate in OST STEM programs tend to seek out more, and this helps them persist in STEM (Bevan & Michalchik, 2013; Falk et al., 2016). Afterschool STEM can help youth see STEM as relevant, interesting, and enjoyable. It can also help youth see themselves, and be seen by others, as accomplished STEM learners and participants.

2. **STEM is best learned through the processes of engaging in scientific practices.** STEM facts, concepts, skills, and relevance are learned while people are actually engaged in practices of investigation, sense-making, and critique (McNeill, Katsh-Singer, & Pelletier, 2015; National Research Council, 2012b). In this process, students gain a deeper understanding of STEM as a way of knowing, and as a field and choice of activity, by developing questions to ask, designing techniques to answer them, and by critically engaging with data to develop or challenge models of understanding.

   Additionally, the practice of doing STEM in a safe setting often helps young people see themselves as a person who can succeed at STEM (Carlone, Scott, & Lowder, 2014). Afterschool settings, with more flexible uses of time and space, are ideally situated for this process of identity development. STEM in afterschool provides an opportunity to develop genuine interest and authentic questions that can be explored by youth and adults together, rather than as a set of facts or disembodied procedures. In this way, students not only learn what STEM is but also that STEM can be enjoyable and empowering.

3. **Programs that leverage and develop student's "21st-century skills" promote deeper learning.** Skills such as creativity, collaboration, and problem solving have long been called "soft skills" and have typically been seen as contributing primarily to a supportive classroom culture and positive behavioral norms. Today they are more correctly identified as "learning skills" and have been linked to the development of sustained and sophisticated learning practices and outcomes (National Research Council, 2012a). They are also skills that are highly valued in the workplace, where adaptability and critical thinking are seen as crucial attributes during an era of rapid transformation that is creating new industries, workplace tools, and work configurations.

   21st-century skills have long been valued by the youth development community that underpins much of the afterschool sector (Halpern, 2002; Pinkard & Austin, 2014). Because individual students are not graded or assessed in afterschool, there are more opportunities for collaborative work, for creativity and redirection of activities, and for sharing. These skills have been demonstrated to carry over into longer term choices and academic performance of youth in school, home, and community settings (Mahoney, Larson, Eccles, & Lord, 2005; National Research Council and Institute of Medicine, 2002).

A 2015 National Research Council report on productive OST STEM programs summarized these and other findings to describe a need to create afterschool STEM programs that (a) are intellectually and emotionally engaging, (b) build on young people's prior interests and cultural resources, and (c) actively make connections across learning opportunities, both conceptually (by referencing and building on young people's direct experiences with STEM in other settings) and physically (by helping youth to identify additional learning opportunities).

There is strong evidence that the qualities discussed above are unevenly distributed in America's schools (Condron, 2011). If afterschool is to realize its potential to help all youth to engage with STEM, these findings must be used to develop, staff, and support the way that high-quality afterschool STEM programs are structured, implemented, and evaluated.

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Implications for Policymakers and Program Leaders

If STEM learning opportunities can be imagined as a network of charging stations—opportunities to reconnect and revitalize interest and skills—across the country, it's evident that some communities have spottier access than others. Children in such communities often not only have less access to high-quality school STEM but also miss the chance to recharge their STEM learning, interest, and identity outside of school, diminishing their capacity to pursue deeper and ongoing school STEM engagement. The research described above suggests a need to invest in a STEM learning infrastructure that provides multiple, varied, and responsive STEM learning opportunities to all children. To help realize this vision, we offer the following set of policy recommendations:

1. **Increase the availability of high-quality afterschool STEM programs for those who need it the most.**

   A. Expand the number of afterschool programs providing STEM learning opportunities to accommodate 10 million more students by 2020. This would cut the number of students waiting for access to afterschool programs in half.

      i. Fully fund programs such as Title IV Part A of the Every Student Succeeds Act at the authorized level of $1.65 billion. This program will allow states and local districts to provide students the well-rounded education they need to be engaged and successful, and to prioritize STEM programs. Increases in funding for both the 21st Century Community Learning Centers (21st CCLC) initiative and the Child Care Development Block Grant (CCDBG) will increase the number of low-income, school-age children regularly participating in federally assisted afterschool and summer learning programs and begin to narrow the opportunity gap.

      ii. Make afterschool programs eligible partners for federal and state grants that support STEM education goals.

   B. Design and evaluate high-quality afterschool STEM programs with characteristics strongly linked to positive learning outcomes in the research literature:

      i. Programs must engage young people in the practices of doing STEM—developing questions, designing investigations, collecting data, and developing evidence-based explanations.

      ii. Programs must recognize and build on student's interests, capacities, and cultural resources. Programs must reflect issues, questions, and problems that matter to them and position STEM as an essential tool for addressing these issues.

      iii. Programs must fully leverage and develop students' 21st-century skills, including teamwork, communication skills, and problem solving.

   C. Create comprehensive collective impact strategies that coordinate and manage investments in afterschool STEM education programs, resources, and activities.

      i. Design programs and initiatives to link afterschool and school STEM learning. For example, Title IV Part A of the Every Student Succeeds Act will support states and local districts to make crucial opportunities available for hands-on STEM learning, increase and improve computer STEM instruction, help integrate informal and formal STEM programs, and increase the number of STEM specialty schools.

      ii. Ensure that informal STEM education stakeholder inputs are solicited and included when establishing federal agency priorities in STEM education.

2. **Support a new corps of afterschool STEM educators.** Expanding access to 10 million additional students in afterschool STEM programs will require at least 500,000 more afterschool educators who can facilitate high-quality STEM programming. This need can be embraced as an opportunity to build bridges between formal, informal, and afterschool institutions and educators in ways that will benefit young people by building continuity and coherence across systems.

   A. Support STEM educator professional development opportunities for both formal and informal educators, using vehicles such as the Higher Education Act.

   B. Make use of informal education spaces (such as science centers and afterschool programs) to serve as low-risk sites for teacher training, where prospective teachers can work with children in more open-ended and nonjudgmental contexts.

   C. Fund partnerships between informal STEM organizations (e.g., science museums) and afterschool programs to expand STEM expertise for the afterschool field.

   D. Engage federally funded STEM researchers, as part of their broader impacts requirements, as afterschool volunteers, mentors, or partners.

3. **Invest in an ambitious afterschool STEM research agenda.** To expand research-based knowledge about productive strategies to support STEM learning in afterschool programs, we need to better understand and document how STEM learning occurs across diverse settings and over time for a wide range of young people. The following types of studies can be used to inform education investments across the federal government and foster interagency collaborations in the afterschool STEM programming portfolio.

   A. Support research that generates qualitative descriptions of STEM programs (e.g., the STEM focus, teaching strategies, student activities, and connections with or relevance to larger community STEM issues, including school STEM). These are needed to understand how different approaches may lead to different student STEM learning outcomes.

   B. Fund fewer small-scale evaluations and more large-scale longitudinal studies with control groups to track children who have participated in afterschool STEM programs. Carefully designed studies can document if and how participation in afterschool STEM programs affects students' lifelong engagement with STEM, academic pathways in STEM, or career pathways in STEM. Such studies would need to account for:

   - The nature and depth of the afterschool STEM experience; and
   - Interacting and intervening factors such as the nature and quality of school STEM experiences, STEM mentors, family role models and support, and other critical factors, including workforce and societal trends, that unfold over decades.

Finally, the role of afterschool and informal programs in the larger STEM learning ecosystem must be elevated by appointing afterschool and informal STEM education experts to a wide range of government advisory bodies, from school districts to governors' initiatives to panels such as the President's Council of Advisors on Science and Technology, the National Science Board, and other senior federal agency policymaking positions.

As our economy changes and grows, we need to ensure that everyone has an opportunity to adapt and grow with it, contribute to it, and share in the resulting prosperity. Investing in STEM education opportunities across a variety of settings, so all young people have opportunities to gain these skills, regardless of zip code, is crucial and needs to be guided by effective policies reflecting our best understanding of how people come to care about and pursue STEM learning. These investments are essential if we are to tap all the talent available in our nation to build our shared future.

Across the grade bands, beginning in elementary and continuing through high school, out-of-school learning is critical for preparing and inspiring young people to engage in and pursue STEM fields. More STEM afterschool is needed but "more" alone is not enough. More must also mean more learning opportunities that are of high quality that are closely aligned to our current best understandings of how people learn. Afterschool STEM must be seen and experienced as relevant, compelling, and engaging by young people. Children and teenagers across all communities must have access to such high-quality STEM learning opportunities if economic prosperity and social capital are to be distributed more fairly. This vision requires an immediate investment in infrastructure—programs, people, and research—to build on the singular opportunity that afterschool provides to deepening and broadening participation in STEM.

Afterschool STEM must be seen and experienced as relevant, compelling, and engaging by young people.

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