Revisiting How the US Engages Young Minds
In Science, Engineering, and Technology

A response to the recommendations contained
in The National Academies’ “Rising Above the Gathering Storm” report

By
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4-H empowers youth to reach their full potential, working and learning in partnership with caring adults.

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Executive Summary

Science, engineering, and technology (SET) literacy is increasingly becoming a prerequisite for active and informed citizenship. As the global economy expands and workforce demands change, the need to improve the knowledge and application of these disciplines will only grow. Yet it is doubtful whether young people in America today will be truly prepared for the complex world of tomorrow. The groundbreaking 2006 report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, offers strategies to address this and other significant challenges to maintaining the nation’s preeminent status as a scientific and technological innovator. However, in failing to incorporate out-of-school time (OST) programs into its recommendations, the report misses an important part of the equation: when it comes to encouraging young minds and enlarging the pipeline of students who are both passionate about and proficient in SET, the learning that happens outside of the classroom is equally as important as what takes place during the school day. OST programs, such as those that are part of the 4-H Science, Engineering and Technology Mission Mandate and others like them, are already investing in the nation’s youngest scientists and engineers. These programs need to be part of the long-term solution for improving the SET literacy and aptitude of America’s youth.

I. What Does It Really Mean to Rise Above the Gathering Storm?

Leadership in both the public and private sectors recognizes that America’s ability to compete in a knowledge-based, global economy largely depends upon two things: 1) a population that is well trained and technically competent, and 2) the scientific and technological innovations they produce (National Academies, 2006, ES-1). Yet for the first time in decades, America’s competitive position is in jeopardy. Student interest and performance in science and technology-related subjects continue to decline, while the market’s demand for proficiency in these same areas is on the rise. US students are also falling behind their international peers when it comes to earning degrees and pursuing SET careers. As industry leaders struggle to fill positions in these sectors from a dwindling American talent pool, it has become painfully clear that the nation is failing to create and fill its pipeline for future innovation.
Elected officials recognize that if America continues to take its scientific and technological superiority for granted, it risks losing it. In 2006, Congress commissioned The National Academies of Sciences and Engineering along with the Institute of Medicine to identify the top strategies needed to enhance US science and technology enterprise and meet this urgent challenge head-on. The National Academies’ report, *Rising Above the Gathering Storm*, was the response.

The report identifies high-quality job creation for Americans and the nation’s need for new energy sources as the two key challenges most closely linked to scientific and engineering prowess (ES-2). It addresses the critical need to enhance academic and vocational experiences in science, engineering, and technology and details the most significant obstacles facing the United States to maintaining its leadership in global innovation. These include:

- Low levels of student ability and interest in science;
- Needed improvements in science education, teacher training, and curriculum;
- Establishment of positive role models in science, engineering, and technology fields;
- Additional opportunities for youth to participate in inquiry-based learning; and,
- Outreach to women, minorities, and underserved populations encouraging pursuit of science-related careers.

The report also openly warns that:

Americans may not know enough about science, technology, or mathematics to significantly contribute to, or fully benefit from, the knowledge-based society that is already taking shape around us. Moreover, most of us do not have enough understanding of the importance of those skills to encourage our children to study those subjects—both for their career opportunities and for the general benefit (p. 3-24).
Recommendations for Staying Ahead—What’s Missing?

At the heart of The Academies’ report are recommendations in three distinct focus areas designed to strengthen national prosperity, health, and security in the new global age. Kindergarten through 12th grades (K-12) and higher education are two of the three focus areas, demonstrating the importance of America’s young minds and educators to the nation’s future. Implementation steps are also offered to achieve the goals outlined in the recommendations.

The recommendations shine a well-deserved spotlight on K-12 science and mathematics education and the fundamental learning and skill-building that take place during the school day. However, a critical fact is overlooked. As Nellie Mae Foundation President and CEO Blenda J. Wilson notes in her remarks to the report *Critical Hours: Afterschool Programs and Educational Success*, “Because young people spend only 20 percent of their time in school, how and where they spend the remaining 80 percent has profound implications for their well-being, and their future” (2003). By extension, how and where young people spend their time outside of school will affect our nation’s competitive position for years to come. OST programs in SET play a vital role in meeting students’ needs once the final school bell has rung and are viable pathways for engaging and inspiring America’s future scientists and engineers. The value of these programs as part of a holistic approach to increasing the number of youth with an interest and competence in SET cannot be ignored and merits new levels of public and private investment.

II. The Case for OST Programs in SET

Young people benefit from participation in effective OST programs. The *Critical Hours* report commissioned by the Nellie Mae Foundation has found that such programs can:

- Increase engagement in learning,
- Increase educational equity, and,
- Build key skills necessary for success in today’s economy (Miller, 2003).
The American Youth Policy Forum (2006) further recognized that:

By introducing real world issues or problems to older youth to solve, OST programs provide an opportunity to engage them in learning about the world. OST programs that focus on civic engagement help youth to hone work-related skills that ease their entry to college and employment. The skill-building and exposure to work help young people think about their futures, and, as a result of their participation in OST activities, many realize that college is within their reach.

From an even broader perspective, research has shown (Lerner, 2005) that OST programs can foster positive youth development (PYD). The PYD perspective views young people as resources to be developed rather than problems to be managed (Eccles & Gootman, 2002). PYD focuses on five characteristics, referred to as the 5 Cs: 1) competence, 2) confidence, 3) connection, 4) character, and 5) caring. Once these five characteristics develop in an individual, a sixth characteristic emerges: contribution. This sixth characteristic occurs when young people contribute to their communities, their families, and themselves (Lerner, 2005).

Findings from The 4-H Study of Positive Youth Development, a national, longitudinal study that has surveyed more than 4,000 young people, indicate that involvement in structured programs and activities during OST play a critical role in helping young people achieve success and minimize risk behaviors. Youth involved in structured programs outside of school have higher scores on measures of PYD. Plus, longer, more frequent participation in structured OST programs is correlated with higher levels of PYD (R.M. Lerner, J.V. Lerner & Phelps, 2008). Quality OST programs incorporate the sustained, positive youth-adult relationships, skill-building, and youth participation and leadership that provide young people with the “social nutrients” they need for healthy development (R.M. Lerner et al., 2008).
The out-of-school hours also offer an optimal environment for building a young person’s competence and confidence in as well as their connection to the scientific world. This happens when they are able to explore topics of interest more deeply and engage in hands-on projects that may further stimulate curiosity about math and science—key to attracting more young people to science, engineering, and technology careers. Out-of-school time SET programs also offer another option for delivering learning experiences beyond the confines of the classroom. According to The Afterschool Alliance (2001), “After-school programs, especially those at middle and high schools, can heighten students’ interest in math and science and sharpen their skills in these subjects.”

The hands-on, interactive experiences offered at informal learning institutions such as science centers, zoos, planetaria, and acquaria can also cultivate a young person’s interest in the sciences. A national study of informal learning institutions and formal science education (Center for Informal Learning and Schools, 2004) found that, of the 475 participating institutions in the study, almost 75 percent offered programs, workshops, or curricular support for K-12 science education (Table 2). With each institution serving a median of 40 schools and eight districts, the Center was able to estimate that 36 million students were impacted by these experiences directly or indirectly.

In their recent article, *The Real Global Technology Challenge*, Leonard Lynn and Harold Salzman (2007) discuss the type of scientists and engineers that will be needed in the new global environment. They find that not only will technological skills be important, but also companies will be looking for individuals who are collaborators and can work across organizational, cultural, and disciplinary boundaries. OST programs foster just such skills. The Afterschool Alliance and the Coalition for Science Afterschool (2008) find the following:

> Combining science, technology, engineering, and math learning with the youth development expertise of after-school professionals has the potential to revolutionize both fields by integrating each others’ strengths. After-school programs are proven to teach the so-called “soft skills” of communication, problem solving, and teamwork, which young people need for any career (Afterschool Alert Issue Brief, No. 26, p. 2).

OST programs can also be a bridge to engaging underrepresented populations in SET experiences. For example, during the summer of
2007, Latino students in the state of Oregon were invited to participate in a five-day “Latino Olympic Summer Camp” hosted at the Oregon 4-H Conference Education Center (http://oregon.4h.oregonstate.edu/programs/events/latinoCamp/latinoCamp.htm). Latino youth in grades 6-12 had opportunities to increase their skills in computer technology and investigate math and science through forestry and environmental science programs. The camp was created as part of a larger effort to combat the state’s high Latino dropout rate by providing opportunities for participants to learn about post-secondary education and ways to fund it, and by engaging them in fun and challenging educational activities. Most importantly, the camp permitted youth to interact with Latino university students and professionals. It also demonstrates how out-of-school programs can introduce students to positive role models, especially in the science, engineering, and technology fields. Exposure to these experiences and role models help youth sustain their interest in the sciences throughout college and into the world of work.

### III. Building Partnerships to Support Success

A shared sense of urgency and recognition that there is strength in numbers has brought organizations, institutions, and corporations together as collective voices for out-of-school SET programs. Groups such as the Coalition for Science Afterschool (www.ScienceAfterSchool.org) and the Afterschool Alliance (www.afterschoolalliance.org) span sector lines as champions for the field. They are powerful advocates with funders and policymakers, bringing deserved attention and resources to the cause. They also function as fluid communication networks for their members and clearinghouses of information and resources related to SET programming in the out-of-school hours. For example, The After-school Science Database, maintained by the Coalition for Science Afterschool, offers an online collection of projects, publications, and partnerships which support SET in out-of-school time.

Tapping America’s Potential (TAP), a coalition of 16 prominent business and technology associations, has committed to bolstering the pipeline of US scientists and engineers. TAP has targeted its efforts towards doubling the number of science, engineering, technology, and mathematics graduates with bachelor’s degrees by 2015 (www.tap2015.org/about). Corporate Voices for Working Families
(www.cvworkingfamilies.org), a coalition of 55 partner companies with annual net revenues of more than $1 trillion, works to identify and promote the corporate and public policies necessary to ensure that young people have the opportunities they need to develop the skills and knowledge needed to be successful in work and life. The coalition’s 2007 report, *Business Leadership: Supporting Youth Development and the Talent Pipeline*, highlights promising practices at Abbott (p. 18), IBM (p. 19), and CVS/pharmacy (p. 25) designed to nurture career pathways for young people in science, engineering, and technology.

Federal agencies, private foundations, and corporations are also making financial investments to ensure that US students are prepared with the math and science skills they need to succeed and that “mathematicians, scientists, and engineers do not become an endangered species in the United States” (Bement, 2007). The National Science Foundation (NSF) funds close to 30 programs in science, engineering, technology, and math education. NSF also partners with other federal agencies, including the US Department of Education, to boost student achievement in SET. The agencies’ joint Math and Science Partnership program (MSP) reaches close to 30,000 K-12 math and science teachers annually with information, teaching tools, and professional development (Bement). Private-sector partners like ExxonMobil and Motorola as well as the Verizon and Noyce Foundations also recognize that investing in out-of-school time SET programs is good business. A November 2007 Motorola corporate news release noted that the Motorola Foundation’s Innovation Generation grants initiative has encouraged young people to embrace science, technology, engineering, and math. Since 2000, the foundation has contributed more than $35 million in grants to a variety of programs that expand student access to science, engineering, and technology fields (www.motorola.com/mediacenter.news).

**IV. 4-H: 100 Years of OST Science, Engineering, and Technology**

In discussing how the nation’s universities can prepare for the movement towards the economy of the future, MIT President Susan Hockfield (2006) has noted that they must “intensify the creative relationships they have built with the knowledge-based economy—to create new, connected models that supplement the long-established pipeline model (New Innovation Model section, para. 9).” These new models mean new opportunities to generate the kind of public-private partnerships that benefit young people, university research, and corporate
development at the local, state, and national levels. OST programs have long been at the forefront in forging exactly these kinds of connections.

One example of such a partnership in action is the 4-H Youth Development Program. As the largest out-of-school youth program in the United States, 4-H is made possible through the shared leadership of National 4-H Headquarters in the Cooperative State Research, Education, and Extension Service of the United States Department of Agriculture (CSREES/USDA) in Washington, D.C., the Cooperative Extension System of land-grant colleges and universities and its partnering institutions, and state and county governments. The public sector dollars that support the program are enhanced by private sector funds raised by National 4-H Council and through fund development at the state and local level.

The 4-H Science, Engineering and Technology Mission Mandate is 4-H’s response to the national concern for improving human capacity and workforce ability in the areas of science, engineering, and technology education. Programs and projects that encourage exploration in the sciences are not new to 4-H. Since the 4-H Youth Development Program began in 1902, 4-H youth have been engaged in demonstration projects that bring valuable land-grant college and university research to local communities. Currently, 4-H youth are engaged in more than 5.9 million SET projects in urban, suburban, and rural communities across America.1 By 2013, 4-H SET programs will prepare 1 million additional youth to excel in science, engineering, and technology and will expose them to a multitude of potential SET majors and careers.

4-H’s unique infrastructure and partnerships with the nation’s 106 land-grant colleges and universities are essential to reaching these new youth. They are also indicative of the kinds of creative and collaborative relationships that can be employed to achieve a marked improvement in SET capacity for youth nationwide. Three federal acts dating back to the years 1862 (state universities and colleges); 1890 (historically black colleges and universities); and 1994 (American Indian tribal colleges) required the establishment of the Cooperative Extension System and 4-H Youth Development as a means of delivering the university’s knowledge, research, and educational programming to the local community and youth. This strong connection between higher education and youth in every community is unprecedented.

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1 Youth may be engaged in more than one 4-H Science, Engineering and Technology project at a time.
Nearly 3,500 4-H educators serve every county in America and the US territories by delivering 4-H programming through clubs, camps, and after-school programs. The 4-H Science, Engineering and Technology Mission Mandate also mobilizes a cadre of state 4-H Science, Engineering and Technology liaisons as part of its outreach and delivery strategy. The liaisons are trained youth development educators who serve as information channels and are responsible for connecting 4-H at the state and local levels back to the national program goals.

4-H Science, Engineering and Technology combines the strengths of 4-H programming and non-formal, experiential-based delivery modes with strong youth-adult partnerships to address content as defined by the National Education Science Standards in order to prepare youth to compete in the 21st century workplace. The National Academies (2006) found that a particular barrier to engaging young people in SET is that they are often confronted with adults who have a “disdain for science and mathematics” (p. 5-9). 4-H’s cadre of trained, caring youth development professionals and adult volunteers mean the 4-H Science, Engineering and Technology Program is well positioned as one solution to this challenge. In a recent survey conducted by Cook and Bowles (2008) among local 4-H educators, respondents expressed a general confidence in their ability to provide content in science, engineering, and technology. In partnership with volunteers, 4-H educators indicated a high interest in providing the following specific SET content areas:

- Communications and technology (83%), *
- Food and nutritional science (78%),
- Animal sciences (69%),
- Health sciences (69%),
- Environmental sciences (65%),
- Energy (64%), and
- Geospatial technology (64%).

This data is also helping 4-H determine the type of professional and volunteer development needed to implement 4-H Science, Engineering and Technology projects and programs successfully. In particular,

* percentage of respondents
volunteers from corporate America with SET knowledge have the potential to boost the quality of programming while meeting a critical community and workforce need—ensuring youth have opportunities to apply science, engineering, and technology skills today and in the future. 4-H’s broad national reach combined with its delivery network of local educators uniquely position the organization to partner with federal, state, and county governments as well as corporations that seek national reach and grassroots impact.

V. Call to Action

Although visibility and funding have been on the rise for OST programs, a number of challenges to quality service still exist. Issues of access to affordable programs in rural and low-income communities, organizational capacity limitations (such as inadequate facilities and low staff compensation), and a need for greater coherence and connection among the agencies serving school-age children have the potential to stifle even the most innovative efforts if they are not addressed (US Department of Health and Human Services, 2006). At the same time, funders of OST programs are increasingly looking to support those opportunities that can demonstrate impact and offer clear evidence of academic achievement. OST programs in science, engineering, and technology can support this academic growth while inspiring and engaging the young person (www.scienceafterschool.org/case.html).

Investments in capacity building, professional development, research, and evaluation (either within individual programs or through broader, movement-wide initiatives) can do much to enhance the sustainability of SET-focused OST programs. These types of investments may be particularly well suited for those funders that have typically supported direct service grants to programs in the past and are now looking to evolve and extend their contribution to the OST field in a new way. Achieving this sustainability calls for a new level of support and investment from federal agencies, private foundations, and corporate partners. Simply spreading the current amount of private and public sector funds directed towards K-12 education to also cover OST programs will do both the formal and non-formal education channels a disservice.
VI. Conclusion

Now, more than ever, we must ensure that our nation’s youth develop the necessary SET competencies and abilities for the US to remain competitive in the 21st century. OST programs in SET are an outstanding (and underutilized) complement to the formal instruction and education young people receive in these disciplines during school hours. OST programs have a proven capacity to deepen a young person’s connection to SET and can foster the kinds of high-tech as well as high-touch skills that are attractive to employers in the sector. These programs can also expand SET experiences to underrepresented audiences, potentially improving the diversity of America’s talent pipeline. The collaborative approach, which is a hallmark of OST programs, leverages the resources of both private and public sector partners in new and creative ways. The 4-H Science, Engineering and Technology Mission Mandate, and other OST initiatives like it, offer much in the way of promising practices and new approaches for impacting the SET capacity of America’s youth.
References


National 4-H Council works to advance the 4-H Youth Development movement, building a world in which youth and adults learn, grow, and work together as catalysts for positive change. National 4-H Council partners with the Cooperative Extension System of land-grant colleges and universities, National 4-H Headquarters at USDA, communities, and other organizations to provide technical support and training, develop curricula, create model programs, and promote positive youth development to fulfill its mission. National 4-H Council also manages the National 4-H Youth Conference Center, a full-service conference facility, and the National 4-H Supply Service, the authorized agent for items bearing the 4-H Name and Emblem. National 4-H Council is a non-profit 501(c)(3) organization. National 4-H Council is committed to a policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, sex, religion, religious creed, ancestry or national origin, age, veteran status, sexual orientation, marital status, disability, physical or mental disability. Mention or display of trademark, proprietary product, or firm in text or figures does not constitute an endorsement by National 4-H Council and does not imply approval to the exclusion of suitable products or firms.

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