STEM READY AMERICA

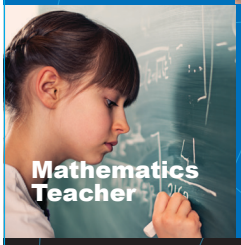
Inspiring and Preparing Students for Success With Afterschool and Summer Learning

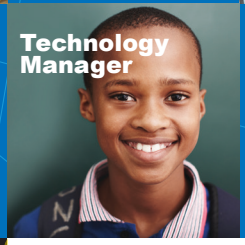
This collection of articles is excerpted from a new resource, *STEM Ready America: Inspiring and Preparing Students for Success with Afterschool and Summer Learning.* In this volume, Executive Editor Ron Ottinger and Contributing Editors Cary Sneider and Ian Hickox have collected expert perspectives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

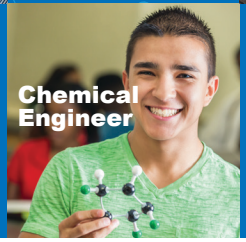
Collectively, these writings from more than 40 thought leaders highlight how young people are developing STEM knowledge and skills that will prepare them to be successful in school today and the workforce tomorrow.

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.

STEM READY AMERICA

Inspiring and Preparing Students for Success with Afterschool and Summer Learning

Evidence and examples on how young people are developing STEM knowledge and skills that will prepare them to be successful in school today and the workforce tomorrow.
www.STEMReadyAmerica.org

The Role of the NGSS in Supporting STEM Learning Beyond School Walls

Stephen Pruitt, Commissioner of Education, State of Kentucky
Cary Sneider, Portland State University

Ronald Ottinger, Executive Editor
STEM Next | Charles Stewart Mott Foundation

The Need for Quality

Kentucky strongly supports afterschool and summer programs. Our legislature has allocated $52 million for Family Resource and Youth Service Centers, which provide afterschool and summer learning opportunities. Approximately 15 percent of our children and youth participate in afterschool programs, including 17,000 annually whose attendance is supported by the U.S. Department of Education's 21st Century Community Learning Centers initiative, the only federal program dedicated to afterschool. Many more children would participate in afterschool and summer programs if we had the funding to support it (Afterschool Alliance, 2014).

As a state we are especially interested in programs that include high-quality STEM activities. Our state's Sector Strategy Plan calls for workforce development that focuses on five fields: (1) automobile and aircraft manufacturing; (2) transportation, distribution, and logistics; (3) business services and research and development; (4) health care; and (5) energy generation and transmission (Wright, 2011). Meeting our workforce demands means that many of today's youth will need to invest their time and energy in STEM fields. Analysts project that between 2014 and 2024 STEM jobs in our state will expand 19 percent, compared with 10 percent for non-STEM jobs (Change the Equation, 2015).

While schools certainly play an essential role, afterschool and summer programs are needed to ignite students' interest, leading both to an initial pursuit of STEM learning and then persistence in STEM as the educational path becomes steeper. Of course, workforce demand is only part of the story; all of our citizens need to be STEM literate to be able to make informed decisions and participate fully in modern society.

Meeting our workforce demands means that many of today's youth will need to invest their time and energy in STEM fields.

Kentucky is not the only state that is supporting afterschool and summer programs. At least 14 other states have either passed or are considering bills to support out-of-school learning (National Summer Learning Association). Additionally, the federal government provides more than $1 billion in aid to the states for afterschool programs. As a consequence of this increased funding, there is also increased scrutiny of program quality and outcomes. While it's only natural for stakeholders to want to see a "return on investment," the desire for tangible outcomes creates a dilemma for providers of afterschool and summer programs. In contrast to teachers, who are accustomed to the idea of measuring and reporting student progress, informal

educators tend to resist giving their students tests. Educators in afterschool and summer programs rightfully prioritize interest and engagement above cognitive gains.

This dilemma was recognized several years ago in a report by Gil Noam and Ashima Shah, *Game Changers and the Assessment Predicament in Afterschool Science* (2013). Since issuing that report, the researchers have undertaken a major effort to develop valid and reliable assessments that can be used, with minimal disruption, to measure outcomes of informal education programs, including STEM interest, engagement, and socioemotional skills. To date Noam, Shah, and their colleagues have collected data from nearly 70,000 children and youth, from grades 3 to 12, making it possible to determine the relative effects of different programs.

Although the work accomplished so far is admirable, we believe there is potential for informal educators to contribute even more to the quality of STEM learning opportunities, especially where informal educators are working closely with school teachers. We acknowledge that this work is not easy; after all, schoolteachers and informal educators have different goals. Teachers in schools must focus on the cognitive changes that are defined by their state's standards; while in the informal setting, interest and engagement typically take precedence over cognitive gains. Certainly educators in both settings strive to accomplish affective and cognitive outcomes, but there is clearly a difference in emphasis.

Using the Next Generation Science Standards as a Common Language Among Educators

How can informal educators help their students develop the cognitive capabilities that they need to do well in school, without giving up the essential qualities of the informal sector? We have a proposal. We believe that the Next Generation Science Standards (NGSS Lead States, 2013) can serve as a common language—a kind of "Rosetta Stone"—to help teachers and informal educators work together to modify informal education programs in ways that will help students develop capabilities that they need in school without compromising the fun and engaging focus of the out-of-school environment. But first we need to provide a brief description of the NGSS and explain why we think it is uniquely suited to this role.

The NGSS has been widely embraced by teachers, administrators, and state educational leaders since its release in April, 2013. In fact, the NGSS and the *Framework for K–12 Science Education* (National Research Council, 2012) are relevant to teaching and learning science in a majority of states, serving well over half of our nation's students. As of this writing, 17 states have formally adopted the NGSS as their official science standards, and several other states have modified them slightly to meet their own needs.

Unlike previous science standards, which specified what students should know after instruction, the NGSS describes what students should be *able to do* with what they know. There is a far greater focus on the student being able to explain biological phenomena or solve engineering problems. While "traditional content" is still needed and available, it is what students DO with that content that brings science into the 21st century.

The NGSS present a new way of thinking not only for our students but also for our teachers and the staff and volunteers of afterschool and summer programs. This new way of thinking will be different for most adults, making it more difficult to teach at first. Despite these difficulties, the NGSS should play a valuable role in afterschool and summer STEM programs. The reality is that students have a great opportunity to learn more about the world around them in an informal setting. Outside the more traditional classroom, students have greater opportunities to access phenomena and engineering due to the structure of OST programs. Informal education using the NGSS or the Framework not only provides a connection for students back to the classroom, it more importantly provides informal educators quality guidance as to what is important for scientific and engineering literacy.

Since the development and release of NGSS, it seems that more professional learning communities have developed both among formal educators and between formal and informal educators. The catalyst for this new way of thinking has been the development of STEM ecosystems. The ecosystem metaphor describes a movement in which communities are enriching STEM learning opportunities for children and youth by connecting the people who are responsible for their learning in school with those who have corresponding responsibilities outside the school walls. Fifteen such ecosystems were featured in Traphagen and Traill's (2014) monograph entitled "How Cross Sector Collaborations Are Advancing STEM Learning." The number of cities that have ecosystem teams, which consist of teachers from local schools and community organizations that run afterschool and summer programs, is growing. In 2015, the STEM Funders Network, a collaboration of philanthropic organizations that support STEM education, announced the selection of 37 cities—from a pool of more than 50 cities that expressed interest—that have committed to developing ecosystems.

Imagine an ecosystem team, consisting of a fifth grade teacher and a community educator that runs a summer program at a nature camp for rising fifth graders. The teacher knows that she will need to teach these students a certain number of performance expectations from the NGSS in the year ahead. Performance expectations are statements of what students should be able to accomplish, which bring together three dimensions of learning: a disciplinary core idea (DCI), a science and engineering practice (SEP), and a crosscutting concept (CCC). The ultimate goal of NGSS is for students to be able use these three dimensions to explain phenomena and solve problems. In short, a scientifically literate student should be able to think three dimensionally. For example, consider the following fifth grade performance expectation:

Students are able to support an argument that differences in the apparent brightness of the sun compared with other stars is due to their relative distances from Earth (NGSS Lead States, 2013).

Since the development and release of NGSS, it seems that more professional learning communities have developed both among formal educators and between formal and informal educators.

The DCI is that the sun is much brighter than the stars because it is much closer to us. The practice is the ability to argue from evidence, and the crosscutting concept is the idea of scale—that natural objects exist from the very small to the immensely large. In other words, students are expected to learn not only that the sun is a star but also to cite the evidence for that claim and to develop a deep understanding of the vast differences in sizes and distances of the stars.

Even if the community educator does not have any background in astronomy, she can still help prepare the students to achieve this performance expectation by helping the students develop their abilities to use the practice of arguing from evidence, and the crosscutting concept of scale. During their summer program, the students could observe animal behaviors, and then gather together to make and defend claims, based on visual evidence, about the various animals they've observed. In other activities, students could learn about the crosscutting concept of scale, noting the vastly different scales of animals from nearly invisible aphids to large mammals that are common in the nature camp. Helping students develop facility with these practices and crosscutting concepts could help them achieve the performance expectation about the sun and stars quoted above, as well as many others.

There are other ways that school teachers can help informal educators improve the quality of their instruction. For example, formative assessments are ways to determine how well students are learning so that the teacher can decide whether to expand the lesson or go on to a different lesson. Formative assessment requires clarity about what students are expected to learn as well as some activities that allow the formal or informal instructor to observe their capabilities. To be fair, developing three-dimensional assessments is a challenge because it tends to be in our nature to develop assessments that assess one dimension at a time. As stated in the Framework, research supports that three-dimensional instruction and assessment will result in more engaging learning that enables students to retain the material longer. That is all the more reason for this collaboration.

A key component of NGSS is that assessments are just part of the performance.

In the example mentioned above, simply observing the students in a discussion might be sufficient as a formative assessment. Or, after some instruction about the importance of supporting claims with evidence, the facilitator could offer a claim without supporting evidence and see how the students react. Would they agree just because an adult made the claim? Or will they demand evidence? The students would probably not see such an assessment as a "test," but it would provide an opportunity for the facilitator to determine how well the students have learned the lesson. In fact, a key component of NGSS is that assessments are just part of the performance. The stop, drop, and test approach needs to end in both the formal and informal environments.

School teachers can also learn much from collaborating with informal educators by seeing how students to acquire the practices of science and engineering and recognize crosscutting concepts in different fields. School teachers can also get new ideas for engaging students' interest and curiosity. We do not suggest that helping facilitators of afterschool and summer programs learn to teach practices of science and engineering and

crosscutting concepts will be easy. It's challenging for experienced science teachers to learn to think three dimensionally, let alone community educators who may have less experience teaching. However, this approach does get around the problem of the wide diversity of facilities, sites, and personnel in informal settings.

To test this idea, teams of formal and informal educators in five cities—Boston, Providence, Baltimore, Palm Springs, and Nashville—will be attempting this work over the next few months. With leadership from ExpandEd Schools, based in New York City, and support from STEM Next, the teams will choose one or two practices that they believe can be taught in existing afterschool or summer programs and develop assessments that will provide useful information to the educator, without subjecting the students to "tests" that would detract from the enjoyable experience of STEM activities. The assessments will not be used to grade or otherwise judge students. Instead, the results will provide useful information to the instructor, and in time may also be used to provide information to stakeholders, who have a right to know if they are getting a good "return on investment" of their tax dollars.

The Way Forward

Compared to students in many other states, Kentucky students are doing fairly well when it comes to STEM. On the 2015 NAEP Science assessment our students scored among the top 10 states. But our work is not finished, not by a long shot, and what remains to be done is not all about improving test scores. To paraphrase Dr. Martin Luther King, Jr., helping young people develop intelligence plus character represents the goal of true education. Good education in our schools is important, but so are the learning experiences students gain in afterschool and during the summer. Finding more ways—such as through the common language that NGSS can provide—to encourage partnership and collaboration among formal and informal educators, so that they can continue to prepare and inspire young people with STEM, will be key to our students' future success.

References

1. Afterschool Alliance. (2014). *America after 3PM: Afterschool programs in demand*. Retrieved from http://www.afterschoolalliance.org/documents/AA3PM-2014/AA3PM_National_Report.pdf
2. Change the Equation. (2015). Vital Signs: Kentucky. Retrieved from http://vitalsigns.changetheequation.org/state/kentucky/overview
3. National Research Council. (2012). *A framework for K–12 science education: Practices, crosscutting concepts and core Ideas*. Washington, DC: The National Academies Press. doi:10.17226/13165
4. Noam, G. G., & Shah, A. M. (2013). *Game changers and the assessment predicament in afterschool science*. Cambridge, MA: Program in Education, Afterschool, and Resiliency.
5. NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: The National Academies Press.
6. Traphagen, K., & Traill, S. (2014). How cross-sector collaborations are advancing STEM learning (Working Paper). Los Altos, CA: Noyce Foundation.
7. Wright, J. (2011, August 17) How Kentucky is transforming its workforce system through sector strategies. Retrieved from http://www.economicmodeling.com/2011/08/17/how-kentucky-is-transforming-its-workforce-system-through-sector-strategies

About the Authors

Stephen L. Pruitt, Ph.D. serves as Kentucky's sixth Commissioner of Education. Commissioner Pruitt came to Kentucky with an extensive background in education at the local, state and national levels, and currently serves on the Board of Directors for the national Council for Chief State School Officers. Pruitt started his education career as a high school chemistry teacher in Fayetteville and Tyrone, Georgia. He later served as senior vice president for Achieve, Inc., a national, nonpartisan, nonprofit education reform organization. During his tenure with Achieve, he was selected to help develop what became *A Framework for K–12 Science Education: Practices, Crosscutting Concepts and Core Ideas*. He was then tapped to lead the effort to implement the *Framework's* guidelines and create the Next Generation Science Standards (NGSS).

Cary Sneider, Ph.D. teaches courses in research methodology in a Masters of Science Teaching Degree program at the Center for Science Education. He also consults on diverse issues in STEM education, such as youth programs at science centers, educational standards, and assessment. He was team leader for engineering for both *A Framework for K-12 Science Education* and the Next Generation Science Standards. Until 2007 Dr. Sneider served as Vice President for Educator Programs at the Museum of Science in Boston, and prior to that he served as Director of Astronomy and Physics Education at the Lawrence Hall of Science at the University of California. Dr. Sneider currently serves as a consultant to STEM Next, formerly the Noyce Foundation.