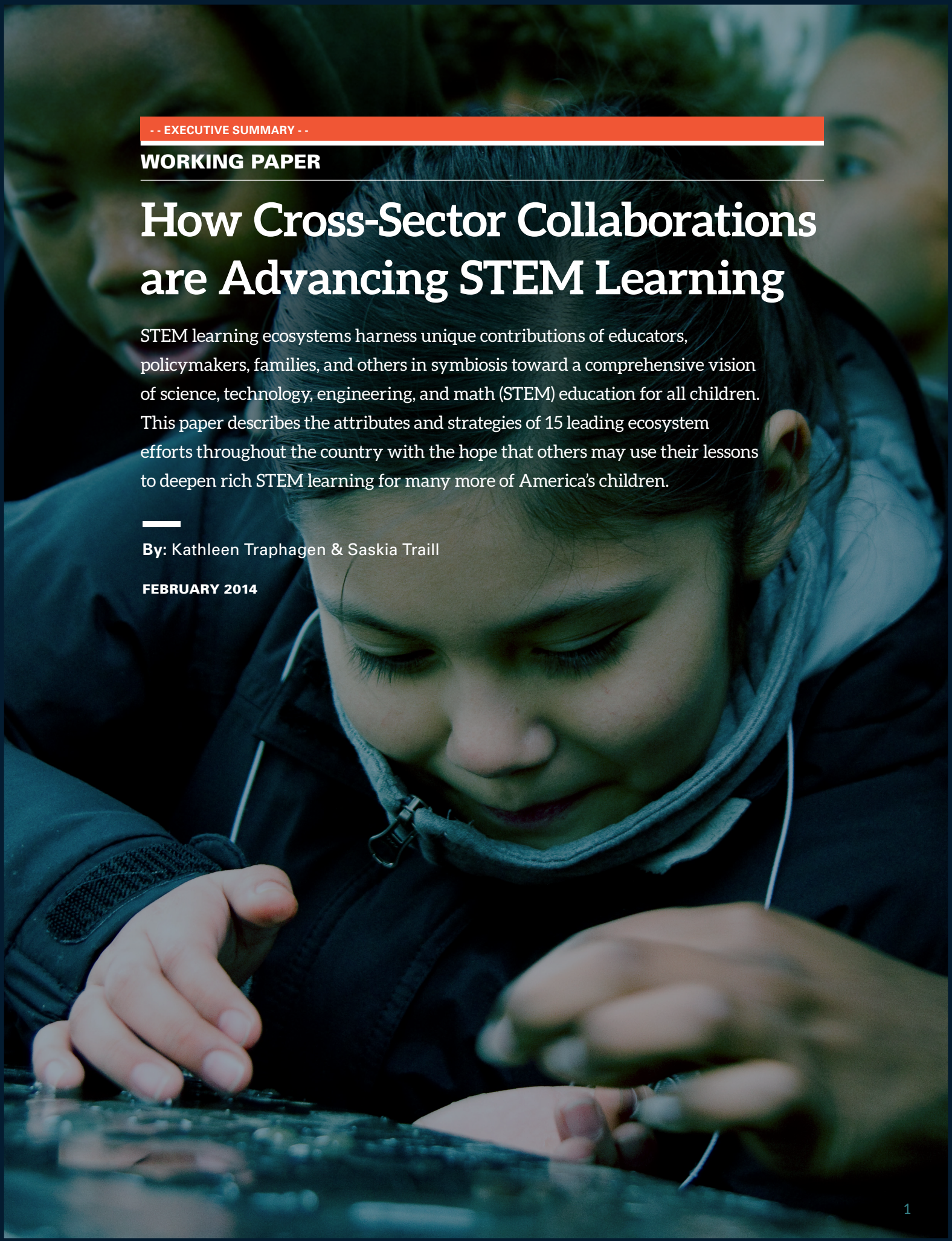


- - EXECUTIVE SUMMARY - -

WORKING PAPER

How Cross-Sector Collaborations are Advancing STEM Learning

STEM learning ecosystems harness unique contributions of educators, policymakers, families, and others in symbiosis toward a comprehensive vision of science, technology, engineering, and math (STEM) education for all children. This paper describes the attributes and strategies of 15 leading ecosystem efforts throughout the country with the hope that others may use their lessons to deepen rich STEM learning for many more of America's children.

By: Kathleen Traphagen & Saskia Traill

FEBRUARY 2014

Executive Summary

Introduction

Substantial energy is now focused on improving science, technology, engineering and math (STEM) education in the United States. Common Core and the Next Generation Science Standards are catalyzing reform of curricula, assessments and teacher professional development. Students also develop STEM skills and knowledge in many ways and multiple places outside of school – in afterschool and summer programs, at science centers and museums, at home with their families, and online.

Yet in most communities, cultural, logistical, financial and philosophical barriers divide educators and leaders from different STEM learning settings. In this paper, we examine an approach to STEM learning that may eventually overcome those barriers: the STEM learning ecosystem. The ecosystem metaphor, while not perfect, captures key concepts of this broader vision: diverse, individual actors interconnected in symbiotic relationships that are adaptive and evolve over time.

STEM Learning Ecosystems – A Definition

A STEM learning ecosystem encompasses schools, community settings such as after-school and summer programs, science centers and museums, and informal experiences at home and in a variety of environments that together constitute a rich array of learning opportunities for young people. A learning ecosystem harnesses the unique contributions of all these different settings in symbiosis to deliver STEM learning for all children. Designed pathways enable young people to become engaged, knowledgeable and skilled in the STEM disciplines as they progress through childhood into adolescence and early adulthood.

STEM learning ecosystems have the potential to:

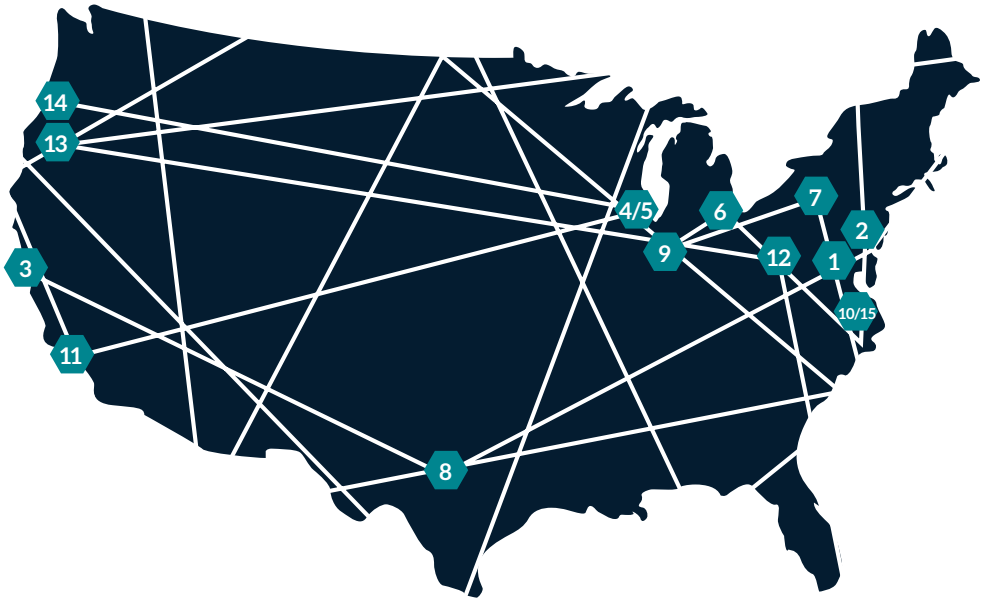
1	**Enable children's understanding of cross-cutting concepts to unfold and deepen in intentionally connected ways over time and across settings**
2	**Build children's scientific practice skills and knowledge through multiple exposures and experiences, including those in which children have the freedom to make and learn from mistakes as part of scientific tinkering and experimentation**
3	**Spark and nurture children's interest in and enthusiasm for STEM over time, by not only bringing science lessons to life in STEM-rich learning environments like museum exhibits, biology labs, recording studios, and marine research vessels, but also exposing children to STEM professionals and a variety of STEM career options**
4	**Ensure that children build complex skills, including how to exercise their own agency, solve real-world problems, build relationships with adults and peers, and test out their own leadership and teamwork capabilities as they experience STEM learning connected across different environments**
5	**Intentionally support those youth historically under-represented in STEM including girls, linguistic and racial minorities, and economically disadvantaged young people, to foster diverse and inter-connected STEM learning experiences**
6	**Increase understanding and build capacity among parents and caregivers to support their children's learning by ensuring they receive consistent messaging, guidance and resources from multiple, diverse learning settings**
7	**Implement creative and diverse methods of assessment, equipping young people with certifications, badges, portfolios or other proof points demonstrating mastery of skills and knowledge that are understood and respected in diverse environments**

Approach of this Study

Commissioned by the Noyce Foundation, this paper identified 15 burgeoning efforts that includes a cross-sector collaboration among formal K-12 education, after-school or summer programs, and/or some type of science-expert organization.

Our goal is to spark conversation, networking, and further research about learning ecosystems by a broad range of stakeholders in the STEM education sector.

Emerging STEM Learning Ecosystems Profiled in this Report



1. **AFTERZONE SUMMER SCHOLARS**
   Providence, RI
2. **BOSTON SUMMER LEARNING PROJECT**
   Boston, MA
3. **CALIFORNIA ACADEMY OF SCIENCES, SCIENCE ACTION CLUBS**
   San Francisco, CA
4. **CENTER FOR THE ADVANCEMENT OF SCIENCE EDUCATION, MUSEUM OF SCIENCE AND INDUSTRY**
   Chicago IL
5. **CHICAGO PRE-COLLEGE SCIENCE AND ENGINEERING PROGRAM**
   Chicago, IL
6. **DETROIT AREA PRE-COLLEGE SCIENCE AND ENGINEERING PROGRAM**
   Detroit, MI
7. **EXPANDED LEARNING NETWORK OF THE SOUTHERN TIER**
   Corning, NY
8. **GIRLSTART**
   Central Texas
9. **INDIANA AFTERSCHOOL STEM INITIATIVE**
   Indiana
10. **NEW YORK CITY STEM EDUCATORS ACADEMY**
    New York, NY
11. **ORANGE COUNTY STEM INITIATIVE**
    Orange County, CA
12. **SHINE (SCHOOLS AND HOMES IN EDUCATION) AFTERSCHOOL PROGRAM**
    Carbon and Schuylkill counties, PA
13. **SMILE (SCIENCE AND MATH INVESTIGATIVE LEARNING EXPERIENCES)**
    Oregon
14. **SYNERGIES**
    Portland, Oregon
15. **URBAN ADVANTAGE**
    New York, NY

Attributes of STEM Learning Ecosystems

STEM learning ecosystems are anchored by strong leaders and a collaborative vision and practice.

Ecosystem building requires at least one organization to be the community influencer and champion who can articulate, persuade and lead the charge. In some cases, ecosystem leaders are experienced system builders with a record of success guiding multi-sector education initiatives, but rely on others for STEM content and knowledge. Since the role of ecosystem driver is as much about creating the capacity for new ways of working as it is about understanding STEM learning, these more general system builders are bringing needed expertise to the challenge.

In many cases, we found the actual on-the-ground programming supporting such a vision is in the very early stages or at a small scale, but the long-term goals are much larger and integrative. Programming differs from more typical cross-sector transactions, with the organizations acting not so much as vendors but collaborators, setting mutual goals and developing aligned strategies to deliver on those goals.

The organizational leaders are confronting the challenges of cobbling together a coalition where the members have uneven power dynamics – schools have more resources, more stability and more credibility, while after-school providers have more flexibility but are often battling outdated perceptions that staff education or experience levels preclude "real" teaching. On the other hand, educators from the informal settings can bring their own preconceptions of the classroom environment as rigidly structured and unimaginative. Each sector also has its own terminology, creating barriers to shared understanding. In our interviews, we found organizational leaders strategically working through these challenges.

STEM learning ecosystems are attentive to the enlightened self-interest of all partners.

Coalition leaders pay attention to meeting the "enlightened self-interest" of their members, ensuring that their participation in ecosystem-building activities enables them to deepen their work toward their own organization's mission. A belief that all parties are committed to meeting their mutual goals and bringing money, talent and time to a shared table grows the effort and creates shared power. Many initiatives began their ecosystem transformation by working in alignment with a partner and are moving along a continuum of integration, through both natural evolution and deliberate efforts.

Collaborating organizations in STEM learning ecosystems are opportunistic and nimble.

Many of the initiatives have the capacity to be flexible and adjust their own plans to seek common ground. They are opportunistic, taking advantage of funding, political will, others' flexibility, and available resources to make progress. They have evolved somewhat organically rather than by following a predetermined work plan.

Strategies of STEM Learning Ecosystems

We asked initiative leaders to describe how they were approaching their work. We have identified six major strategies they are using to creating and connecting STEM-rich learning environments:

1. **Building the capacity of educators in all sectors, by tapping resources and expertise from STEM-expert institutions, schools, after-school/summer programs, and others.**
2. **Equipping educators from different settings with tools and structures to enable sustained planning and collaboration.**
3. **Linking in- and out-of-school STEM learning day by day.**
4. **Creating learning progressions for young people that connect and deepen STEM experiences over time.**
5. **Focusing curricula and instruction on inquiry, project-based learning and real-world connections to increase relevance for young people.**
6. **Implementing programs and public outreach to engage families and communities in understanding and supporting children's STEM success.**

Conclusion and Recommendations

This limited investigation into emerging STEM learning ecosystems in the U.S. uncovered tremendous activity, from urban centers to rural districts. Practitioners of all stripes are working to connect previously disparate settings in explicit ways that support STEM teaching and learning among educators, young people and their families. They have gone beyond binary, transactional arrangements, however they still face formidable challenges to moving toward the aspirational definition of STEM Learning Ecosystems offered in our introduction:

Challenges

1. **Accessing adequate, sustained funding.** Said Kenneth Hill of the Chicago Pre-College Science and Engineering Program, "The only reason we don't have 2000 children and parents yet [in our Saturday classes] is we need more money."
2. **Collecting data and assessing outcomes** in a comprehensive manner, across learning settings and over time.
3. Finding time and trust to successfully **navigate differences among formal and informal cultures**, including language and terminology, education and experience, accountability and vision.
4. **Successfully engaging families**, as efforts often fall short in attracting participation and assessing their impact is difficult.
5. Figuring out which organization or group of organizations is best positioned to **drive the ecosystem building effort**, and giving them the power to do so.
6. **Transitioning through leadership changes**, particularly in the formal education system, which can set back efforts.

In conclusion, we provide recommendations in the areas of practice, research and evaluation, and policy. These issues should be on the field's collective agenda, rather than faced by each initiative in isolation from others.

Recommendations

1 PRACTICE

1. **Get ready to scale by learning more about what works and what does not.** Public and private funders should help emerging STEM ecosystems better understand how to scale their efforts, including how to integrate strategies for scaling into their design.

2. **Create a community of practice for STEM learning ecosystems:** National stakeholders, including Achieve, Inc., the National Academy of Sciences, Afterschool Alliance, Association of Science-Technology Centers (ASTC), the National Science Teachers Association, the Council of State Science Supervisors, and Every Hour Counts should support an ongoing community of practice for emerging STEM ecosystems to share innovative and effective practices, address the challenges specified above, and help to develop and grow their efforts.

3. **Examine how STEM learning ecosystems can help realize the goals of Common Core mathematics, NGSS and the Framework for K-12 Science Education.** As the lead organization coordinating the development of the Next Generation Science Standards and the Common Core state standards, Achieve Inc. should integrate into its ongoing work an examination of the potential for STEM learning ecosystems to help realize the goals of Common Core mathematics, NGSS and the Framework for K-12 Science Education. This effort could focus on how interconnected STEM learning experiences provide a rich tapestry for teaching and learning cross -cutting concepts and scientific practices over the full developmental trajectory of preK-12.

2 RESEARCH & EVALUATION

1. **Learn how to assess learning outcomes across settings:** Although many of these initiatives are quite sophisticated in tracking outcomes of individual program components, none of them have developed a way to track the impact of all the interconnections they are building among STEM learning experiences.

   An important, related challenge is the imperative states now face to develop assessments for the new Next Generation Science Standards, which may spur formal educators and education policymakers to think in new ways about designing and implementing assessments. Those who see the value of what children and youth can learn in many different learning settings have an opportunity to help push the conversation and the vision beyond conventional parameters of what happens in the classroom.

2. **Disseminate relevant research more broadly and across sectors.** We recommend that researchers, practitioners, and public and private funders work to make relevant research more accessible across the broad array of stakeholders involved in STEM learning. We identified web resources that could encourage cross-sector dissemination of a common research base. None of our interviewees cited using these types of resources in developing their model. Broad dissemination of relevant research and existing resources could be part of the work of the learning community described above.

RESOURCES FOR CONNECTING RESEARCH AND PRACTICE

- Learning in Informal and Formal Environments (LIFE) Center, www.life-slc.org
- Relating Research to Practice, http://relatingresearchtopractice.org/
- The Center for Informal Learning and Schools, cils.exploratorium.edu
- Learning Activation Lab, www.activationlab.org

3. **Increase opportunities to connect research and practice across sectors.** We recommend that public and private funders encourage researchers and practitioners to develop collaborative agendas that span across informal and formal environments. Research agendas should build on the implementation and impact questions of both formal and informal learning. This collaborative approach to research and practice is a challenge within one STEM learning setting, so it will take extra effort to build research-and-practice models that address the entire STEM learning ecosystem.

3 POLICY

1. **Craft a policy agenda that identifies strategic levers at different levels to advance ecosystem building efforts.** The U.S. Department of Education, state education agencies, local school districts and private funders can encourage or require formal educators to partner with community organizations and STEM-rich cultural institutions. Public and private youth development funders can encourage or require community partners applying for youth development funds to address STEM and connections to formal education.

   Schools and school districts, youth development providers and science institutions can also proactively select people for leadership positions who understand the value of collaboration and possess collaborative skills and experience.

2. **Take better advantage of the flexibility embedded in existing policies.** Many funding streams offer more flexibility than is currently used in practice.

By separating recommendations into discrete areas, we do not mean to suggest that only some stakeholders should tackle any one of these recommendations. It will require a diverse range of stakeholders in each of these areas to make progress. Our hope is that the ideas of this report help spark the curiosity and imagination of all the stakeholders working to ensure that young people are engaged, inspired and prepared in the STEM disciplines as they develop into future scholars and leaders in our communities.

NOYCE FOUNDATION

To download this and other publications written or commissioned by the Noyce Foundation, visit *www.noycefdn.org*.

This report was commissioned by the Noyce Foundation and written by Kathleen Traphagen and Saskia Traill.

Acknowledgements

Our deepest thanks to the leaders and stakeholders of the 15 initiatives profiled in this study for giving freely of their time and sharing their stories with us, and to Ron Ottinger of the Noyce Foundation for his support, inspiration and guidance.

This report also benefitted from the comments and suggestions of Alan Friedman, Anita Krishnamurthi, Jay Labov, Jan Morrison, Ron Ottinger, Jennifer Peck, Sara Spiegel, Cary Sneider, Gerald Solomon, and Martin Storksdieck.

Author Bios

Kathleen Traphagen is an independent writer and strategist with expertise in education and youth development. Her client portfolio includes national networks of philanthropies focused on out-of-school time and STEM learning, and local networks focused on reading proficiency (Springfield, MA), and K-12 education (Boston). Kathleen has 20+ years of experience in the non-profit and governmental sectors. She served as Executive Director of the Boston 2:00-to-6:00 After-School Initiative and as Senior Policy Analyst for the Mayor's Office of Intergovernmental Relations. Kathleen holds an MBA from Northeastern and a BA from Carnegie Mellon.

Saskia Traill is the vice president of policy and research at TASC, a New York City-based organization redesigning learning opportunities for STEM and other disciplines. Saskia holds a Ph.D. from Stanford University and a BA from Columbia University. She leads research and policy efforts for TASC's ExpandED Schools, a reinvention of urban public schools that brings together all members of the school and community to expand the day and increase learning options for students, including the integration of formal and informal science learning. She has co-authored articles, policy briefs and reports on a range of issues, including engaging young people in STEM and how to fund innovative education strategies.

Designed By

MADEBYWE.ORG