



# Community STEM Collaborations that Support Children and Families

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## Authors' Note:

Over the past two years, our three organizations - the Afterschool Alliance, Space Science Institute/STAR Library Network, and Global Family Research Project - have partnered to present at a variety of national conferences around the power of creating connections among libraries, afterschool programs, and families to promote equitable STEM learning opportunities during out-of-school hours. We are often asked during our presentations what brings our three somewhat distinct organizations together, and inevitably we answer with the same idea; that creating pathways for STEM learning when school is out is critical to building educational equity and preparing children and families for a future that requires complex reasoning, creativity, and mental agility. In this paper, and the accompanying resource guide, we lay out the main ideas we have captured during these presentations in hopes that we will continue an ongoing conversation and partnership among families, librarians, and afterschool providers across the nation around the importance of STEM learning.



Global Family  
Research Project



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# Introduction: The Out-of-School Time STEM Ecology

Youth are natural scientists at birth, discovering and exploring their world and trying to make sense of it (Bers, 2008). A child's education is not limited to just the time they spend in the classroom. Children learn at home with their families, in public libraries, or through out-of-school-time (OST) experiences provided at community centers and in afterschool and summer learning programs, and even on vacations (Falk et al., 2010). In this paper, we endeavor to make the case that Science, Technology, Engineering, and Math (STEM) is an ideal subject area that can engage children with fun, active learning activities. It is also an important societal area around which parents, librarians, and OST providers can collaborate and complement the work of schools.

During the average school year, any given child in the United States will probably spend a little more than 1,200 hours in school. This may seem like a lot of time at first glance, but this only adds up to over twenty percent of any given child's waking hours. Given that we know that children are learning all the time, wherever they happen to be, this reveals how critical it is that our approach to educating children must include not just the structures, content, and relationships that children navigate within the confines of their schools, but must also reflect and integrate the things that they are learning – and can learn – across the wide array of other settings in which they can and do spend time. By accounting for the range of learning environments in which children spend their time, we begin to find that together these environments comprise a broader STEM Learning Ecosystem, which provides a valuable conceptual framework for how communities can nurture a healthy learning environment. This ecosystem comprises K-12 schools,

OST providers, higher education institutions (e.g., community colleges, universities), STEM-rich institutions (e.g. science museums), the business community, public libraries, and of course families. Strong ecosystems feature dynamic collaborations among these diverse organizations. Leveraging the experience of anchor institutions like public libraries and engaging families appropriately are key for improved STEM learning in communities of all sizes.

If we are to take advantage of the potential of all of the learning environments within which children spend their time, it is important to consider these environments and assess their positioning in the community, the educational opportunities they already offer, and how to most effectively align the educational opportunities that are available to youth. Beyond schools themselves, which environments and organizations are the easiest, most effective, and most efficient levers for improving learning outcomes? And furthermore, what content can be most seamlessly integrated across these settings?

Three groups that are both uniquely well-situated within the community and which offer tremendous – and complementary – opportunities for improving children's experiences and outcomes outside of the regular school day are library staff, OST providers, and the families of the children themselves. These three groups working in tandem bring with them innumerable opportunities for improving child learning, from access to STEM content and resources, to influence over how children spend their time, to what messages and information are imparted and reinforced in their day-to-day experiences.

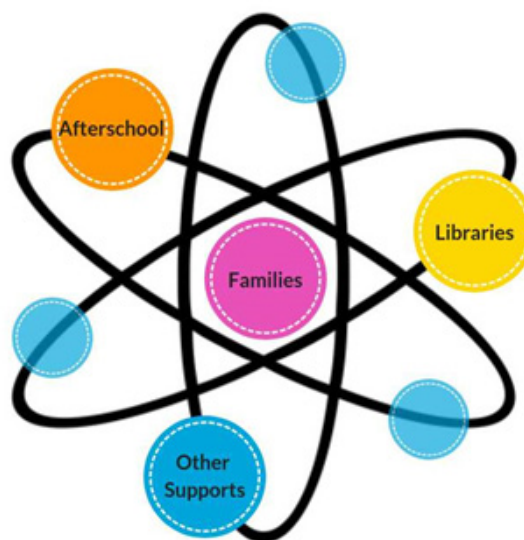
In our framing here, we approach STEM not just as a collection of the four different fields that make up its moniker, but also as a set of skills and a way of thinking that is genuinely valuable to the development of any young mind. It's not just about knowing how to solve a particular equation, or write a particular line of code, or identify a particular scientific phenomenon; it's a way of knowing what questions to ask and how to find the answers. At its core, STEM is a way of thinking, of being, and of learning.

In the words of Dr. Richard Larson, Director of the Center for Engineering Systems Fundamentals at the Massachusetts Institute of Technology:

*“A person has STEM literacy if she can understand the world around her in a logical way guided by the principles of scientific thought. A STEM-literate person can think for herself. She asks critical questions. She can form hypotheses and seek data to confirm or deny them. She sees the beauty and complexity in nature and seeks to understand. She sees the modern world that mankind has created and hopes to use her STEM-related skills and knowledge to improve it.” - Dr. Richard Larson, “STEM is for everyone”*

Regardless of whether a given young person is interested in going into a STEM-related field, there is a universality to the skills that fall within this broad STEM umbrella that makes them applicable to every child's life. Furthermore, we know from research that STEM skills benefit from being reinforced across different settings. This critical suite of skills will help children be better learners, better students, and better citizens.

## OST STEM Learning Ecosystem



In this paper we will break down three inter-dependent pieces of an OST STEM learning ecosystem for which we are advocating – public libraries, OST programs, and family interactions. Although we focus on these three contexts, we also acknowledge that there are many other critical and valuable contributors to an OST STEM learning ecology that expand and amplify one another's work including museums and science centers, early childhood programs, parks, and others. We will explore how librarians, afterschool providers, and families can join together to build pathways for children's STEM learning and success.

In this report we make a compelling case for libraries, OST providers, and families to collaborate with each other to improve children's access to high quality STEM learning experiences, and provide several examples of how both libraries and OST providers are already doing this work around the country. In addition to this report, we have developed a [curated list of valuable resources](http://www.starnetlibraries.org/stem-in-libraries/) to help inform library and OST providers to improve both children's access to high quality STEM programming and the effectiveness of the informal learning ecosystem through which those opportunities are made available. These resources are located at: <http://www.starnetlibraries.org/stem-in-libraries/>

# Critical Access to the Practice of STEM through OST and Library Programs

STEM fields and discoveries power our economy and drive our society. Within the education space, STEM is increasingly becoming an important part of the conversation when discussing how to prepare our children for the future (Charting a Course, 2018). However, understanding what STEM learning is and the benefits it provides goes beyond understanding STEM content. STEM learning instills a way of thinking about the world that helps children develop problem solving, collaboration, leadership, and communication skills.

Like languages, the best ways for children to learn these skills is through immersion. STEM learners benefit from regular opportunities to practice their skills and engage in hands-on opportunities that relate to their interests. While we typically think of STEM learning as something reserved for older children, building STEM skill fluency can start at any age, and early exposure is important for building children's confidence and life-long interest in STEM.

While many children engage with STEM subjects in school, the time outside of the normal school day is critical for STEM learning. Quality STEM programs ensure that programming reinforces content that youth are learning during the school-day. Both OST and library programs provide many children with much-needed exposure to STEM experiences outside of the traditional school day and provide valuable access to unique and impactful opportunities for STEM learning.

However, for these opportunities to have the greatest effect on youth, spark interest, and build those critical STEM skills, youth need access to an ecosystem of opportunities. Research tells us that the

frequency and amount of STEM programming is critical to both retaining children's interest in STEM fields and encouraging them to persist in their interest in the long run (Benbow et al., 2010; and Gorges et al., 2015). OST programs can substantially expand access to STEM learning by providing a consistent, structured environment in which they can pursue their interests and passions. Like OST programs, libraries also have a prominent role to play; libraries and often provide young people and their families with exposure to unique information, resources, and experiences that can both ignite their passions and expand their view of what doing STEM really is.

## Engaging Families in STEM: DC Public Library

The DC Public Library project has connected families to computational thinking and digital literacy activities through library-led family activities. Led by Children's Librarian Paula Langsam, the library set up a series of stations for families to participate in activities that connected to the different components of computational thinking. These included things like learning to tie a shoe and connecting that process to algorithms. Paula also developed a brochure for families that explains computational thinking, and made sure that the language in the brochure supported the reading skills and abilities of English language learners and non-proficient readers. You can read about Paula's work and the brochure for families is available too.



Children enjoying the Discover Tech exhibit. Credit: Ypsilanti District Library, Michigan

*“These are the kids who don’t make it to the library often. It’s great to get them in. Through this partnership, they got access.”  
- Ypsilanti District Library*

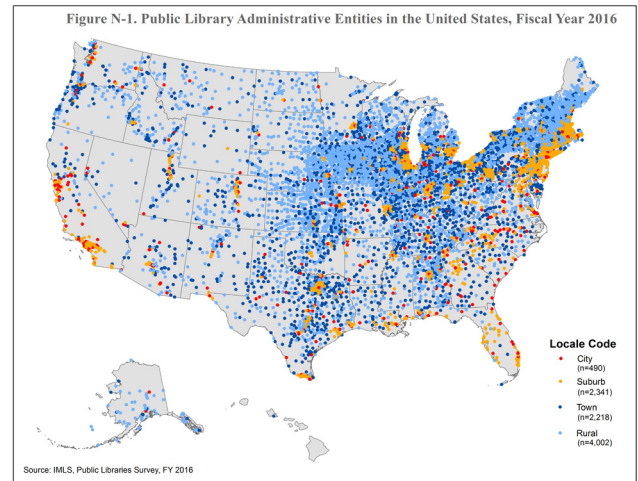
Afterschool and summer learning programs, libraries, and families can all play a major role in expanding access to STEM learning for all youth. In OST programs across the country, children are participating in citizen science initiatives, completing engineering challenges, coding their own websites and mobile applications, and more - learning

skills that will assist them through school, college, career, and life. Libraries offer access to not just a robust set of resources, but also to the expertise of youth service librarians. And the families of the youth themselves can be the most important factor of all, helping children see themselves how their interests in and passion for STEM can play out into their future goals for education and potentially even a career. STEM education depends on a diversity of opportunities and experiences that create an ecosystem of learning to practice and engage in STEM, and these three groups are perfectly situated to make up the connective tissue of that ecosystem.

# Public Libraries: An on-ramp for STEM Learning

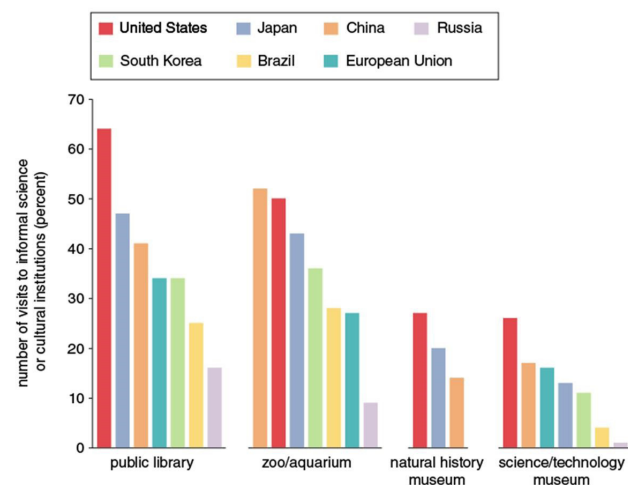
In a world where the focus on education often lies with schools and discussions of common core and other teaching strategies, it's easy to downplay the vital role that libraries can play when discussing places that reach families with meaningful STEM programming. To discount their importance, however, is arguably foolhardy: a large portion of the American public visit libraries on a regular basis – checking out books, participating in programming, and accessing library staff expertise. More Americans visit public libraries than any other informal learning institution. See figure below.

Knowing that visits are frequent, though, is only a small part of the picture. In addition to being venues that are seen as “safe” by the majority of the population, they also reach the majority of the population, especially rural communities and underserved populations. 77% of public libraries around the United States serve populations of less than 25,000 people. These communities rarely have access to other informal education venues, and libraries are often critical hubs for informal education in these areas (IMLS, 2018).



Credit: Institute of Museum and Library Services

Consistency of access to public libraries is also met by their capacity to provide all-too-uncommon services to underserved populations. Americans made 1.4 billion visits in 2016 to the nation's 16,000 public library locations. Ethnic minorities are very well represented in these visits: 72% Latinx individuals use their public library, as do 69% of African Americans (Pew Research Center, 2013).



Credit: American Scientist

But how does the public use these libraries? When the Space Science Institute's STAR Library Network (STAR Net) project initially surveyed libraries in 2008, many librarians did not feel comfortable conducting STEM programming, didn't know that exhibit opportunities were available to them (they were far more comfortable with history and literature subjects), and did not feel like they had received any instruction on how to implement a hands-on STEM program. A more recent survey in 2015 from Jim Hakala at the University of Colorado (Hakala et al., 2015) showed dramatic changes: only 14% of respondents did not offer STEM-rich learning experiences. 69% of respondents had



Family enjoying the 2017 Total Solar Eclipse.  
Credit: Eclipse Public Library Participant

conducted hands-on investigations, 51% had done art-based STEM projects, and 34% host informal STEM hubs known as makerspaces. Furthermore, 84% of respondents said that Science would interest the library staff and patrons. In just a decade, libraries around the country have significantly shifted - and continue shifting - their practice towards STEM, which should not be surprising, as libraries have responded to community interest and needs.

Libraries offer multiple entry points for collaborating with families and OST providers. They serve a variety of audiences: 57% provide focused STEM programming for a pre-K audience; 87% serve elementary-aged students; and 36% said they make concerted efforts to conduct whole family programming. These programs take a variety of formats and cover diverse topics in STEM, as well as the arts. *STAR Net's* online community of 8,000+ members describe their STEM programs, makerspaces, and collaborations through active blog contributions.

Overall, these different data points provide a clear picture of how libraries offer both broader and deeper STEM learning opportunities to their patrons than they were just a decade ago. While some misconceptions of the role of public libraries in the informal education space may persist, around the country there are thousands of librarians who have taken it upon themselves to ensure that their libraries have the resources, expertise, and programming required for their communities to compete in a 21st century world; one that is dominated by STEM needs and challenges.

### STEM as a Priority Area: Los Angeles Public Library

As a system, the Los Angeles Public Library considers STEM to be a core service area and offers a broad range of programming focused on engaging entire families in interactive STEAM (STEM + Arts) activities. Activities are generally designed for children ages 3 to 18, but the activities are typically very hands-on and the libraries actively invite entire families to take part in the programming. Most of these programs take the form of hands-on workshops, during which children learn about a concept - such as circuitry principles or structural engineering - and then provide the opportunity to either make something that has already been designed or that they design themselves. These workshops have included producing small robots and building structures that will remain secure during hurricanes or earthquakes. In order to maximize the impact of these efforts, the Library also partners with organizations like Girls Who Code to ensure that they maximize the programs' reach and capitalize on the expertise that already exists in the broader LA community.



# Afterschool and Summer Programs: Demand Outpaces Availability

More than 10.2 million youth around the country participated in afterschool programs according to the Afterschool Alliance's America After 3 PM report (2014). While that is a tremendous increase from the 6.5 million kids that were in afterschool programs just a decade earlier, it is also important to note that demand for afterschool programs has increased even more dramatically over the same period; today, for every child in an afterschool program, there are two children who are not in a program, but would participate if one were available & affordable.

Similarly, we know that 51% of families want their child to be enrolled in a summer learning program every year, yet only 33% of families had at least one child in a summer learning program in 2014, up from 25% just 5 years earlier. Yet again, access and affordability have proven to be notable obstacles. Summer learning programs can prove to be invaluable supports that help prevent summer learning loss and address the achievement gap between high- and low-income families (Polikoff, 2017; Alexander et al., 2007; Achievement Gap, 2019; and Augustine et al., 2011).

## OST STEM Programming: After School Matters

After School Matters in Chicago Illinois has partnered with Columbia College to offer their "Music in STEM" program, which gives teenage participants the unique opportunity to design and fabricate their own musical instruments, while also providing them a solid understanding of the mathematics and scientific concepts behind sound and music.

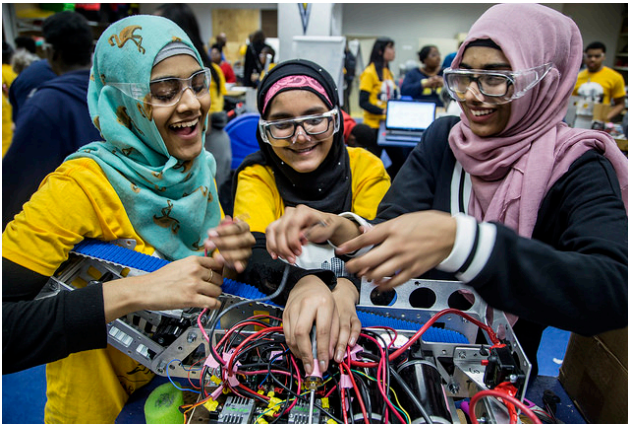


Megan Burton, STEM and Learning Supervisor and student at the Kitsap Regional Library. Credit: Afterschool Alliance

The reasons that demand has outpaced supply for OST programs, however, seems to be fairly straightforward: both the improvements in program quality from recent decades and the increasing number of children served by these programs every year have shown youth and parents around the country just how important these programs can be for young people.

Like libraries, OST programs have made a dramatic shift towards providing high quality STEM programming in recent years. According to the Afterschool Alliance's America After 3PM Full STEM Ahead Special Report, 69% of parents with a child in an afterschool program said that their child had access to STEM learning opportunities in the program, and, of those, 76% of parents said their child had access to STEM learning opportunities at least once per week.

We also know that demand for STEM programming in particular is driving some of the increase in demand for OST programs: 53% of parents surveyed - and 57% of low-income parents surveyed



Students at the Michigan Engineering Zone  
Credit: Afterschool Alliance

- agreed that STEM opportunities were important in selecting the program that their child would attend, although programs that served low-income populations were less likely to actually offer STEM programming.

We also know from the Afterschool Alliance's 2017 Library and Afterschool Partnerships Report that 74% of afterschool programs either are working with or have worked with public libraries before, showing that OST programs are already working to connect the youth and families that they serve to the formidable set of resources that libraries offer. It is important to note, however, that only 29% of the afterschool programs surveyed said that they were partnering around STEM activities in particular, revealing that there are still plenty of opportunities to increase the number of partnerships around this particular subject.

Given the sheer quantity of youth that already participate in OST programs around the country – and the fact that a significant majority of those programs are already offering STEM programming – it should be unsurprising that we consider out-of-school time program providers as having a unique leverage point within the ecology of STEM learning. These programs can help to connect youth and families to STEM resources at libraries, can help improve the consistency of access to library services and resources for families, and can help communicate to families just how important it is to ensure that their children have access to – and a support system built around – STEM learning opportunities.

## STEM Through Creative Design: Maker Mart

The Maker Mart in Roanoke, Virginia provides children with unique opportunities to explore STEM through hands-on experience with creative design and manufacturing. Led by Aaron Dysktra, an Air Force Veteran of the 94th Fighter Squadron who also has a wide array of experience with blacksmithing, woodworking, and bicycle frame construction, Maker Mart provides children with an opportunity to explore STEM through practical experiences with welding, woodworking, and rudimentary industrial design.

# Family Engagement: Crucial Support for STEM Learning

While schools, OST programs, and public libraries are important settings for children and youth to learn STEM skills, it's also important to keep in mind that families play a critical role in the STEM learning ecology, too.

Families support and reinforce STEM learning at home and in the community when they provide opportunities for children to engage in active, meaningful, joyful play and have engaging conversations about the world around them. Families instill confidence and a positive attitude in their children about STEM when they have high expectations for what they can do and accomplish. Families serve as connectors between their children and the multiple spaces where STEM learning occurs – linkages to spaces like libraries and OST programs. And families are often co-learners with their children, engaging in different STEM experiences with them, alternating between guiding learning and letting their children take the lead. When families are engaged in their children's STEM learning in these ways, youth enjoy stronger early STEM abilities, and are often more likely to take higher-level science and math courses, and consider STEM-focused careers (Caspé et al., 2018).



Students at MS. 358 in Jamaica, Queens.  
Credit: Afterschool Alliance

## Celebrating OST as a Family: Lights On Afterschool

Originally launched in October 2000, the Afterschool Alliance's Lights On Afterschool is the largest - and only nationwide - event celebrating afterschool programs and the important role that they play in the lives of children, families, and communities. Every October, more than one hundred thousand families organize and gather at Lights On Afterschool celebrations in all 50 states and the District of Columbia. Last year had youth, parents, and afterschool programs come together in communities across the country to plan parades, rallies, open houses, talent shows, family nights, and more!

How then might OST programs and libraries join together to create opportunities for families to expand on activities they naturally do with their children, learn new ideas and strategies, and be exposed to new tools and resources? One way is through processes called the 5Rs - Reaching out to families, Raising up their interests, Reinforcing their knowledge, helping families to build Relationships and networks with each other, and Reimagining services and programs (Caspé et al., 2018; and Weiss et al., 2016). When OST and library leaders convey the value of family engagement and support a climate of innovation with the 5Rs, it becomes possible to design exciting learning experiences for the whole family. This has the power to make STEM more equitable for children and families, to strengthen parent-child relationships, better connect school and out-of-school learning, and create avenues for youth voice and parent empowerment.

Below we describe the 5Rs and what they look like in practice.

OST programs and libraries are successful in engaging families in STEM learning when they reach out to all families, especially those who are often disproportionately underserved or represented. They break down stereotypes about which youth are “more likely” to have interests in STEM subjects or which families are “more likely” to attend, and take extra efforts to make sure their services are widely accessible. Reaching out might exist on a continuum ranging from OST programs and libraries working together to ensure sign-up opportunities and deadlines are widely known and programming flexible enough to suit families’ scheduling and other needs. It can also include having librarians and OST program staff talking with parents about what children do while in these out-of-school spaces, creating special family STEM nights to celebrate children’s successes, or offering opportunities for families and children to co-create together.

OST programs and libraries are also successful when they raise up family members’ experiences and knowledge related to STEM topics and co-create services and programs with them. The way families use math to solve problems, or cook, or build together can help children connect STEM to their everyday lives. OST program staff and librarians can learn about these family practices through focus groups, surveys, home visits, or other methods. For example, community dialogues are loosely facilitated discussions that provide opportunities for STEM education stakeholders and community leaders to discuss common community-based challenges and aspirations and dig deeper into what families hope to see in their children’s STEM learning. They can then use these family experiences, which might connect to cultural practices and parents’ own occupations, to join together with families to create programs that demonstrate how STEM skills apply to daily life as well as how they prepare young people for future careers (Holland et al., 2019). Project-based learning as well as family-service learning projects are another poten-

tial mechanism to bring families and communities together around co-created STEM concepts.

OST program staff and librarians in STEM-focused programs also make family engagement meaningful when they reinforce family members’ role in supporting their children’s learning. This can be done by encouraging activities such as block play in early childhood, setting high expectations for math achievement, and having a positive mindset toward STEM subjects and careers. It can also be achieved by creating co-learning opportunities where families learn from their children at the same time that children learn with their families; especially in using new technology and digital media like 3D printers or new apps for smartphones. OST program staff and librarians can further support home-school-community connections through “kits” that families can borrow to do at home or through events such as family science nights or workshops. Even if parents, grandparents, or other adults in the family have skills in the STEM fields, they might not naturally know how to break down this knowledge for children or communicate it in an engaging way. Informal STEM educators can help them make those connections and ultimately support these adults in being a “guide on the side” over the more traditional teaching role of “sage on the stage.”



A family works together to construct a model of our Solar System. Credit: Chelsea Public Library

Libraries and OST programs are most effective when they offer families opportunities to build relationships with each other that might not be able to take place in a typical school classroom or throughout families' busy daily lives. Through participation in hands-on STEM learning activities, parents not only strengthen their relationships with their children, but also develop connections with other families in a comfortable setting that is more focused on the joy of learning and not the pressure of whether students are meeting academic standards.

### **In Winter Darkness, Families Learn with Light: Homer Public Library**

The Homer Public Library (AK) has hosted a STEM-focused program on circuits and circuit-building skills, called Let It Glow! Helping families to construct light-up pop-up holiday cards, library staff modeled ways to support children's learning while empowering parents and other family members, who worked with their children to build a circuit. Families learned valuable lessons about persevering through failure, as well as how to build something as a family. Having the opportunity to meet other families in the community and to become more familiar with the library was an added bonus! Read more at: <https://medium.com/ideabook/in-winter-darkness-families-learn-with-light-ce21beb6f80d>

Makerspaces, for example, which many libraries today are now offering, engage children while also feeding adults' own curiosity about science and technology. These social connections often lead to other benefits. Having varied social networks promotes family well-being, especially among families living in poverty, and is linked to families feeling more self-confident and better able to provide home environments with greater cognitive stimulation.

Finally, OST programs and libraries can make a difference for families and children in STEM when they work together with schools and other community organizations to reimagine what learning looks like. These partnerships can increase families' access to information. Partnerships also allow organizations to combine resources, such as funding and personnel, and to pool expertise. For example, partnerships with different museums or scientific associations can ensure that STEM learning programs are connected to the latest scientific discoveries and innovations in technology.

By engaging the whole family in STEM learning, OST programs and libraries are filling the gaps that exist in the STEM workforce and setting youth on a pathway toward a STEM career that they might not have envisioned for themselves.

# Connecting the Dots: Building the Ecosystem from the Ground Up

Engaging in high-impact, strategic partnerships may sometimes seem like a daunting task, but thousands of OST programs and public libraries around the country are effectively engaging families and implementing high quality STEM programs for their communities every day. The focus of this report is to not just convey that each of these pieces is imbued with its own importance and leverage, but that coordinating our efforts within the broader ecology of learning is a no-brainer. What is needed is a consistent, sustainable STEM support system that will benefit all communities, large and small.

Like schools, libraries and OST programs often operate in silos, only communicating with each other when there is some transactional partnering to be done. We know that both libraries and OST programs are always trying - and sometimes succeeding - at engaging the families of the youth they serve. We know that libraries have difficulty with consistency of attendance at programming, and we know that OST programs are often strapped for time and resources. For any given library or pro-

gram, it can be difficult to juggle family engagement, library-OST partnerships, and STEM opportunities all at once, but the case we're making is that the costs of juggling all of these different pieces are a lot lower than the benefits to the youth we serve, and that all of these pieces are mutually reinforcing in truly substantial ways.

We know that tens of millions of young people around the country spend time in afterschool programs, summer learning programs, and libraries every year; we know that families are out there every day looking for the best opportunities for their children, provide the critical support structures that every young learner needs, and are often co-learning with their children; and we know that STEM learning opportunities both are more important than ever before and benefit greatly from reinforcement and repetition across learning environments. These three important components of a viable STEM Learning Ecosystem, when they operate in tandem, will pay lasting dividends and nurture the kind of communities that we all desire.

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