Partnerships to Transform STEM Learning

A Case Study of Tulsa, Oklahoma's Ecosystem

This document is a condensed version of the full case study. To read the full report, visit:
www.thepearinstitute.org/tulsa-case-study-full

Kristin M. Lewis-Warner, M.Ed.

Patricia J. Allen, Ph.D.

Gil G. Noam, Ed.D., Dr. Habil.

The PEAR Institute: Partnerships in Education and Resilience
McLean Hospital
Harvard Medical School

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How do STEM Ecosystems form and thrive?

STEM innovation is important to the growth of the U.S. economy and a skilled and talented workforce drives innovation. In recent years, as more and more professionals see the need to build STEM literacy in students, there have been multiple influential public and private sector collaborations designed to build STEM engagement, knowledge, and awareness and attract more young people to STEM. An innovative effort that aims to transform STEM education models through community partnerships is The STEM Learning Ecosystem (SLE) Community of Practice (CoP).

Launched by the STEM Funders Network in 2015, and organized by the Teaching Institute for Excellence in STEM (TIES), this national effort promotes local collaborations between community sectors to improve STEM teaching and provide quality STEM-rich learning experiences for all young people, their families, and the larger community (Traphagen & Traill, 2014).

As the SLE CoP is an established initiative entering its fifth year—with 68 communities across the world working to change STEM education models—it is time to explore in-depth how ecosystems put theory into action to transform STEM teaching and learning.

The development and enrichment of strategic partnerships through STEM learning ecosystems has been identified as one of the key pathways to success by the U.S. federal government in its latest five-year strategic plan for STEM education (National Science & Technology Council, 2018; Levy et. al., 2018). The present case study aims to explore how STEM ecosystems form, develop, evolve, and sustain over time. Evidence will be used for two purposes: (1) to identify key factors that contribute to the resilience and vulnerability of ecosystems to inform practice, and (2) to generate hypotheses that can be used to inform future studies on a larger scale.

This foundational work is necessary to understand whether SLE CoP strategies are effective in engaging children and youth in STEM learning and motivating more children and youth to persist through a pathway leading to a STEM career. We conducted one of the first SLE CoP case studies by focusing on the development and evolution of the Tulsa Regional STEM Alliance (TRSA)—the lead entity of the Tulsa, Oklahoma (OK) ecosystem—and its partners. As part of the study, we collected educational data, exit surveys, indicator tools, and conducted interviews, focus groups, document review, observations, and extensive online research.

Questions related to development and impact of the ecosystem framed the study, and a four-dimensional partnership typology was used to understand how collaborations formed to create, develop, and sustain the ecosystem and the STEM learning opportunities it provides to children and youth (Noam & Tillinger, 2004). Our inquiry was framed by the following questions:

- Why and how does a community come together to form an ecosystem?
- How are ecosystem aspirations transformed into action?
- How does an ecosystem measure the effectiveness of its efforts?
- What are indicators of ecosystem sustainability?

By focusing closely on one ecosystem, this study allowed for a comprehensive review of assets and resources, origin story and developmental trajectory, partnership stages, ecosystem theory in practice, program quality, youth experiences, opportunities and barriers, and indicators of sustainability, especially shared qualities and strategies that can provide a roadmap for others.

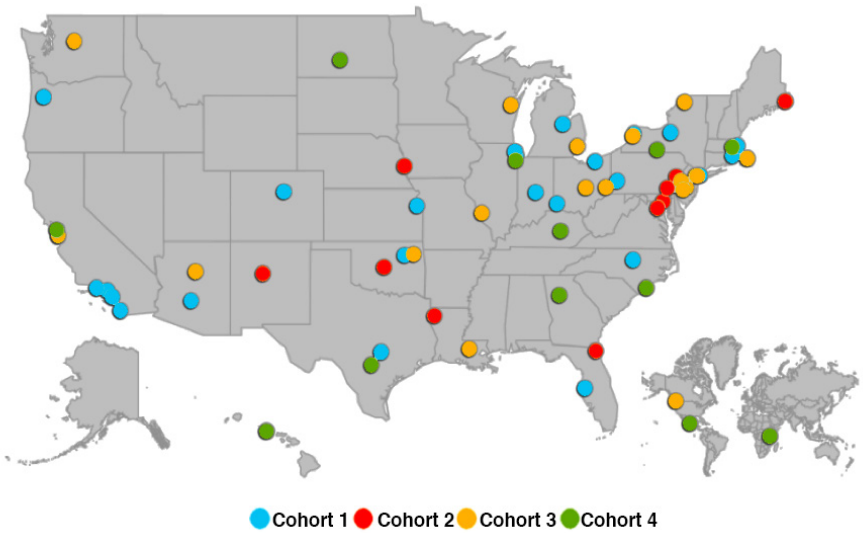


Figure 1. STEM Learning Ecosystems by Cohort (2015-2018)

Photo of downtown Tulsa by Jon Grogan on Unsplash

"In Oklahoma, we have both the oil and gas industry and the aeronautics and space industries who are huge consumers of STEM and STEM education, so I don't believe STEM will go away in Oklahoma."

– K-12 school district partner

Tulsa, Oklahoma at a Glance

- 2nd largest city in northeastern region of Oklahoma (population of Tulsa was 401,800 as of 2017).
- 1 in 5 Tulsans are living below the national poverty level.
- Oklahoma has the highest enrollment of Native American students in the nation.
- Native American tribes within the city of Tulsa include the Creek, Cherokee, and Osage.
- 694,816 students were enrolled in pre-kindergarten (pre-K) through 12th grade across Oklahoma in 2017.
- Almost 9 out of 10 people (87%) age 25 years or older graduated from high school or higher-level institutions across Oklahoma.
- 1 out of 3 people (31%) have obtained a bachelor's degree or higher.
- 1 in 10 Tulsa students in 8th grade (11%) scored proficient or higher in mathematics on the Oklahoma School Testing Program (OSTP) (compared to 1 in 5 for Oklahoma overall, 20%).
- 1 in 4 Tulsa students in 8th grade (25%) scored proficient or higher in science on the OSTP (compared to about 2 of 5 for Oklahoma overall, 39%).
- STEM jobs are projected to grow between 6% to 13% between 2016 and 2026 in Oklahoma.

Data Sources: U.S. Census, 2018; Southwest Educational Development Laboratory, 2018; Oklahoma State Department of Education, 2018; Oklahoma Employment Security Commission & Economic Research and Analysis Division, 2017

Oklahoma is home to a wide variety of STEM-related businesses and industries, including oil, natural gas, energy, aerospace, and manufacturing, but aerospace is the largest sector. Tulsa City, the principal municipality of the greater Tulsa metropolitan area, serves as an influential base for various local industries in the state, including but not limited to aerospace, manufacturing, oil and natural resources, and telecommunication. Many STEM-related businesses, including NORDAM, Cimarex Energy, ERB, ONE Gas, ONEOK, Cox Media Group, Oklahoma Energy Resource Board, and Williams are actively collaborating with the TRSA, providing financial and resource supports and co-organizing events to create and sustain local STEM education programs for children and youth in Tulsa County.

The Tulsa Regional STEM Alliance (TRSA)

The Tulsa Regional STEM Alliance (TRSA) is an intermediary organization (a self-described "dynamic mesh network") based in Tulsa, OK that serves as an "...advocate for STEM teaching and learning to ensure that education policy initiatives on a local, state, and federal level appropriately identify the needs and deploy vital resources responsibly and effectively to ensure every student has access to the best possible STEM education." (Tulsa Regional STEM Alliance, 2019)

The TRSA began as a formal alliance in 2013 thanks to the hard work of a large and inclusive group of organizations, a highly charismatic and energetic leader, and a motivated funder, who together successfully designed and produced a blueprint for the STEM learning community with help of expert consultants in the field.

The organization, which leads the community from the afterschool sector, has four goals ("the four C's"): to *calculate* (i.e., to use common performance metrics to measure the efficacy of TRSA programs and events), *communicate* (i.e., to increase awareness and access to STEM resources and activities through centralized information sharing), *collaborate* (i.e., to use shared resources to broaden impact), and *cultivate* (i.e., to grow the ecosystem with STEM education events and activities and to secure resources necessary to sustain the ecosystem's activities).

The TRSA provides training and professional development opportunities for STEM educators, collaborates with other organizations (inside and outside the afterschool sector) to implement STEM-related programs and events, and designs and delivers STEM programming to children and adolescents. They attend staff meetings regularly with the district STEM coordinators, teachers, and principals from various schools to reflect on strengths and challenges, to identify gaps, to action plan, and to offer support where needed.

". . . all sectors, from community, government, K-12, funders, business [came together], and the topic was what was going on in STEM in our area, what needs to be going on, what can we do that doesn't duplicate other efforts."

(TRSA Strategy Plan, 2013)

Image used with permission from the TRSA.

The STEM Learning Ecosystems (SLE) Community of Practice (CoP)

To reconcile the many divides among the different sectors at the center of a national STEM reformation, a new and inclusive approach to STEM education, known as The STEM Learning Ecosystems (SLE) Community of Practice (CoP), was developed and implemented on a national scale (Traphagen & Traill, 2014).

The SLE CoP model promotes local collaborations between school districts, businesses, cultural institutions, research organizations, youth-serving organizations, and funders to provide quality STEM teaching and learning experiences to benefit all young people, their families, and the larger community (Figure 2). The mission of the SLE CoP is to "spark young people's engagement, develop their knowledge, strengthen their persistence and nurture their sense of identity and belonging in STEM disciplines."

The SLE CoP framework encompasses four strategies (Table 1). All ecosystems are also provided with ten design principles that align to the framework (Traill, Traphagen, & Devaney, 2015). Principles include focusing on cultivating dynamic partnerships between diverse stakeholders, experimenting with new and creative means of partnering across sectors, and increasing the quantity and quality of active, inquiry-based STEM learning opportunities for all young people (including youth historically underserved or underrepresented in STEM). Individual ecosystems are encouraged to adapt the strategies in ways that best suit the community—taking into consideration the various sectors and unique political, social, economic, educational, and cultural contexts.

Figure 2. STEM Learning Ecosystems Model

Table 1. SLE CoP Strategies (STEM Learning Ecosystems, 2018)

Strategies	Definition	Examples of Actions
1. **Cultivating cross-sector partnerships**	Assess gaps, identify partners, and determine collective goals based on each community's needs, assets, and interests.	Identifying a lead organization, engaging a broad range of stakeholders from key sectors, assessing the community's readiness to collaborate, and defining the landscape and potential gaps.
2. **Creating and connecting STEM-rich learning environments**	Ensure STEM learning opportunities are high-quality, universally accessible, youth-centered, and connected so learners can deepen their skills and interests and tackle increasingly complex challenges.	Aligning with reputable and vetted national standards, connecting in and out-of-school STEM learning, and employing evidence-based strategies to promote successful STEM learning for all students, especially those traditionally underserved.
3. **Equipping educators**	Build educators' capacity through high-quality relevant professional development, cross-sector experiences, and sharing effective practices.	Designing and implementing high-quality trainings, connecting educators with private/public sector STEM employees and developing approaches to continuous improvement (e.g., data sharing to increase quality).
4. **Supporting youth pathways**	Enable young people to become engaged, knowledgeable, and skilled in the STEM disciplines as they progress from childhood into early adulthood.	Connecting young people to STEM mentors, teach about the range of STEM careers and opportunities starting at an early age, and create new credential models (badging, certifications, etc.).

Who participated in the case study?

The present case study employs a mixed-methods approach (using qualitative and quantitative methods) to understand how the Tulsa, Oklahoma community and their lead organization, the TRSA, uses the SLE CoP network and how it can transform STEM learning models using SLE CoP principles. Multiple data sources were used to build evidence for the case, including the ecosystem design blueprint; the SLE CoP membership application; one focus group and 15 individual interviews with key ecosystem stakeholders; 10 exit surveys following interviews; 37 observations using the Dimensions of Success (DoS) STEM program quality observation tool; 7,713 afterschool/summer youth surveys using the Common Instrument Suite for Students (CIS-S), and 30 afterschool/summer educator surveys using the Common Instrument Suite for Educators (CIS-E).

About the Measures

- **Dimensions of Success (DoS)** is an observation tool designed by The PEAR Institute to assess levels of quality of informal STEM activities (Shah, Wylie, Gitomer, & Noam, 2018, Peabody et al., under review). The tool is evidence-based and captures 12 dimensions of STEM program quality along four organizing domains. Rigorous training and certification provided by The PEAR Institute are required to perform DoS observations. All programs supported by the TRSA have the opportunity to participate in training to support their data collection and continuous improvement efforts. For more on DoS, visit: www.thepearinstitute.org/dimensions-of-success

- **Common Instrument Suite for Students (CIS-S)** a student self-report measure of five STEM attitudes predictive of future STEM participation (e.g., STEM engagement and career interest) and four 21st-century skills (e.g., critical thinking and perseverance) developed by The PEAR Institute (Allen, Noam, & Little, 2017; Little et al., in press; Malti, Zuffianò, & Noam, 2017; Martinez, Linkow, Velez, & DeLisi, 2014; Noam, Allen, Sonnert, & Sadler, in preparation; Noam, Malti, & Guhn, 2012). All programs supported by the TRSA have the opportunity to participate in CIS-S data collection. For more on the CIS-S, visit: www.thepearinstitute.org/common-instrument-suite

- **Common Instrument Suite for Educators (CIS-E)** an assessment for informal STEM educators that was designed by The PEAR Institute to complement the CIS-S and DoS. The CIS-E contains questions about the training and professional development that afterschool STEM educators received to lead informal STEM, the training and professional development that they would like to receive in the future, their interest and ability and confidence levels for leading STEM, and their feelings about how they have impacted their students' proficiency and confidence in math, science, and social skills. Like the DoS and the CIS-S, all programs supported by the TRSA have the opportunity to participate in CIS-E data collection.

- **STEM Learning Ecosystem (SLE) Indicator Tool** an ecosystem self-report survey developed by TIES to measure ecosystem progress in five domains that align with the SLE CoP strategies and design principles: (1) cross-sector partnerships, (2) architectural and organizational features required for sustainability, (3) alignment of learning inside and outside of school with evaluation to ensure quality and impact, (4) equipping educators with tools and training to maximize benefit, and (5) college and career readiness and development of articulated career pathways. For more on TIES' tools and services visit: www.tiesteach.org

DoS, CIS-S, and CIS-E are part of the data collection and reporting platform created by The PEAR Institute. The automated platform produces an online dashboard with living, actionable data shortly after collection is completed that evaluators and practitioners can use to improve their programs and share with funders. This data reporting system also enables users to make comparisons with a national data set, so program leaders can determine how well their programs compare with afterschool and summer programs nationwide.

How did the TRSA put the SLE CoP strategies into action?

Archival documents, interviews, focus groups, and exit surveys provided evidence for how the TRSA has been putting national SLE CoP theory into action based on the four SLE CoP strategies:

1. Establish and sustain cross-sector partnerships

As of 2018, the TRSA is collaborating with more than 140 local STEM partners and is continuously working to establish new partnerships. Of the 40 events that the TRSA organized in 2018, which have grown in number over the years, one out of two (52.5%) involved the participation of partners representing four or more sectors, and two out of three (67.5%) involved partners from three or more sectors.

". . . I hesitate to think where we would be as a city without the TRSA. They have been a major player in making connections across informal and formal education."

– K-12 school district partner

2. Create and connect STEM-rich learning environments in diverse settings

There is evidence that the TRSA has been working to increase diversity in two areas: learning environments and populations served. Ecosystem partners participating in interviews identified various settings in which the TRSA is successfully hosting programming and promoting STEM learning opportunities in different locations around the city and the county. The TRSA has been scaling their efforts to reach all children and youth across Tulsa community, especially low-income youth, youth of color, and youth with special needs.

"We simply don't have enough supply as in resources, manpower, and time, and transportation to get to all these different places and provide the resources we need to. So, we work through that by offering different avenues. We have a lot of virtual space . . . [that] provides ways to engage various diverse populations that we wouldn't engage otherwise."

– TRSA staff member

3. Equip educators to lead active learning in diverse settings

Working with TIES and the Tulsa Public Schools, the TRSA helped to identify and implement STEM priorities in the public schools including:

1. Piloting grade level STEM experiences and lessons that promoted partnerships with area STEM organizations.
2. Leading STEM practitioner professional development opportunities (two cohorts, one per year, where teachers worked on developing inquiry and problem-based pedagogy).
3. Offering STEM in out-of-school time settings (e.g., STEM clubs, events and competitions).

Records from these interventions showed that 1,432 students, 41 teachers, 59 classrooms, and 27 schools from various districts in Tulsa were engaged in these efforts. In addition, TIES, in partnership with the TRSA, spent substantial time assisting Union Public Schools in their design process and integration of STEM into school curriculum.

This partnership resulted in STEM being deeply embedded throughout the district, including the offering of more STEM programming, the integration of Project Lead the Way coursework, and the hiring of a new STEM coordinator for program oversight and integration. The innovative work of the Union Public Schools made national headlines in reputable newspapers (Kirp, 2017; Thompson, 2017), and the current focus is on connecting the work of school districts to out-of-school time programming.

"So I often say one of my best moments at [TRSA] was, in one of the first couple months with the organization, sitting down at a table and having all of the local school districts at the same table . . . talking about maybe there are ways to collaborate . . . I just have never seen in another city the openness and willing to connect to other people beyond their district, that was fabulous."

– TRSA staff member

4. Support youth to access pathways and exploration to further learning and STEM careers

To foster STEM interest and workforce development, the TRSA has established many programs and events, in partnership with area businesses and industry, designed to support youth access to pathways that lead to further learning and careers in the field. Examples include:

- **Engineering Signing:** High school students are provided with the opportunity to network with engineers in the community.
- **The Engineer Games Scissortail:** High school students compete to design, build, and solve engineering challenges alongside STEM professionals who help guide and mentor students through the challenges.
- **Mentorships:** Professionals work regularly with students to form meaningful relationships, positive influences, and encouragement and guidance to pursue STEM careers.
- **"STEM Cafes":** STEM experts visit various schools to discuss their areas of expertise.
- **Sonia Kovalevsky Day:** An "all girls, all math, all day" event where company employees are engaged in making STEM meaningful for over 300 middle and high schools girls and their teachers.
- **Visits to local businesses:** Students learn more about STEM, and professionals coming to schools to educate students about local industry and STEM.

". . . when those students are 30 years old, they might not remember the person by name, but they will remember they had a [Me and My Math] mentor who helped them with factoring and played dominoes with them every week and helped them count forward and backwards. Those students are walking away with more confidence, and that is tremendous to me . . ."

– Business and industry partner

What did we learn about outcomes?

TRSA Outcomes

Quantitative data show significant growth in STEM engagement in Tulsa led by the TRSA—with increasing numbers of youth participating in events, programs, and camps (177,858 in 2017; 194,914 in 2018), educators participating in professional development offerings (1,232 in 2017; 1,310 in 2018), and STEM professionals participating in mentoring opportunities (229 in 2017; 301 in 2018). Based on these values, it is estimated that the TRSA will serve more than 250,000 children and youth within Tulsa County and beyond by 2020.

This forecast is based on levels of "student impact" documented and reported by the TRSA between 2013 and 2018, which includes direct student engagement at programs, events, camps, and mentoring opportunities as well as indirect student engagement through professional development, Tulsa Resource Area for STEM Educators (TRASE), and grants. Note that these values do not represent unique cases, as the TRSA may serve youth (directly or indirectly) multiple times per year (Figure 3).

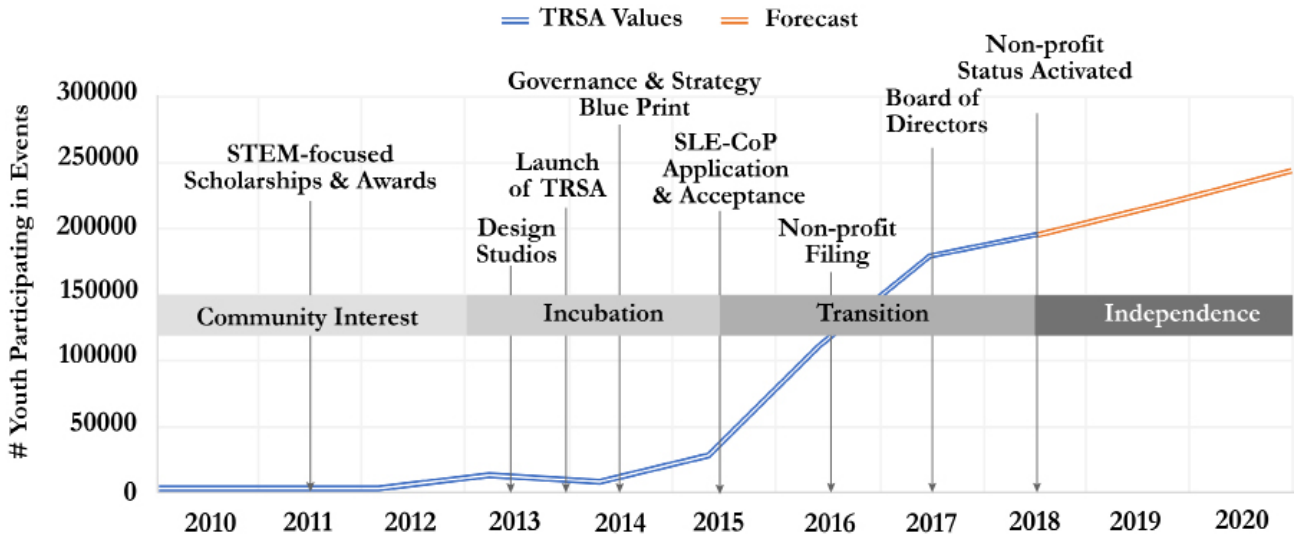


Figure 3. TRSA and Youth STEM Engagement Forecast

Student Outcomes

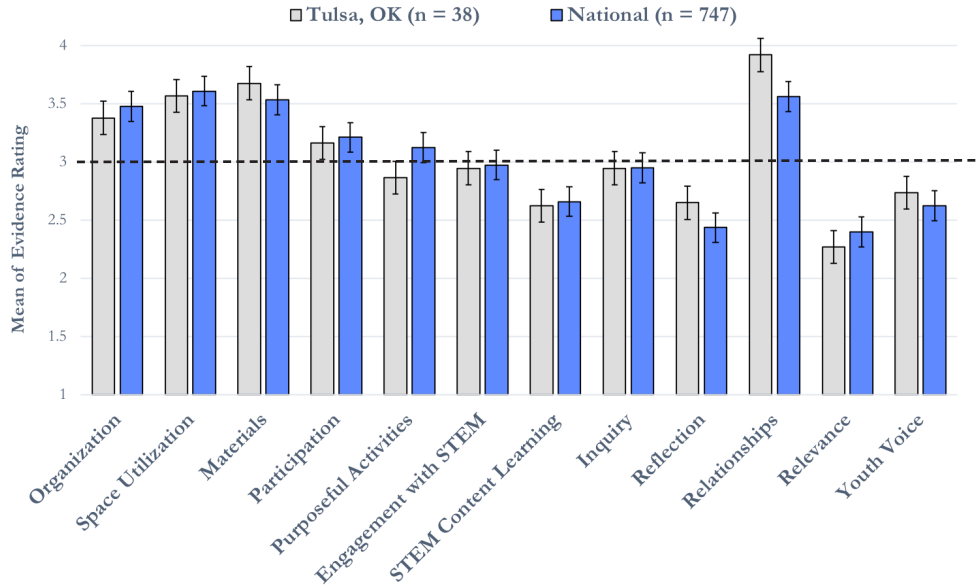
Quantitative data demonstrated positive changes among youth participating in TRSA-supported programming. Aggregated survey results from PEAR's Common Instrument Suite-Student (CIS-S) for programs supported by the TRSA from 2016-2018 showed that, at the end of programming, Tulsa youth reported significantly more growth in all STEM-related attitudes and 21st-century skills measured (except STEM activity participation) relative to peers participating in similar out-of-school time programming across the U.S. (national standardization sample). They also began their programs with significantly higher ratings for all four 21st-century skills (critical thinking, perseverance, relationships with peers, and relationships with adults) and STEM engagement, career interest and knowledge, and identity. Overall for 2016-2018, more than 80 percent of youth reported positive changes in STEM engagement, critical thinking, perseverance, relationships with peers, and relationships with adults.

Program Quality Outcomes

Tulsa's ecosystem has made significant investments to ensure youth are participating in quality programming. Starting in 2015, and now in its fourth year of implementation, the TRSA adopted a widely-used, evidence-based framework known as the Dimensions of Success developed by The PEAR Institute (DoS; Shah et al., 2018).

DoS provides a common definition of high-quality practices for informal STEM activities based on broad categories of impact outlined in a National Science Foundation workshop report entitled Framework for Evaluating Impacts of Informal Science Education Projects (Friedman, 2008) as well as the six-strand framework put forth by the National Research Council (2009).

A total of 38 DoS observations were performed in TRSA-supported programs between 2016 and 2018. Figure 4 displays average ratings of STEM program quality for TRSA-supported programs relative to similar STEM programs across the U.S. Results showed that at least four out of every five STEM activities were observed to have reasonable to compelling evidence of quality for several dimensions, including organization (86%), materials (84%), space utilization (89%), inquiry (81%), and relationships (100%). Additionally, at least two out of every three STEM activities were observed to have reasonable to compelling evidence for participation (76%) and purposeful activities (68%).



Strength of Evidence: 1 = Absent, 2 = Inconsistent, 3 = Reasonable, 4 = Compelling

Figure 4. Average Ratings of STEM Program Quality Measured using the Dimensions of Success (DoS) Observation Tool from 2016 to 2018

Levels of quality improved for three dimensions over two years, including organization, participation, and relevance; however, there were different programs participating each year. Evidence indicates that young people participating in high quality afterschool STEM programming are more likely to report positive change in STEM-related attitudes like engagement and career interest than those participating in lower quality programming (Allen, Noam, & Little, 2017).

"... the DoS tool really is a good fit for what we're trying to do in the afterschool setting because it combines science with the 21st-century skills ... It is a good fit for us and has provided us with a common language and a common tool across sites to show our educators this is what we're going for and to talk about the different pieces. It's been incredibly helpful to us and will continue to be so, especially as we continue to train more DoS observers."

– TRSA leadership

What did we learn about partnerships?

The Partnership Typology

To explore how different community sectors join within an ecosystem to transform STEM education models, we used a four-dimensional typology designed to study partnerships between institutions and organizations (Noam & Tillinger, 2004). The advantage of this framework is that it can be used to inform strategies that promote healthy and productive environments and sustainable relationships, which we hypothesize will improve and expand STEM learning opportunities for children and youth (Figure 5).

- *Opportunity-based partnerships:* Members maintain their autonomy. Collaboration with other organizations is seen as functional for networking and sharing knowledge and resources.
- *Collaborative partnerships:* Participants develop common goals, mutually benefiting from one another's strengths and experiences, and establish a level of accountability.
- *Interconnected partnerships:* Members develop equal voices, there is clear communication, a level of intimacy, joint decision-making, shared programming and celebration of accomplishments.
- *Transformational partnerships:* Hierarchy is discouraged, instead equality and an intermediary environment is promoted with members accomplishing more together than independently.

The guiding hypothesis for this study is that ecosystems benefit children and youth by developing strong partnerships within and between sectors, improving quantity and quality of STEM-rich learning opportunities, and promoting inclusiveness and diversity in STEM teaching and learning.

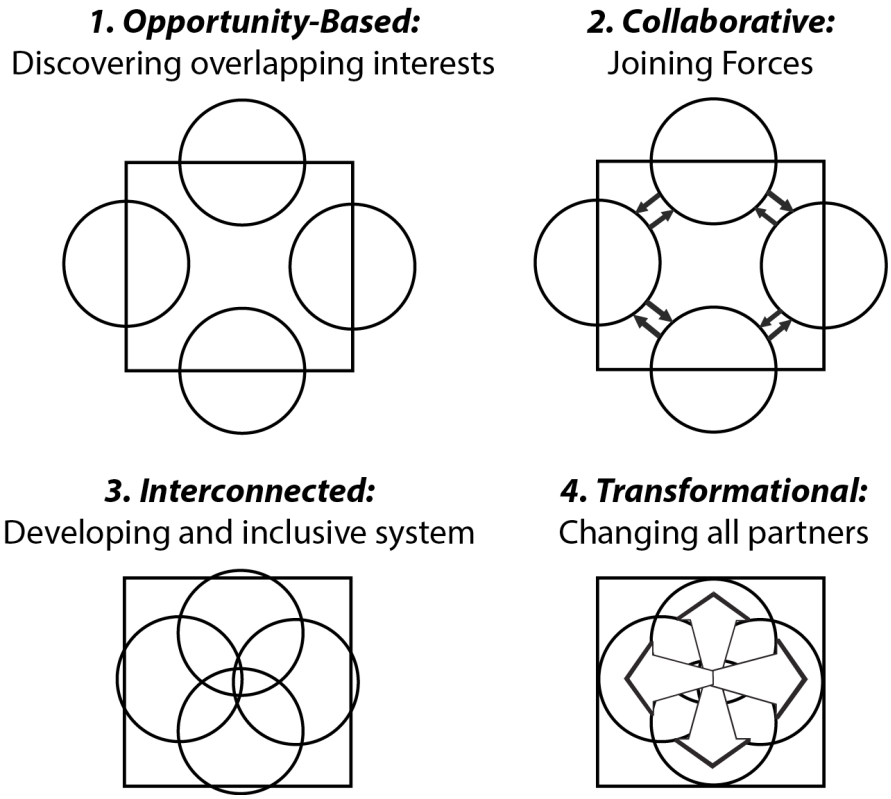


Figure 5. Partnership Typology

Applying the Typology to TRSA

It is clear from the number and quality of activities and events conducted by the TRSA that its work relies on partnerships. Analysis of partnership typology, based on interviews (n = 15) and exit surveys (n = 10), shows that the out-of-school time (OST) sector (including afterschool and summer programs, science centers and museums) has developed strong collaborative partnerships, with increasing signs of interconnectedness. Considering the ecosystem as a whole, most exit survey respondents reported that they know each other well, do not compete against one another, agree on common goals, share information in a transparent way, integrate activities with a joint mission, share resources or costs to help each other, defend one another from criticism, agree about strategic direction, attend events to celebrate shared accomplishments, and believe they accomplish more together than alone.

"Paying careful attention to the ways various STEM community members are engaging, and further could fall short, TRSA has set maintaining mutually beneficial and respectful relationships with all partners as a golden rule for the Alliance."

– TRSA leadership

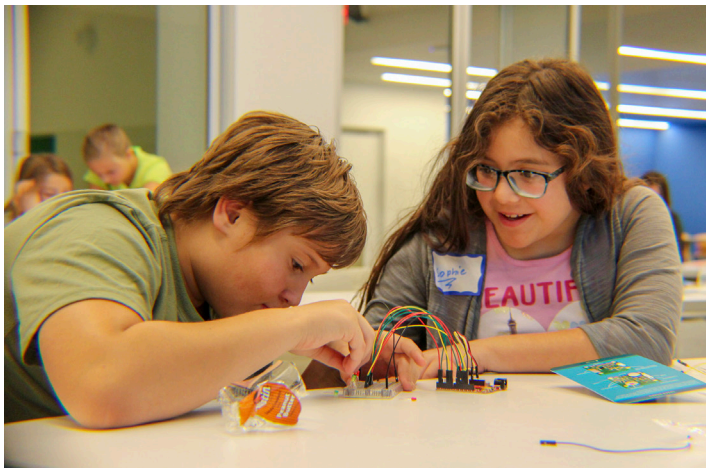
The ecosystem has moved far beyond an opportunity-based type, which is usually found in early stages of partnerships when a funding opportunity pulls organizations and people toward a joint application. This often leads to postponing the foundational work of partnering to the future and can be the cause of many problems once the funding becomes available because the relationships have not been fully developed. On the other extreme, ecosystems and partnerships can be so powerful that they transform the practices—and even the identity—of many of the partnering organizations. While there is some evidence that the TRSA is moving in that direction, it will be interesting to watch this level of partnership evolve.

There were also indications from the data that partnerships outside of the OST sector, which is most closely aligned with the TRSA, were less well-developed. There was some disagreement by members of the K-12 and business sectors for exit survey items pertaining to efficiency, goal-setting, and decision-making, suggesting that these partnerships are in earlier stages of development (or oscillating between opportunistic and collaborative partnership types, depending on the school district or business).

Taken together, the data indicate that the TRSA is beginning to show early signs of interconnected partnerships with the informal/out-of-school time sector and collaborative partnerships with K-12 and business sectors (though crisis and opportunity can and have shifted partnerships forward and backward, requiring monitoring and maintenance). As expected, there were few signs of transformational partnership types, which is rarely observed in practice and is characterized by equal benefit of funding and resources, changing practices to align with others, and adopting a shared framework to understand the community.

"We have to be good about the expectation of continuous improvement and the expectation of a data-driven, evidence driven organization. Every time we engage, we have to be very intentional about what kind of data we are able to gather and want to gather . . . making adjustments based on the evidence we are seeing."

– TRSA leadership



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What did we learn from this case study?

Tulsa, Oklahoma's ecosystem is a powerful example of how people, groups, and organizations from a community took initiative and created an organization and system of strong partnerships within and between sectors to improve access to quality STEM learning opportunities for children and youth. The TRSA, the lead organization of Tulsa's ecosystem, is an exemplary model for the national initiative with evidence showing how all four SLE CoP strategies have been successfully implemented. By leveraging strategies from the SLE CoP to partners—especially afterschool and summer programs, businesses, funders, school districts, and community organizations—the TRSA has grown and scaled in a variety of ways outlined in this summary.

There is evidence of strong partnerships, high quality programming, positive youth experiences, and funding to expand opportunities and increase access to new opportunities, and an established data system and community of practice around data to inform continuous improvement efforts. Nevertheless, their work is not done, especially around developing stronger partnerships with key sectors like schools and businesses and improving areas of quality that have been persistently challenging, both locally and nationally. Specifically, more professional development is needed to facilitate activities that provide young people with more opportunities to reflect on learning (reflection), to connect content to everyday lives (relevance), to deepen their STEM knowledge and understanding (STEM content learning), and to practice skills used by STEM professionals in the "real world" (inquiry).

Importantly, national work has shown how investments in program quality (using the DoS framework) translates to better outcomes for youth (using the CIS-S; Allen et al., 2017). Until recently, this community of practice formed around data in Tulsa has only been implemented in programs held outside of school, but there are currently efforts underway to involve school districts.

The TRSA has already started this work by adopting an evidence-based framework and common assessments used across afterschool and summer programs, a model they are now expanding to school. A holistic, longitudinal approach is needed to understand whether Tulsa's ecosystem is moving the needle in terms of math and science performance and persistence in the STEM pathway towards college majors and careers. Tulsa's ecosystem has accomplished so much and has covered an impressive amount of ground in its short history.

We recommend in the next chapter of its work to focus on the breadth and depth of its work, thinking strategically about how to leverage partners in the community more, diversifying funding and resources, developing meaningful partnerships, improving quality of activities in school as well as outside of school, and tackling STEM performance head-on.

By going into depth with this case study, we are able to see what the ideas and principles of the SLE CoP have contributed to Tulsa's STEM ecosystem. The TRSA had many fertile elements that contributed to its growth, including strong leadership, demonstrated philanthropic will, and companies and school districts ready to partner for the benefit of all youth. As the first case study of a SLE CoP, we believe this study can be an example for other cities and funders. Looking at more than 60 communities at a time will not give you the insight you can glean from a deep study of one robust community.

The work done in Tulsa is just the beginning; we must now take the measures and quality indicators into the school day and across districts to better serve all students, especially those traditionally underserved. The initiative must not end with improvements to OST STEM opportunities, but with core transformation of STEM education across all learning environments. This vision includes more project- and engagement-oriented learning opportunities that have support in the home, community, and classroom.

"I love the fact that we are part of a STEM ecosystem. And, the word 'ecosystem' is absolutely critical to describe Tulsa on a local level, on a state level, and particularly on a national level. Because ecosystems have to be nurtured—they're alive, they have to be fed, and think of all the things that are required to be alive. . . . adaptability is probably the number one characteristic that everyone one of us has to have in this very changing environment. But we are alive, and we can't be treated like just a model or something that can be done by . . . Watson, the super computer. We're just a bunch of people trying to accomplish something. And things, and organizations like the Tulsa Regional STEM Alliance, makes sure our organism is in balance."

– Out-of-school time partner

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About the Authors

Kristin Lewis-Warner, Ed.M.

Project Manager of STEM Research, The PEAR Institute

Kristin Lewis-Warner, Ed.M, manages national STEM projects at The PEAR Institute. She holds a B.A. in Developmental Psychology and a M.Ed. in Learning, Cognition, and Development. She is a research and evaluation professional with over 15 years of experience in the education sector, with a focus in STEM learning, out-of-school time (OST), teacher professional development, and student-centered learning. Before joining PEAR in April 2017, Kristin worked as an independent consultant serving as an external evaluator on multiple Massachusetts-based initiatives. She was drawn to The PEAR Institute's exploration of theory, research, and practice in both STEM and SEL and the use of living data to guide continuous improvement.

Contact Kristin: klewis-warner@mclean.harvard.edu

Patricia J. Allen, Ph.D.

Senior Manager of Research and Evaluation, The PEAR Institute

Patricia J. Allen, Ph.D., is the Senior Research Manager at The PEAR Institute and an Instructor in Psychiatry at Harvard Medical School. She was awarded a Ph.D. in Experimental Psychology from Tufts University in 2013 after gaining expertise in psychology and behavioral neuroscience research. Today, she manages the implementation and development of PEAR's quantitative assessments that measure student outcomes in Science, Technology, Engineering and Math (STEM, using the Common Instrument Suite) and social-emotional development (using the Holistic Student Assessment). She leads national research and evaluation efforts to collect evidence of STEM learning to help ensure that children across the country have positive, high-quality experiences when they participate in STEM activities inside and outside of school.

Contact Patty: pallen@mclean.harvard.edu

Gil G. Noam, Ed.D., Dr. Habil

Founder and Director of The PEAR Institute

Gil G. Noam is the founder and director of The PEAR Institute, which focuses on two areas of research and practice: social-emotional learning and STEM. He is an associate professor at Harvard Medical School focusing on prevention and resilience. He has published over 200 papers, articles, and books in the areas of child and adolescent development as well as risk and resiliency in clinical, school, and afterschool settings. Dr. Noam's group has developed a comprehensive approach to informing on the quality of students' STEM learning experiences and providing a common language around STEM outcomes. Dr. Noam is trained as a clinical and developmental psychologist and psychoanalyst in both Europe and the United States.

Contact Gil: gil_noam@hms.harvard.edu

About The PEAR Institute

The PEAR Institute: Partnerships in Education and Resilience is a nonprofit organization created to promote innovation in education. Based on a belief that high-quality programming can build youth social-emotional resiliency and contribute to school and life success, Dr. Gil G. Noam founded the institute in 1999 as a collaboration between the Harvard Graduate School of Education and Harvard Medical School before relocating to McLean Hospital in Belmont, MA.

The PEAR Institute takes a developmental approach to the study of new models of effective educational programming and incorporates educational, health, public policy, and psychological perspectives. Its programs and projects are a part of a number of schools and afterschool programs across the United States and internationally. PEAR partners with school districts, out-of-school-time programs and youth-serving organizations to promote social-emotional development in the service of student engagement, academic achievement, and life success. PEAR has been involved with STEM activities and assessment for many years. PEAR's mission to promote social-emotional well-being in children, with a focus on out-of-school time (OST), as well as its experience in developing assessment tools, led naturally to involvement with the movement to ensure that children have positive, high-quality experiences when they participate in OST STEM activities.

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