Overdeck Family Foundation | education northwest

**A NATIONAL SCAN**

# Scaling Out-of-School Time STEM Programming

*May 2020*

# About Education Northwest

Founded as a nonprofit corporation in 1966, Education Northwest builds capacity in schools, families, and communities through applied research and development.

We gratefully acknowledge the collaboration with Overdeck Family Foundation in support of this work. Specifically, we would like to thank Gemma Lenowitz for her many contributions to this scan. Our appreciation goes out to our Education Northwest colleagues, Rebecca Moyer, Sara Taylor, Julie Petrokubi, Christopher Mazzeo, Traci Fantz, and Lisa Rummler, for their contributions to this project and their feedback on this report. Finally, we are grateful to the participants who shared their impressions through surveys and interviews.

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# Executive Summary

To gather information about national opportunities for out-of-school time science, technology, engineering, and math (OST STEM) learning, Education Northwest conducted a systematic review of OST STEM programs for the Overdeck Family Foundation. The goal of this work was to better understand what programs and program elements have been successful in scaling up to regional and national levels. We were also interested in the evidence that these programs meet their academic and social goals with students, particularly students underrepresented in STEM, and how evidence of effectiveness relates to program scale. Overdeck plans to disseminate these findings to provide insights for the OST STEM field, as well as use the findings to shape its own approach to grant-making.

## KEY FINDINGS

1. *What types of OST STEM programs have successfully scaled to multiple cities and beyond?*

    - Most programs in our scan prioritize engagement of underrepresented youth. Some allow for the prioritization of different groups based on implementation location.
    - Most offer a range of STEM programming, although a few offer programs specific to computer science, math, or environmental science.
    - Most programs focus on sustained, hands-on, and youth-driven learning opportunities that encourage collaboration. Only about half focus on adult-youth relationships (i.e., mentoring)— but for those that do, it is a crucial element.
    - Key informants discussed the importance of using culturally relevant and socially meaningful programming for scaling, and over three-quarters of programs indicated that these were key elements of their offerings.
    - Fewer programs connect OST activities to school-day activities, particularly through direct connection with in-school educators. Some use school-day standards to align curricula.
    - A key component of successfully scaling programs is educator training—both program-specific training and training in general STEM skills and how to build relationships with youth. However, staff turnover is a challenge to retaining the training investment over time.

2. *How have OST STEM programs successfully scaled?*

    - OST STEM programs identified in this scan varied considerably in size, but the majority have spread to more than one region across the country. For most programs, networking and outreach to existing OST programs, schools, or districts were the primary strategies for connecting to new sites that may be good candidates for scaling.
    - To operate across multiple settings, OST STEM programs must be flexible. Ensuring that programs remain adaptable to their new sites builds ownership among site leaders and was consistently discussed as both a present and necessary component of scaled programs.

- Access to consistent, multiyear funding was seen as a critical support for programs to scale. Key informants also emphasized that this funding should be able to be used for the administrative tasks of scaling rather than just for program implementation.
- All but one organization has a vision for growing the program, yet only about half of programs have a theory of change that is up to date and includes stakeholders' views. Program interviewees emphasized the importance of being mission-driven, and key informants said intentionality is needed for programs to scale.
- A few programs indicated that they worked to develop deep learning among educators, but staff turnover in OST programs may be affecting this aspect of scaling.

3. *What is the evidence supporting the effectiveness of these scaled programs?*
   - Most programs measure students' STEM attitudes, career interest, and/or knowledge, but fewer measure school-based outcomes, such as math or science achievement and GPA.
   - Programs most often use newsletters or events to foster family and community engagement. For programs that do encourage more active participation, more engage community members than families.
   - Only a few programs measure educator, family, and community outcomes.
   - Most programs directly observe site implementation to determine quality, and about half use external evaluators.
   - Program interviewees stressed the importance of using data for continuous improvement. In addition, key informants said data should be intentional and usable so that programs can adapt, as needed, based on their findings.
4. *What lessons learned from these findings can Overdeck, other funders, and practitioners leverage to scale OST STEM learning?*
   - Confirm that programs that are scaling fit the needs of the local community.
   - Ensure the program has the capacity it needs to scale.
   - Keep the program adaptable to community needs.
   - Support the use of data and evidence for continuous improvement.
   - Maintain consistent communication with stakeholders about the benefits of the program.

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# Chapter 1. Introduction

Out-of-school time (OST) programs are a critical opportunity for learning related to science, technology, engineering, and math (STEM), but evidence suggests that youth do not have equitable access to high-quality STEM learning in OST (National Research Council, 2015). To expand and improve equitable access, STEM learning needs to occur cohesively across diverse settings (Penuel, Lee, & Bevan, 2014). However, the Coalition for Science After School reports that many students in OST programs spend little to no time participating in high-quality science learning and that the quality of science materials used in OST settings varies greatly (Freeman, Dorph, & Chi, 2009). Although there is interest among OST staff members to improve both the quantity and quality of science activities, many lack science expertise or basic teaching skills, which can limit their confidence in successfully implementing OST STEM program content (Freeman et al., 2009). Additionally, there are significant challenges in the OST sector, such as limited funding, inadequate time, limited availability of staff training, and a lack of staff interest in science programming (Chi, Freeman, & Lee, 2008).

One way to address these issues is purposeful scaling of successful OST STEM programs. Although OST STEM programs of various degrees of quality are being adopted and scaled across the United States, there is no mechanism for tracking these efforts nationwide or documenting the lessons learned. The purpose of this landscape scan is to provide the Overdeck Family Foundation with answers to the following research questions:

1. What types of OST STEM programs have successfully scaled to multiple cities and beyond?
    a. What are their features *(e.g., hands-on experiences, mentoring, family engagement, staff professional development)* and characteristics *(e.g., age of students, location, content area)*?
2. How have OST STEM programs successfully scaled?
    a. What practices do programs use to scale successfully *(e.g., site recruitment, building ownership in program sites, funding strategies)*?
    b. What are the contextual conditions that enable scaling, and what barriers to scaling do programs experience?
    c. How do programs ensure implementation fidelity and/or quality while scaling?
3. What is the evidence supporting the effectiveness of these scaled programs *(e.g., academic achievement in math, building sense of belonging in STEM fields)*?
4. What lessons learned from these findings can Overdeck, other funders, and practitioners leverage to scale OST STEM learning?

This report summarizes Education Northwest's scan of OST STEM programs that have successfully scaled. It also offers recommendations to Overdeck, other funders, and practitioners for continuing to scale successful OST STEM programs.

## Landscape scan approach

"OST STEM" is a large bucket—and many types of programs, models, curricula, and activities can fit into it. In collaboration with Overdeck, we chose to restrict our search to programs or models that meet a specific set of criteria:

1. They provide implementation support to educators (including teachers and OST program facilitators). Accordingly, we did not include activities, curricula, or platforms that stand alone or give educators only written guidance on how to implement them. Instead, we included programs that allow educators to be connected to a central office, a network of educators, or some form of support for implementation.[1]
2. They reach students who are 5 to 14 years old for at least 20 hours of STEM programming.
3. They have expanded to at least more than one city, if not regionally or nationally.

### Methods

We reviewed recent landscape scans using various approaches (Bridgespan Group, n.d.; Collaborative for Academic, Social, and Emotional Learning, 2017; Education First, 2017; Petrokubi, Bates, & Denton, 2019; Harder+Company Community Research & Edge Research, 2017; Henig, Riehl, Houston, Rebell, & Wolff, 2016; Jankowski & Makela, 2010; Youth Development Executives of King County, 2018). From this review, we found that many landscape scans follow a general pattern:

- Identify objectives, scope, and pertinent information to gather
- Conduct a web search
- Create and administer a survey and/or focus groups and interviews
- Synthesize findings

We followed these steps for our scan, described in detail below.

### Document and website scan

First, we conducted a preliminary document and web search, which helped identify programs that met Overdeck's criteria. It also helped us refine our survey and interview questions. From this list of identified programs, we used academic literature and white papers, as well as the websites of key intermediary, research, and funding organizations in the OST and STEM fields (appendix A), to generate a more refined list of programs that we would survey and potentially interview. We then analyzed listed programs' websites to determine which ones met our criteria and which ones show evidence of student, educator, community, or program outcomes.

[1] These can be programs solely focused on STEM or STEM models that may be implemented in a broader OST program or camp. Research suggests that building educator capacity through training and networking with other educators is an important element of successful OST STEM programming (Maiese, 2005; Penuel et al., 2014; Santo, 2017).

### Interviews with key informants

To further refine our survey and interview questions, as well as build our list of programs, we interviewed 11 key informants from seven intermediary, research, and funding organizations in the field (see appendix A). For these interviews, we worked with Overdeck to develop a semi-structured interview protocol that focused on better understanding trends in the OST STEM field. Each interview lasted about one hour.

### Survey of regional and national program leaders

We then developed an OST STEM scan survey in partnership with Overdeck. The survey was sent to leaders of 35 programs identified through the website and document scan and with the help of Overdeck and key informants. Through discussions with program leaders, eight programs were removed from the list because they did not meet criteria for inclusion. Of the remaining 27 programs (see appendix A), 25 responded to our survey—a 93 percent response rate. The survey was designed to collect information and insights on scaled programs' characteristics, key features, scaling practices, evidence of impact, and organizational attributes.

### Interviews with regional and national program leaders

Informed by the results of the survey, Education Northwest researchers conducted one-hour interviews with 12 individuals who completed the survey. In collaboration with Overdeck, we developed a semi-structured interview protocol that included questions about program features and practices; scaling processes; and the leadership, culture, and funding of the organization.

We also conducted similar interviews with individuals from large youth development organizations (YDOs) with numerous local affiliates nationwide that offer a wide range of OST programming. Unlike the 27 STEM-focused programs we surveyed, these organizations do not explicitly concentrate on STEM. However, given their ability to incorporate aspects of STEM into their existing programming (Noam & Shah, 2014) and serve greater numbers of students across the country, their insight into the scaling of OST STEM programming is important. YDOs that discussed their approach to STEM programming included 21st Century Community Learning Centers (21st CCLC), Boys & Girls Clubs of America, Camp Fire, Girls Inc., and the YMCA (see appendix A). As these programs have diverse and at times complex approaches to STEM programming, they were not asked to complete the program-specific survey. Instead, they were asked to describe their general approaches to STEM.

***Table 1. List of interview and survey respondents from each category***

| | Key informants | OST STEM programs | YDOs |
|---|---|---|---|
| **Interview** | 11 | 12 | 5 |
| **Survey** | - | 25* | - |

*Source: Education Northwest analysis of OST STEM landscape scan survey and interview data.*

## Structure of the report

Chapter 2 presents an overview of the characteristics and features of OST STEM programs from our scan that have successfully scaled. Chapter 3 provides insight into how these programs have scaled, including how they have expanded, built depth, and supported sustainability and ownership in multiple locales (Coburn, 2003). Chapter 4 examines the evidence of these scaled programs, including community and student, educator, and family outcomes. Finally, in Chapter 5, we offer recommendations for how Overdeck, other funders, and practitioners can leverage the lessons learned from these programs to scale OST STEM learning.

# Chapter 2. Characteristics and Features of Scaled OST STEM Programs

Our scan identified 27 OST STEM programs that met our criteria for scaling (see appendix A). This chapter draws on surveys with 25 of these programs and interviews with 12 to describe their characteristics and features. Additional perspective is provided by interviews with thought leaders and YDO leaders.

## Summary

### Program characteristics:

- Most programs in our scan prioritize engagement of underrepresented youth. Some prioritize different groups based on implementation location.
- Most offer a range of STEM programming, although a few offer programs specific to computer science, math, or environmental science.

### Program features:

- Most programs focus on sustained, hands-on, and youth-driven learning opportunities that encourage collaboration. Only about half use adult-youth relationships (i.e., mentoring)— but for those that do, it is a crucial element.
- Key informants discussed the importance of using culturally relevant and socially meaningful programming for scaling, and over three-quarters of programs indicated that these were key elements of their offerings.
- Fewer programs connect OST activities to school-day activities, particularly through direct connection with in-school educators. Some use school-day standards to align curricula.
- A key component of successfully scaling programs is educator training—both program-specific training and training in general STEM skills and how to build relationships with youth. However, staff turnover is a challenge to retaining the training investment over time.

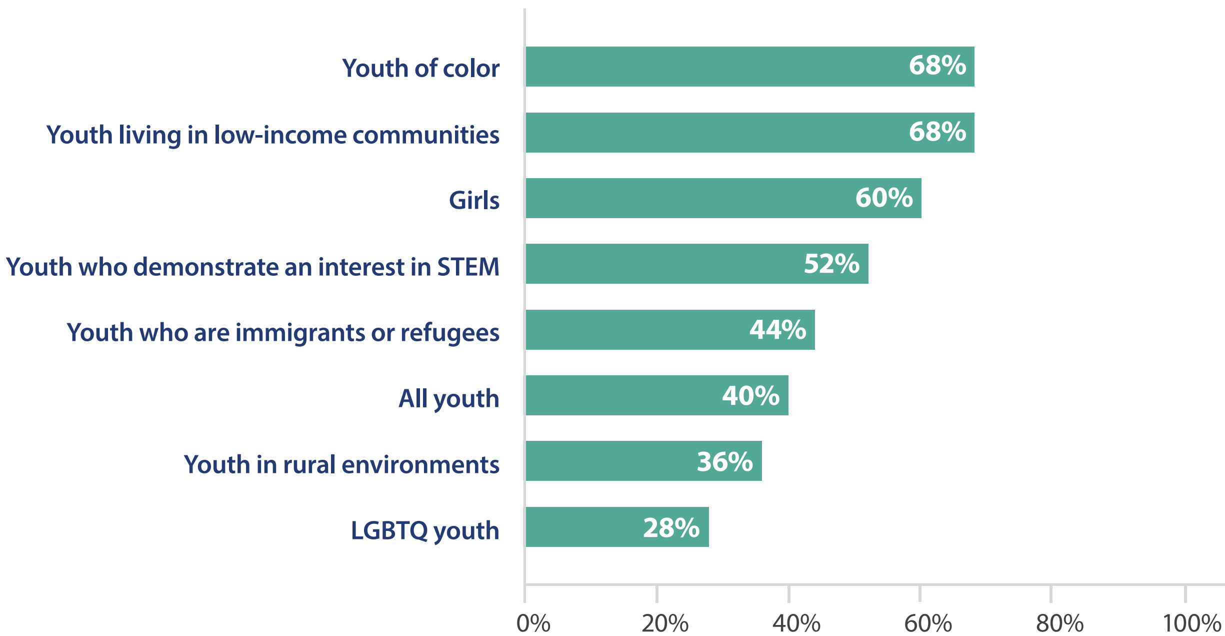
## Program characteristics

Despite the national priority to attract and retain women, as well as non-white and non-Asian individuals, in STEM disciplines, these groups remain underrepresented. This has been described as a leak in the scientific pipeline (Hernandez, Schultz, Estrada, Woodcock, & Chance, 2013). The decline in interest and motivation to pursue STEM learning opportunities begins as early as elementary school and increases as students get older (Potvin & Hasni, 2014). Providing traditionally underrepresented students with opportunities to engage in authentic, relevant, and open-ended STEM learning activities during OST has been shown to increase their interest in STEM fields and careers, expand their STEM knowledge and skills, and improve their likelihood of graduating from high school (Afterschool Alliance, 2011; Dabney et al., 2012; Sahin, Ayar, & Adiguzel, 2014).

A recent meta-analysis concluded that OST can have a positive impact on student interest in STEM and that programs with an academic and social focus had a larger effect than programs with only an academic focus (Young, Ortiz, & Young, 2017). Although other factors keep underrepresented student groups from STEM careers (e.g., access to courses), building interest can be an important step in closing that gap.

We asked survey respondents to describe the students they prioritize with their programming, including a range of student groups traditionally underserved in STEM (figure 1). When looked at individually, 76 percent of programs prioritize the engagement of youth traditionally underserved in STEM, for example students of color, girls, or youth living in rural environments. The programs that do not prioritize youth traditionally underrepresented in STEM focus broadly on all youth.

***Figure 1. Over two-thirds of programs prioritize the engagement of youth of color and youth living in low-income communities (n = 25)***




Note: Participants could select all that apply.

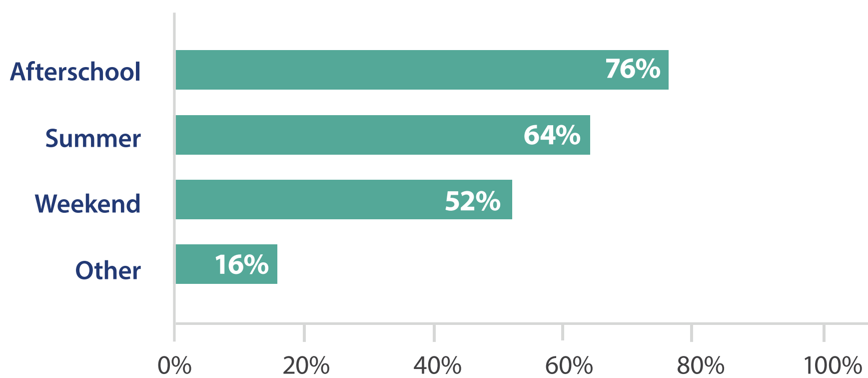
*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

Overall, 68 percent of programs prioritize both youth of color and youth in low-income communities (see figure 1). Strategies to prioritize underrepresented youth vary, however. Some interviewees said the population being prioritized was flexible and that sites could determine the underserved population most in need of the program in their community. Other programs, such as those that prioritized girls, made recruitment and enrollment of the underserved population a fundamental required element.

Program interviewees described varied strategies to prioritize underrepresented youth. Some programs allowed sites to determine which underserved population would be prioritized based on the needs in their community. Others, such as those who prioritized girls in their programming, made recruitment and enrollment of the underserved population a fundamental required element.

We also asked programs to describe when they operate (figure 2). Overall, 76 percent are afterschool programs, and 64 percent are summer programs. A few programs mentioned they also operate during then school day when asked to describe the other times they operate.

***Figure 2. About three-quarters of programs operate after school, but 15 of these programs also operate over the summer, on the weekend, and/or during other times (n = 25)***

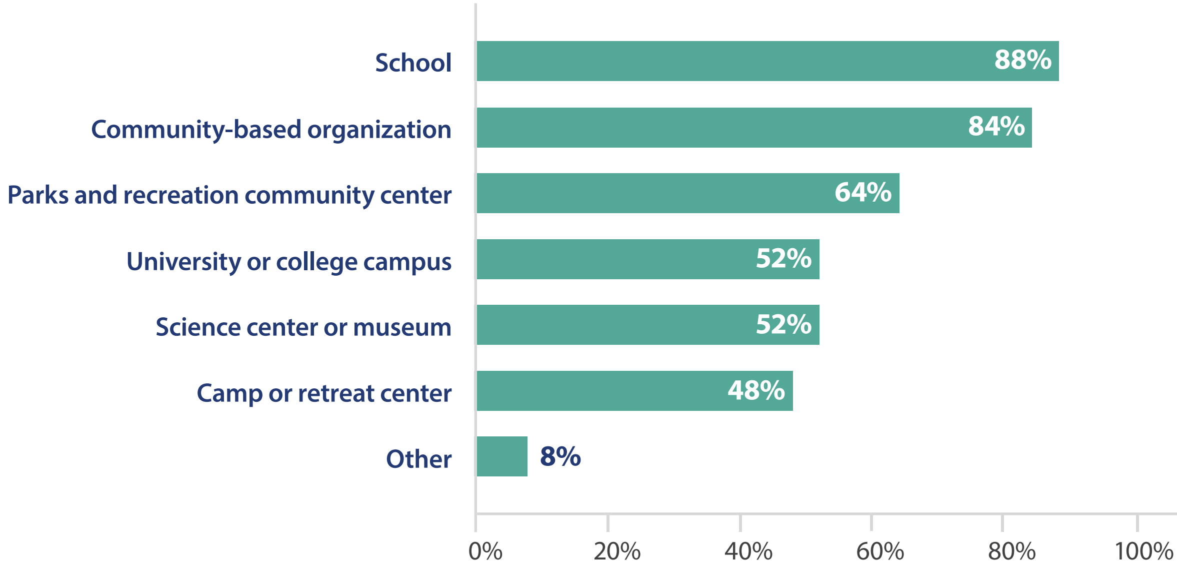



Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

In addition, we asked programs to describe where they operate (figure 3). Most programs take place in a school (88 percent) or community-based organization (84 percent). Programs also mentioned libraries as settings for their programs when asked to describe other locations in which their programs operate.

***Figure 3. Most programs take place in a school or community-based organization (n = 25)***



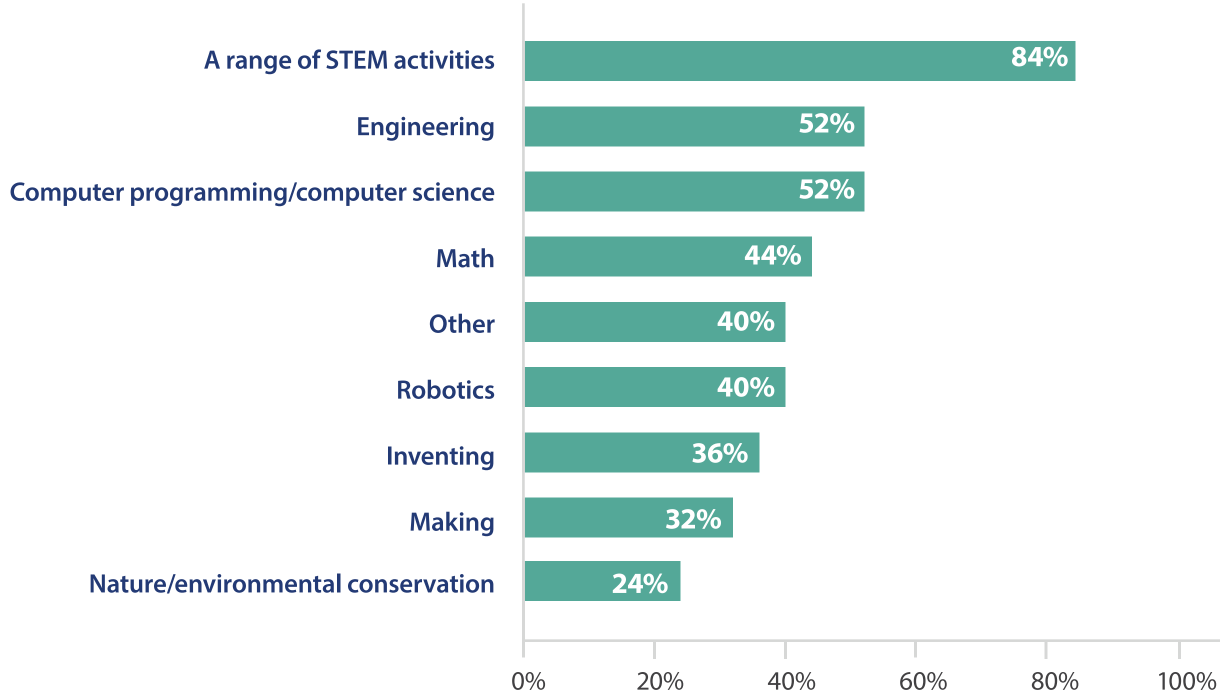

Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

In surveys, 84 percent of programs said they serve middle school students, as well as other grade bands. Students are recruited by on-site staff members in 88 percent of programs. In addition, 52 percent of program leaders said staff educators are recruited by site managers, and 32 percent said staff educators are recruited from existing OST programs. Criteria for recruitment also vary and include having to be a certified educator (52 percent), OST educator with STEM experience (52 percent), or a college/graduate school student (40 percent). Interviewees described different degrees of staffing assistance their program provides. Some said staffing is up to the program itself, and others said they assist with recruitment.

We also asked programs what activities they offer (figure 4). Overall, 84 percent offer a range of STEM activities. When asked to list other focus areas for activities, programs said social and emotional learning (SEL), leadership, and problem-solving skills, as well as innovation, cryptography, space science, and arts and humanities.

*Figure 4. Most programs that have scaled offer a range of STEM activities (n = 25)*

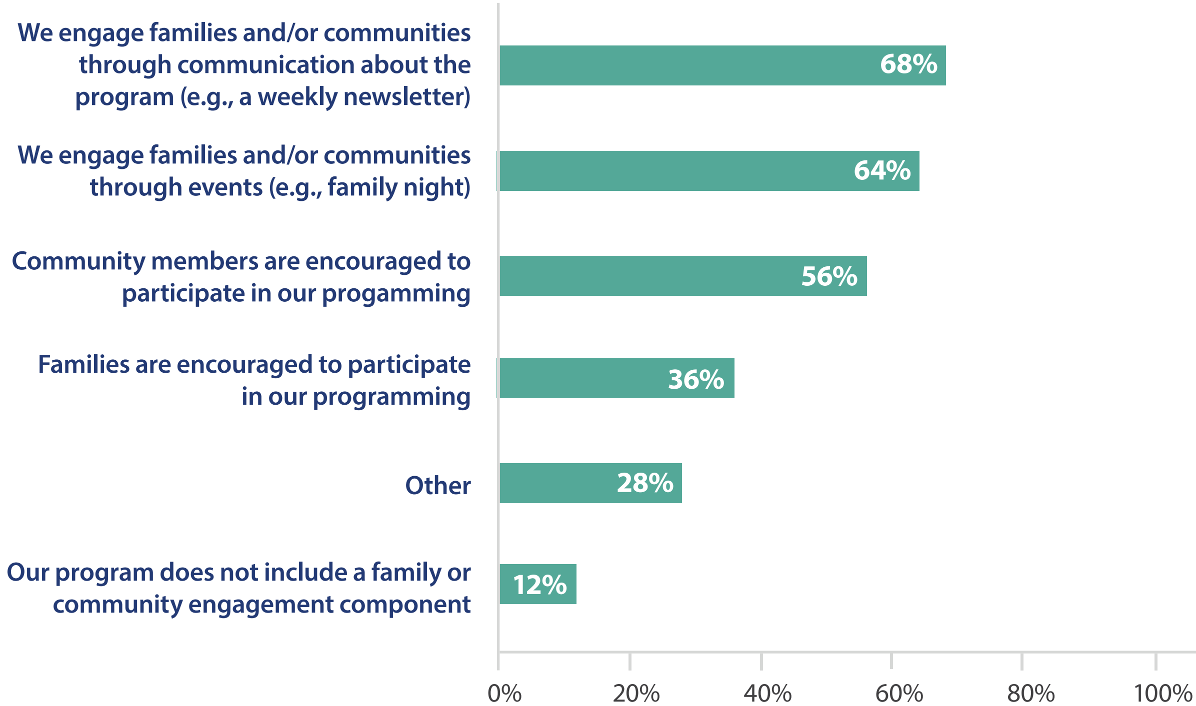



Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

We also asked programs how they involve families and communities (figure 5). The most common engagement strategies are basic communication (68 percent) and events (64 percent). More programs encourage community participation than family participation (56 percent and 36 percent, respectively), and 12 percent do not have a family or community engagement component. Programs that involve families and communities in other ways do so by directly or indirectly supporting the work local affiliates do to connect to families and communities. A few described curricula or resources that are in place or in development to facilitate local affiliates' efforts.

*Figure 5. Programs' approaches to family and community engagement vary (n = 25)*



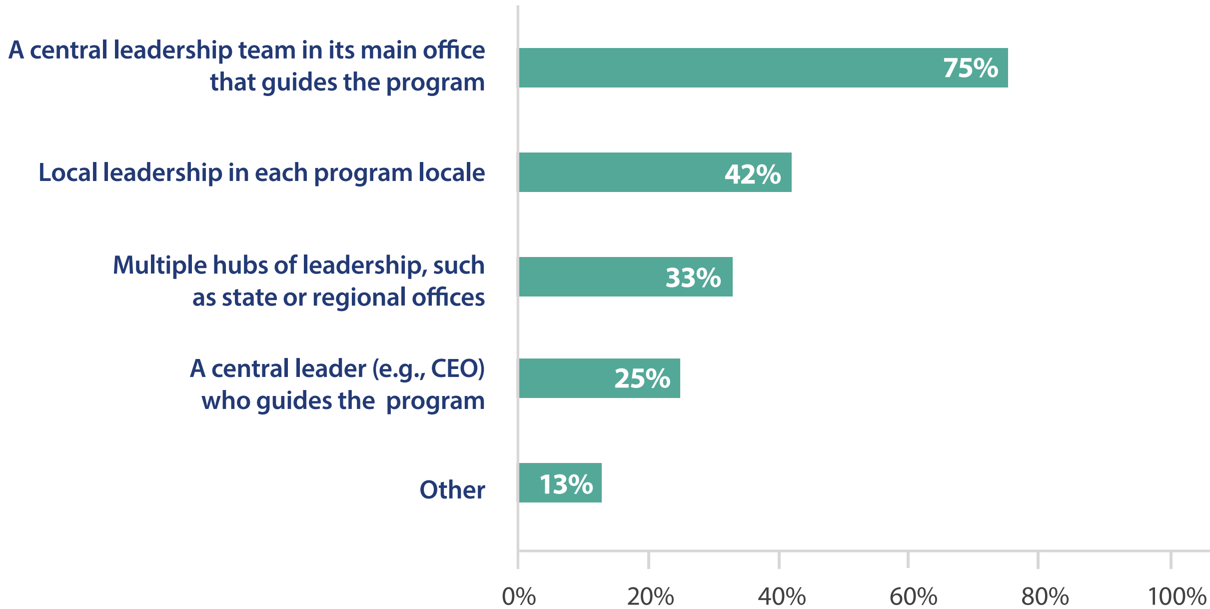

Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

In surveys, some program leaders indicated that families were involved through events or showcases of participants' work and that community members sometimes served as an audience for these events. In one or two programs, families participated in extended learning when their children brought curricula home and/or attended events at which parents learn alongside youth. In a few programs, community members served as event volunteers, guest speakers, mentors, or donors and sponsors.

Finally, we asked programs to describe their leadership structure(s) (figure 6). Overall, 75 percent use a central leadership team, but most of these programs have a local, regional, state, or CEO-based leadership structure, as well.

***Figure 6. Three-quarters of programs have a central leadership team, but most also use other leadership structures (n = 24)***




Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

Several program interviewees said their program has a leadership team that comprises members in different roles who work together collaboratively and with transparency. They also described the importance of having a leadership team that is dedicated to the program's mission.

> ***"We're very mission-driven. I think it starts with recruiting people for the team who demonstrate evidence of a deep commitment to the kind of work we do, which is at the intersection of STEM, sure, but it's also about youth empowerment. It's about social justice."*** (The Clubhouse Network)

## Program features

This section focuses on program features that designate how programs should be facilitated (e.g., provide hands-on learning opportunitites, connect OST activities to the school day). These features were seen across programs, and they can be consistently scaled.

To determine the features of successful OST STEM programs, we used three high-level features (National Research Council, 2015):

- Engage young people intellectually, academically, socially, and emotionally
- Respond to young people's interests, experiences, and cultural practices
- Connect STEM learning in out-of-school time, school, home, and other settings

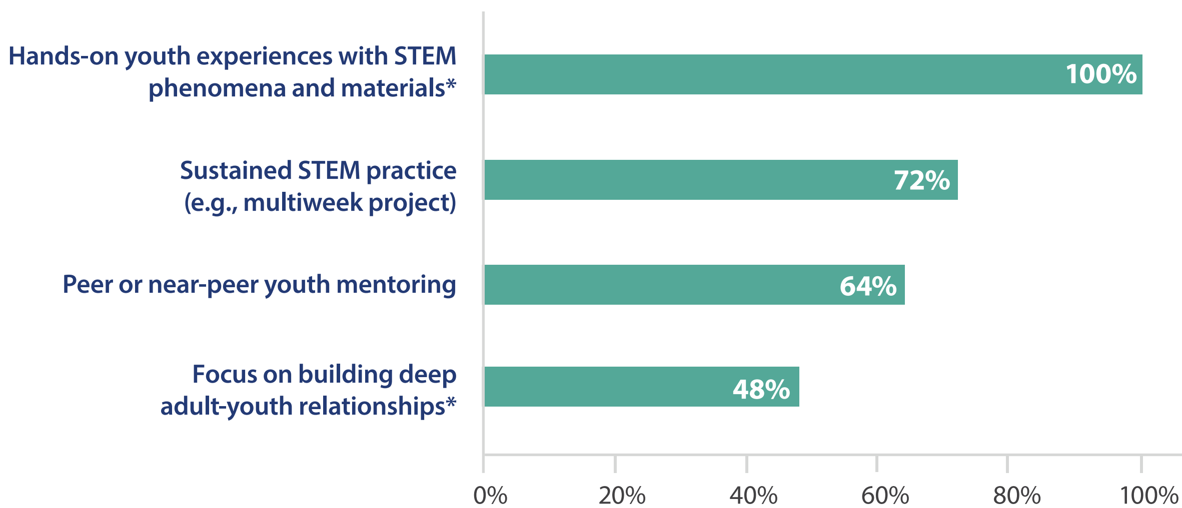
We also included staff training and capacity as a key feature (National Research Council, 2015).

### Engage young people intellectually, academically, socially, and emotionally

First, scaled programs include activities and resources that engage youth intellectually, academically, socially, and emotionally; the engagement of the whole child is a key criterion for positive student outcomes (National Research Council, 2015). In addition, students benefit from working on projects that are meaningful and relevant to their lives (High Quality Project Based Learning, n.d.). OST STEM programming provides a key opportunity to engage in activities and curricula that are connected to real-world problems.

We asked programs to indicate whether they include features that engage youth intellectually, academically, socially, and emotionally (figure 7). Overall, 100 percent of programs offer hands-on experiences. Key informants discussed the importance of these experiences, especially for students traditionally underrepresented in STEM, who may not have as much access to these types of learning opportunities. Program and YDO interviewees also emphasized the importance of hands-on programming that is "project-based" and includes key aspects, such as "design thinking" and "creative problem-solving."

***Figure 7. All programs provide hands-on experiences, but only about half focus on building deep adult-youth relationships (n=25)***




* These items were described as "non-negotiables" (or required program items) during program interviews.

Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

Additionally, 72 percent of programs provide sustained STEM practice. Program, YDO, and key informant interviewees discussed the importance of providing opportunities for youth to experience persistence and take risks in STEM activities, made possible in part by sustained STEM practice.

> ***"We want to give kids a time to iterate. We want them to learn through failure. We want them to feel comfortable with failure. If they're not able to redesign or retool their project, they're going to feel like they failed versus knowing that the design failed. We want them to understand that they can be successful even if their design isn't."*** (Robert Noyce/Ellen Lettvin Informal STEM Education Fellow)

> ***"I think the whole philosophy of [our program] has been "Let's take some risks. You, as an educator—you need to take some risks. You need to try things that are out of your comfort zone."*** (Girls Excelling in Math and Science [GEMS])

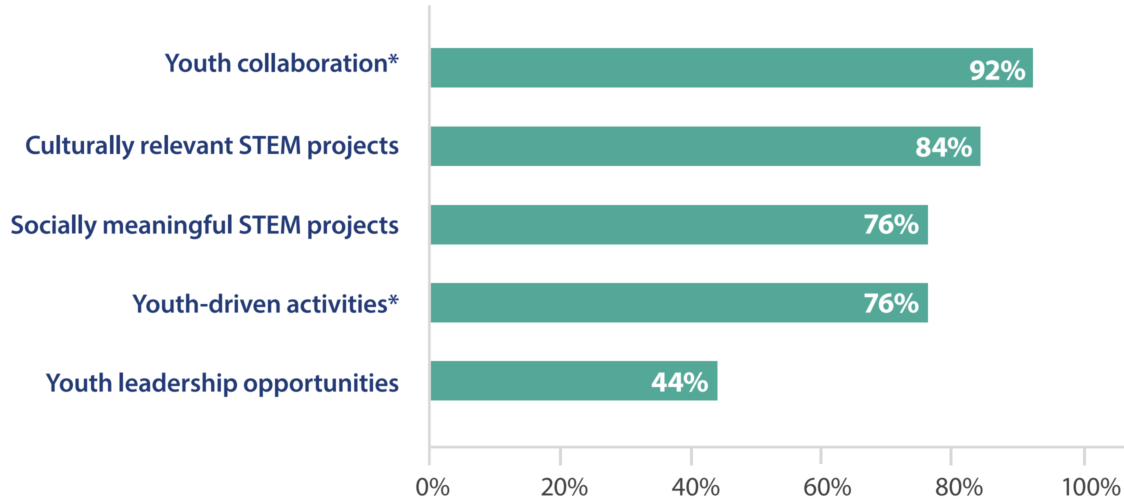
Although only 48 percent of programs focus on building deep adult-youth relationships, both program and key informant interviewees emphasized the importance of providing students with access to STEM mentors who are trained to support youth learning.

### Respond to young people's interests, experiences, and cultural practices

Scaled programs also include activities and resources that are socially meaningful, culturally relevant, and collaborative (National Research Council, 2015). In addition, successful programming is responsive to youth's lived experiences, especially if the program is inclusive of groups traditionally underserved in STEM (High Quality Project Based Learning, n.d.; National Research Council, 2015). This responsiveness can be key to a program's scalability as it is implemented with multiple populations.

We asked programs to indicate whether they include features that respond to young people's interests, experiences, and cultural practices (figure 8). Overall, 92 percent of programs include elements of youth collaboration. Program and YDO interviewees said "foster[ing] peer-to-peer sharing" was a non-negotiable element of their program, as was youth-driven STEM programming. Key informants also described how building collaborative skills is a key benefit of STEM programming.

***Figure 8. Most programs provide youth with opportunities to collaborate and engage in culturally relevant, socially meaningful, youth-driven activities (n=25)***




* These items were described as "non-negotiables" (or required program items) during program interviews.

Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

> ***"A lot of STEM programs are based around a project-based learning model, where students are working in groups or teams and they're hitting on not only just the relevant curriculum and subject but also, in order to do that successfully, they have to work together. They have to be able to communicate successfully and understand how to work through difficult problems. And I think that STEM itself is a great environment for that."*** (Afterschool Alliance)

Many programs also include culturally relevant (84 percent) and socially meaningful (76 percent) STEM projects for youth—which key informants described as crucial. These aspects were seen as especially important for scaling up programming to multiple locales.

> ***"I want kids to learn how to solve problems that matter. I want them to be able to critically use their critical learning, their critical skills. I want them to apply their knowledge in something that has meaning. I want them to be able to solve problems. I don't want them doing busy work in an after-school STEM program that has no value. I want them to be in the most valued time of their lives. I want them to be doing valued work."*** (TIES)

Additionally, 76 percent of programs provide youth-driven activities, but only 44 percent provide youth leadership opportunities.

> ***"It's youth-directed creative self-expression through technology."*** (The Clubhouse Network)

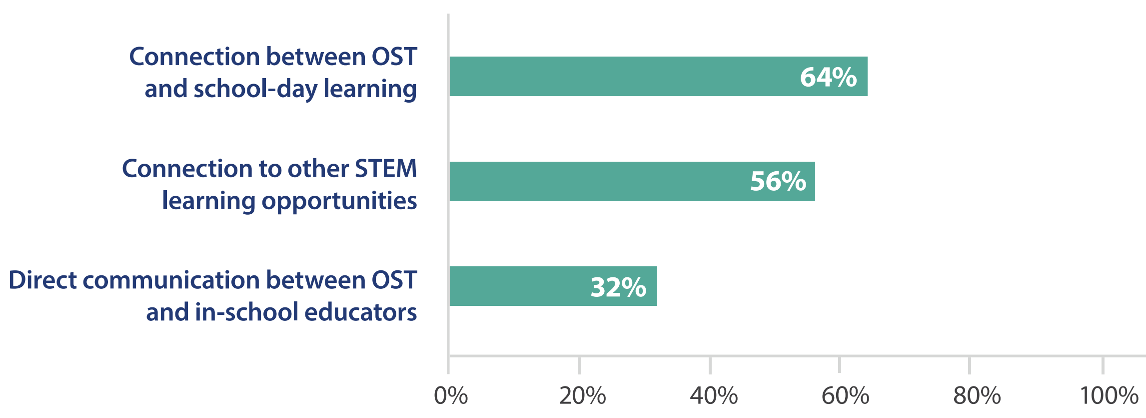
### Connect STEM learning in out-of-school time, school, home, and other settings

Some scaled programs include structures that connect OST learning to school, home, and other settings (National Research Council, 2015). Further, STEM programming with successful student outcomes leverages learning opportunities with multiple partners in multiple settings (Bevan & Michalchik, 2013; National Research Council, 2015). This can also ensure the sustainability of programming by building a network of practitioners and other stakeholders to support the work.

We asked programs to indicate whether they include features that connect OST STEM learning to school and other settings (figure 9). Overall, 64 percent connect OST and school-day learning, but only 32 percent do so through direct communication between OST and in-school educators. Key informants said many programs connect OST and school-day learning by using the Next Generation Science Standards or other school-day standards, which may account for this difference.

> ***"We really want [OST and school-day educators] to be in communication with one another. And from what I've seen, the majority of them do actually do that. It's important to have those communications and get that feedback from the teachers so the students can get the help that they need—but also [so that] the teachers are aware that we're looking at specific things to be able to work with students, especially in STEM. … [The program has to] meet the challenging state academic standards. Also, the programs have to make sure that whatever they do in that program, it has to align with the day-time school program."*** (21st Century Community Learning Center)

***Figure 9. Over half of programs connect OST to school-day learning and other STEM opportunities, but only about a third provide avenues for communication between OST and in-school educators (n=25)***




Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

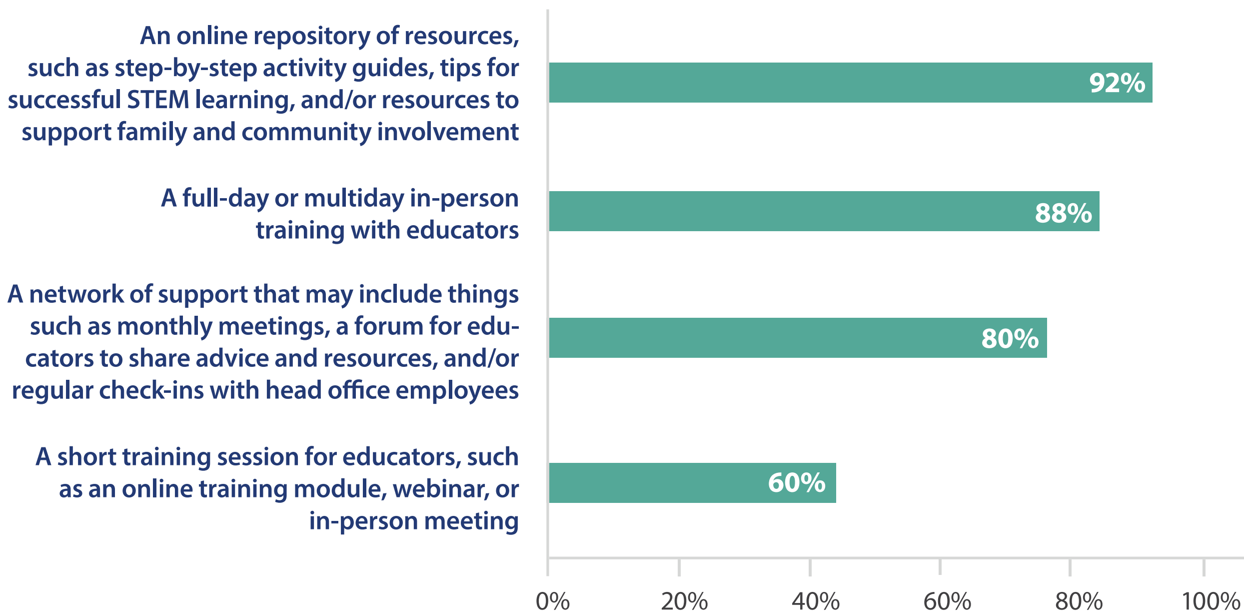
### Increase educator capacity through effective skill-building strategies

In contrast to isolated professional development, capacity building is a multilevel change process that improves an organization's ability to achieve its mission by increasing skills and knowledge in key tasks, such as planning and implementing programs and developing sustainable infrastructure or systems (Maiese, 2005). Building capacity can foster a sense of ownership in practitioners, improve the sustainability of the program, and increase the likelihood it will scale.

One way to build capacity is to develop a network of practitioners. Especially in the resource-limited environment of OST programming, networks can help practitioners change their practices by sharing expertise, learning from one another, and exploring the common issues they face (Santo, 2017). Thus, developing connectivity between practitioners is a critical component of the supportive infrastructures necessary to sustain high-quality OST STEM learning across multiple settings (Penuel et al., 2014).

We asked programs to indicate whether they include features that build capacity in educators (figure 10). Most programs offer a full- or multiday in-person training (88 percent) or a consistent network of support (80 percent), in addition to online resources (92 percent) or short training sessions (60 percent). These findings are consistent with the literature suggesting the need for capacity building among educators for successful programming.

***Figure 10. Most programs offer an online repository of resources, and they all supplement this through a full- or multiday in-person training or a consistent network of support (n=25)***




Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

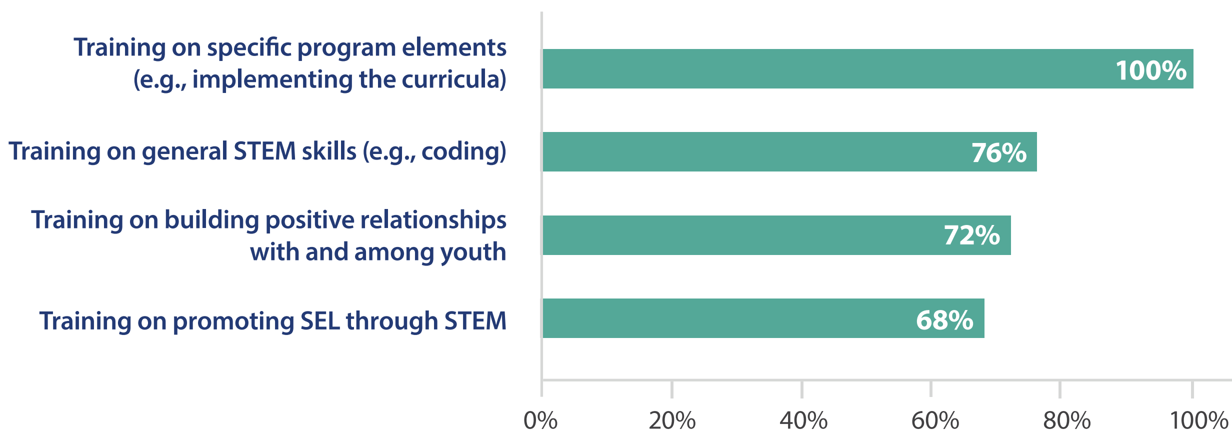
The content of training sessions is also key to ensuring the success of scaling programs; OST STEM program practitioners often lack science expertise or basic teaching skills, which can hinder the implementation of program content (Freeman et al., 2009). Step-by-step, hands-on professional development can help practitioners build the skills to deliver STEM education to program fidelity across multiple locales (Durlak, Weissberg, & Pachan, 2010).

Overall, 100 percent of programs provide staff members with training on specific program elements (figure 11), and most also offer training on STEM skills (76 percent), relationship building (72 percent), and SEL through STEM (68 percent). These findings were reflected in program interviews.

> ***"FIRST Professional Development is focused on providing teachers with the tools and resources needed to develop facilitation skills for project based learning, 21st century and social emotional learning. We focus on training teachers to be facilitators of our programs where students explore, ask the questions, find the answers, and drive the learning while being guided by their teachers."*** (For Inspiration and Recognition of Science and Technology [FIRST])

> ***"A lot of our facilitators might not have backgrounds in STEM, or they were told, "Guess what? You get to do the STEM programming." … A lot of time [training is] focused on really encouraging folks "You don't have to be the experts in these things… it's okay for you not to know the answer, and it's okay for you to learn with the girls."*** (Eureka!)

***Figure 11. All programs provide training on program elements, and most offer specific training in STEM, relationship building, and SEL through STEM (n=25)***




Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

While emphasizing the importance of investing in professional development for educators, programs described staffing as one of the largest barriers to scaling. The learning curve associated with implementing a new program and the challenge of trying to continue implementing a program without specific professional development are additional challenges they face.

Some YDO interviewees described little to no designated training for STEM programming, but they also said this is a need and that it may be addressed as STEM becomes a larger portion of their activities. Others said their training came through partnerships with other organizations (e.g., 21st CCLC's You for Youth[2] partnership with NASA, the National Park Service, the Institute of Museum and Library Services, and the National Oceanic and Atmospheric Administration).

[2] For more information, see https://y4y.ed.gov/stem-initiatives.

# Chapter 3. Scaling OST STEM Programs

In this chapter, we describe the avenues by which the OST STEM programs from our scan have successfully scaled. In this report, "scale" does not merely refer to the number of sites or students a program serves but to how well that program is taken up in the sites in which it is implemented. We use the following elements of scaling (Coburn, 2003) as a guide:

- ***Spread:*** The expansion of practices to new sites
- ***Ownership:*** The transfer of knowledge and authority to sustain the reform to the actors at the ground level
- ***Sustainability:*** The creation and adaption of policy and an infrastructure system to sustain a practice
- ***Depth:*** The extent to which practice is transformed in a meaningful way

We address each of these elements below, but we found that "ownership" was one of the more complex and important elements of scaling programs.

## Summary

- ***OST STEM programs identified in this scan varied considerably in size,*** but the majority have spread to more than one region across the country. For most programs, networking and outreach to existing OST programs, schools, or districts were the primary strategies for connecting to new sites that may be good candidates for scaling.
- ***To operate across multiple settings, OST STEM programs must be flexible.*** Ensuring that programs remain adaptable to their new sites builds ownership among site leaders and was consistently discussed as both a present and necessary component of scaled programs.
- Access to ***consistent, multiyear funding*** was seen as a critical support for programs to scale. Key informants also emphasized that this funding should be able to be used for the administrative tasks of scaling rather than just for program implementation.
- ***All but one organization has a vision for growing the program, yet only about half of programs have a theory of change*** that is up to date and includes stakeholders' views. Program interviewees emphasized the importance of being mission-driven, and key informants said intentionality is needed for programs to scale.
- ***A few programs indicated that they worked to develop deep learning among educators,*** but staff turnover in OST programs may be affecting this aspect of scaling.

## Spread

Many key informants said that if a program is to scale, it must be meeting the needs of the local community. Along those lines, it must fill a void, and it must be able to communicate to others—especially parents and caregivers—how it fills that void. They also emphasized the need for programs to be intentional while scaling and to start small and slowly build to refine their offerings.

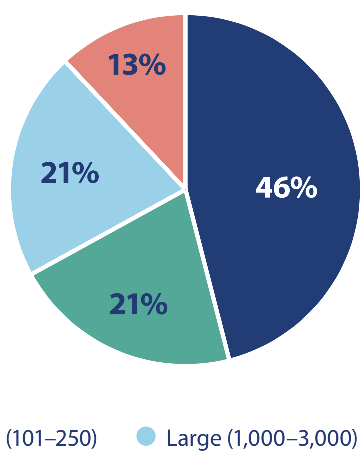
> ***"The user downstream is everything. And out of school has been very smart to ask and to know who those users are, what their needs are at the different time in life—different age groups, different demographics—and meet the needs."*** (TIES)

> ***"Instead of doing something to a community, "Look, we're bringing this really cool thing to you," it's more of, "And we have this cool thing. Do you think it will work here? And, what sort of changes or adaptations might be necessary so it would work for you?" And then co-creating a pilot with the stakeholders and the community to see what works. And then taking those learnings and incorporating them into a larger scale effort."*** (National Girls Collaborative Project [NGCP])

> ***"We add value. We do things that people want us to do. We meet them where they are. We want to do work that is relevant to them. We deliver results. We show people that we want true partnerships."*** (Girlstart)

We asked programs to estimate the number of sites they serve (figure 12). Although most programs served 100 sites or fewer, the number of sites implementing programs from our scan varied considerably.

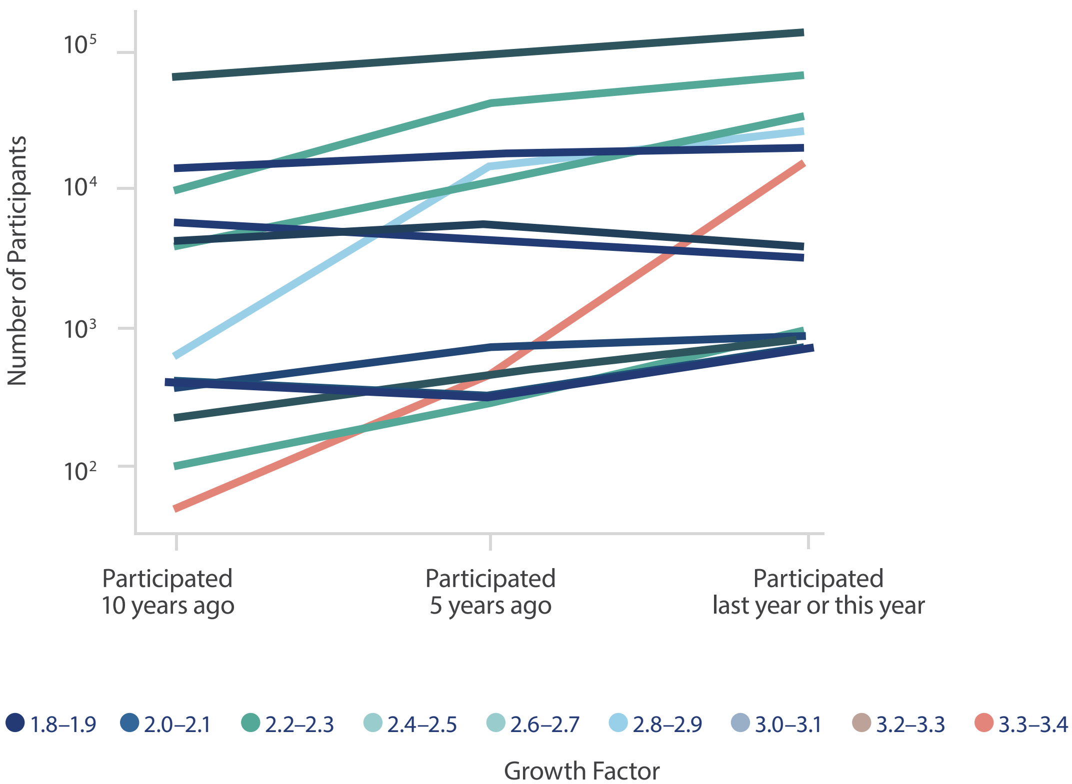
***Figure 12. The number of sites programs serve varies from six to 60,000 (n = 24)***




*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

We also asked programs to estimate the number of students who had participated over the last 10 years, the last five years, and the last or current year (figure 13). In figure 13, every line represents a program that responded to our survey and has had participants for the past 10 years. The growth factor scale is a log of the average percentage change in the number of participants over the past 10 years. The larger the growth factor, the larger the percentage growth in participants.

***Figure 13. Rate of growth in program participants***



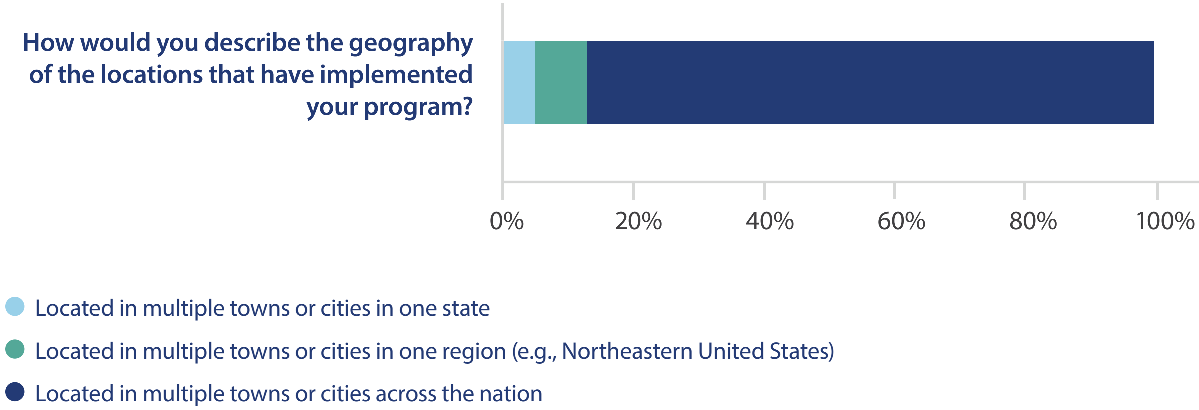

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

Note: Not all data from the survey were included to improve graph clarity. Programs were excluded that either had no participants 10 years ago or had exponentially more participants than other programs.

Figure 13 indicates that most programs grew at a relatively steady rate over the past 10 years (indicated by the teal and blue lines), and a few programs experienced slight declines in participation (indicated by purple lines). Two programs experienced higher rates of growth (indicated by the yellow and green lines).

In addition, we asked programs to describe their geographic spread (figure 14). Overall, 88 percent of programs have locations across the country, 8 percent have a more regional distribution, and 4 percent are concentrated in one state.

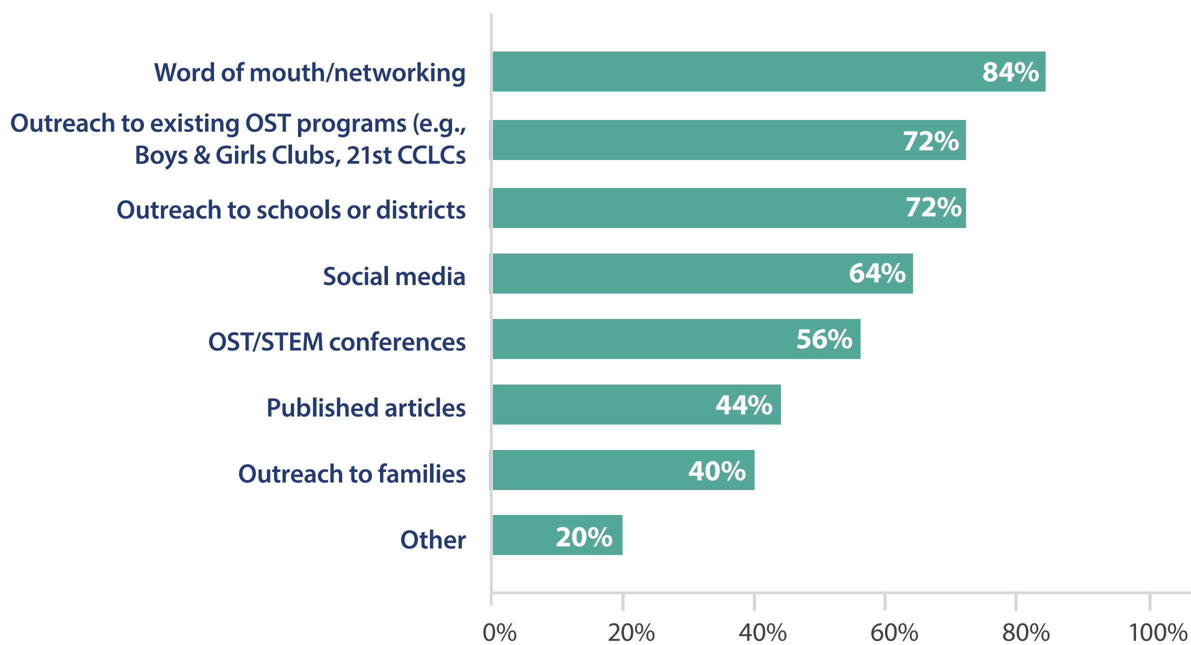
*Figure 14. Most programs are spread throughout the nation*




*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

We also asked programs how they recruit sites (figure 15). Most programs do so by building relationships through networking (84 percent), outreach to existing OST programs (72 percent), and outreach to schools or districts (72 percent). Social media and conferences play an important role for a little more than half of programs (64 percent and 56 percent, respectively).

*Figure 15. Most programs recruit sites by building relationships through networking or outreach to schools, districts, and OST programs (n = 25)*




Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

Some program interviewees said they go through a recruitment process, starting with intentional and targeted networking and outreach, that involves assessing whether potential sites or partners would be a good fit.

> ***"I send sometimes our application—not to encourage them to fill it out but rather as a way to give them more information about what the benefits are and what the requirements are. Then usually, at some point, we'll jump on [a] call to assess and begin to build a relationship. Again, we're all about relationship. At some point, it'll be appropriate for them to complete the application, and that point is typically when they feel like they have the funding to be able to move forward and have the community support and buy-in that they'll need."*** (The Clubhouse Network)

Other program interviewees said sites often reach out to them. These programs use word of mouth, along with other site-recruitment strategies.

> ***"Mostly they've come to us. We haven't done much active recruiting. We've been very successful just through organic word of mouth. Teachers hearing from other teachers about our program and how different this is and how the students respond to it is, I think, the biggest factor that's contributed to people wanting to implement the program."*** (FUSE)

In interviews, we asked key informants how they saw innovation, as well as innovative OST STEM programs, spreading in the sector. They mentioned more formal communication channels (e.g., STEM ecosystems, brokering organizations/intermediaries) and the use of existing OST programs and networks (e.g., 21st CCLCs, The Connectory). However, they also mentioned more informal means, such as trusted networks of practitioners and simple internet searches.

YDO interviewees said they advertise STEM programming internally to build scale and that they also do so through their intranet, blog posts, and/or requests for proposals from their sites. In addition, they said they provide suggestions for programming but still encourage local sites to determine what works best for their community's needs.

## Ownership

Programs' spread is a crucial element of scaling. However, program, YDO, and key informant interviewees described the development of ownership among local actors as especially critical. Along those lines, key informants emphasized the importance of building the program in and through the community with which the program works.

> ***"When I looked to scale, I looked for partners that had deep and sustained connections with youth and families in under-resourced communities. While we had identified program elements that made our program successful in our original site, we knew that these elements would need to be adapted for new communities. We looked to partners who could take our essentials and modify them to meet the needs and interests of their youth and families. In this way, we could leverage their expertise and relationships. It is a balancing act that requires making sure new partners understand the program model and the rationale behind the essentials and entrusting them to adapt with culturally responsive elements that empower youth and their families."*** (STEM Next Opportunity Fund)

> ***"One of the biggest challenges with scale that I see is to help a community own it, to increase sustainability, as opposed to one organization. An organization that's developed something often continues to own and control the program they developed, they have a dream or vision of scaling it out across many communities. And I think often in the mind of the program developers, it's the same program and they plan to do it times 50, as opposed to increasing the capacity of new trainers and new educators so they can connect with each other and own it themselves."*** (NGCP)

All program interviewees said educators feel ownership of their programming and the success of their youth. Program leaders described the flexible or adaptable items generally as differences that can foster ownership among sites (for example, coastal sites may focus on marine issues, and those in the Midwest may focus on farming issues), which allows educators and students to feel more tied to the work.

> ***"There are lots of things where we need to adapt to the local environment. Our homework help and academic skill building relate to elements of STEM and are aligned with our host schools and districts."*** (Higher Achievement)

Program leaders also described differences due to the specific setting (e.g., after school, during the school day) and region where the program was being implemented.

> ***"These programs are used in summer camp settings, afterschool settings, and even traditional classroom settings. We had flexibility in mind when designing these units. The pacing and structure are flexible, so the setting is not going to impact the overall experience that the curriculum has on educators and students. The curriculum design really allows the units to fit into a variety of environments."*** (Engineering Adventures and Engineering Everywhere)

YDO interviewees described the importance of building ownership among local sites. These organizations encourage local adaptation of curriculum and programming, similar to program interviewees, but some also encourage flexible implementation of STEM programming apart from key program features (e.g., reflection, problem-solving, communication).

> ***"It isn't so much about STEM programs specifically or curriculum specifically—it is about the journey that we provide the youth when they experience STEM programming. So, things around reflection, right? How do staff appropriately facilitate conversations that encourage reflection and asking purposeful questions and make sure that we are helping the youth reflect on their experiences?"*** (YMCA)

***"Camp Fire National Headquarters provides curriculum to our affiliates, we provide it free of charge, and they have the freedom to do what they wish with it. They're not mandated to use it. We talk about and train on what fidelity looks like, but also suggest ways to adjust it to the needs of the local communities that they're working with. Every year we ask our affiliates to report back, "Did you use this curriculum? Did you use it as is? Did you adjust it?" So that we have a sense of what program staff are doing with content and can continue to evolve and adapt how we train and support the youth workers who are striving to meet the needs and requests of the young people in Camp Fire."*** (Camp Fire)

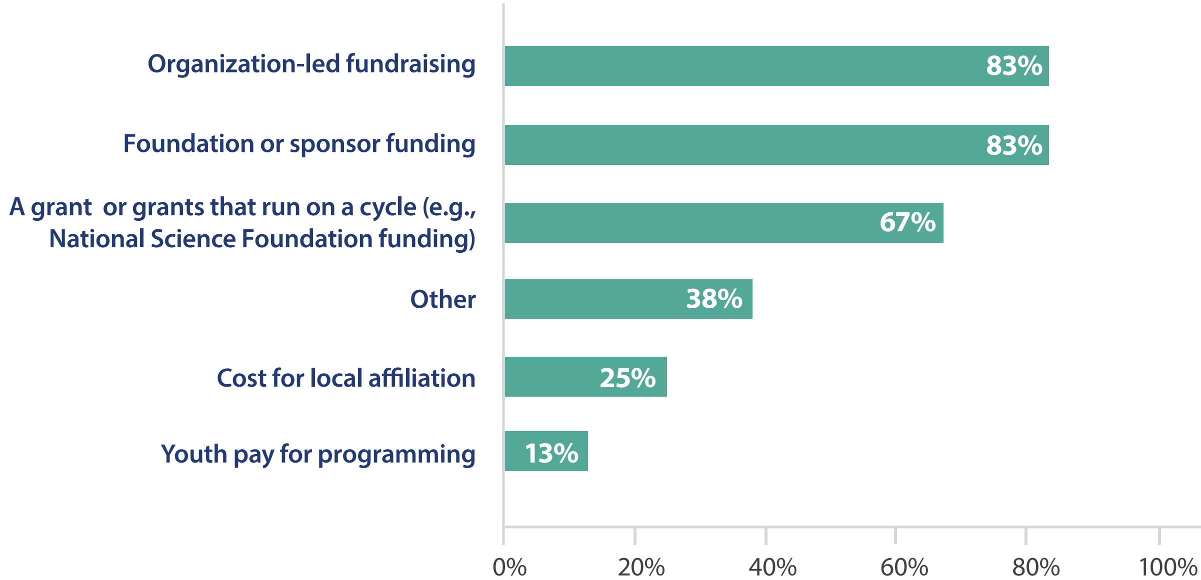
## Sustainability

For programs that spread to new locales to be sustained, policies and infrastructure need to be in place to support their scaled practices. We looked at programs' funding strategies, vision for growth, and theories of change to indicate the infrastructure in place to support scaling.

First, scaled programs require access to consistent and adequate funding—one of the primary challenges OST programs face in implementing science activities (Chi et al., 2008). Adequate funding can ensure that high-quality, regularly scheduled science activities remain a top priority for OST programs.

We asked programs about their sources of funding (figure 16). Most engage in fundraising led by the central organization (83 percent) and/or through foundations or sponsors (83 percent). In addition, 67 percent of organizations work off a grant cycle, and 13 percent have youth pay for their own programming. Other sources of funding include federal funding (e.g., Title I, taxpayer-supported), as well as school, district, university, or local organization funding.

***Figure 16. Most organizations use multiple streams of funding to pay for programming, and few charge local sites or youth to participate (n = 24)***




Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

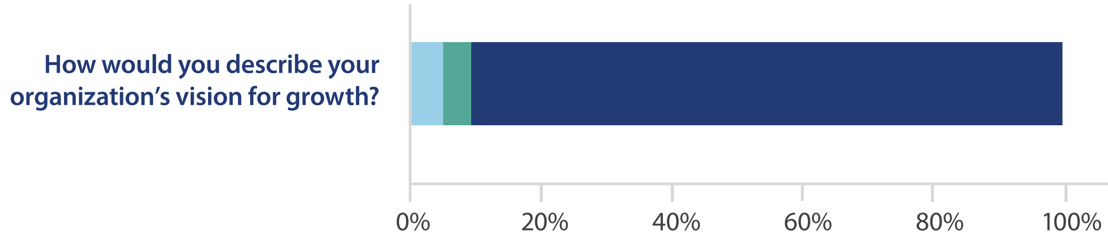
Program interviewees said they use various sources of funding, such as corporations or foundations, individual donors, grants, and program registration fees. Program and YDO interviewees emphasized the importance of networking, reaching out to potential donors, and keeping program costs down. Some key informants said programs need to have regular, multiyear funding (for both administrative costs related to scaling and direct program needs) to be able to scale successfully.

> ***"The funding—you've probably heard this from lots of partners—the predictability of funding, having multiyear funding ... we rely on a diverse set of dollars which does insulate us from risk, it also makes it slower to grow and harder to manage."*** (Higher Achievement)

We also asked programs to describe the vision for growth that guides their scaled programming. (figure 17). Overall, 96 percent of programs have some vision for growth, and 92 percent have strategies for achieving that growth. Key informant interviewees described the need for intentionality when scaling practices.

> ***"They have to have a process in place at the beginning for a growth scale model. You have to know how to design intending to grow and scale. If you do it at the tail end of it and you have to circle back on it, it is 10 times harder."*** (TIES)

*Figure 17. Most programs have a vision for growth and strategies to achieve it (n = 23)*

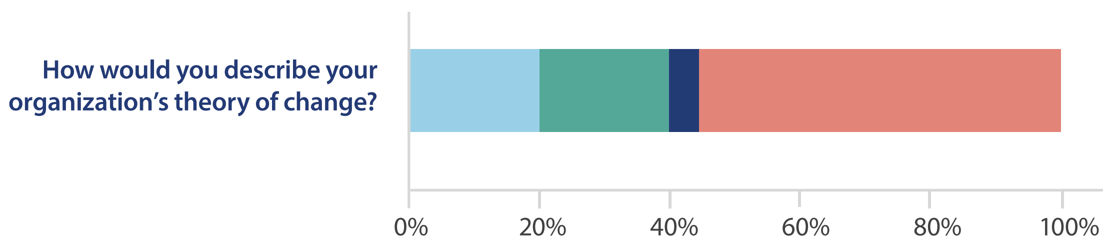



- We have a vision that does not explicitly include growing the organization
- We have a vision for growth, but we have no strategies for achieving that growth
- We have a vision for growth, and we have strategies for how to achieve that growth

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

In addition, we asked programs to describe their theory of change (figure 18). Although nearly all programs in our landscape scan had a vision for growth, 22 percent did not have a formal theory of change, and 17 percent had an outdated theory of change. However, 57 percent did have an up-to-date theory of change that included stakeholders' views.

*Figure 18. More than half of programs have an up-to-date theory of change (n = 23)*




- We have no formal theory of change
- Our theory of change is outdated
- Our theory of change is up to date but was created without stakeholder involvement
- Our theory of change is up to date and represents the views of our stakeholders

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

## Depth

Programs scale by having educators carry out activities—and by transforming educators' practice in a meaningful way. This can be done by developing deep knowledge and skills related to facilitating STEM learning. Some program interviewees emphasized how this program-sponsored professional development encourages deep learning and change by helping educators reconsider their relationship with STEM and/or program participants.

> ***"One of the philosophical things that we address pretty head-on in the trainings is that we see our program suggesting a pretty different role for teachers and facilitators and a different relationship to students—and also that we feel like it provides an opportunity for them to see students differently."*** (FUSE)

> ***"[Educators] have expressed over and over and over that [coaching MATHCOUNTS] really improved their own math skills, their own understanding, their own problem-solving skills—that's what we really hear about—and their own confidence in math and also their willingness to show kids that they may not know the answer right away, and that's okay."*** (MATHCOUNTS)

However, as indicated in Chapter 4, educator outcomes are often not evaluated by programs in a way that would indicate whether deep learning is occurring among educators. Staff turnover and the lack of time to develop deep learning may be affecting this element of scale. As indicated in surveys, about half of programs recruit certified educators (52 percent) and OST educators with STEM experience (52 percent). However, other programs recruit college students (40 percent), parents or other family members (28 percent), or STEM experts in the community, such as engineers (28 percent) who may not experience the same level of retention as career educators. Thus, whenever possible, staff turnover should be addressed in scaling OST STEM programs.

# Chapter 4. Evidence of Program Effectiveness

This chapter describes the evidence scaled programs gather to demonstrate their effectiveness. We asked program leaders to describe the student, educator, and family and community outcomes they measure. We also asked program and YDO interviewees to describe how they collect data, as well as the ways they use and share the information they collect (particularly any efforts toward continuous improvement). Finally, we conducted a literature review to find available evidence for each of these programs. Although limited to items that are publicly available and easily accessible, these items can provide some insights into the efficacy of the programs we found in our scan. The findings from this literature review are in appendix B. Most literature we found to support programs was based on surveys, but a few programs conducted randomized controlled trials, quasi-experimental design studies, and longitudinal impact studies.

## Summary

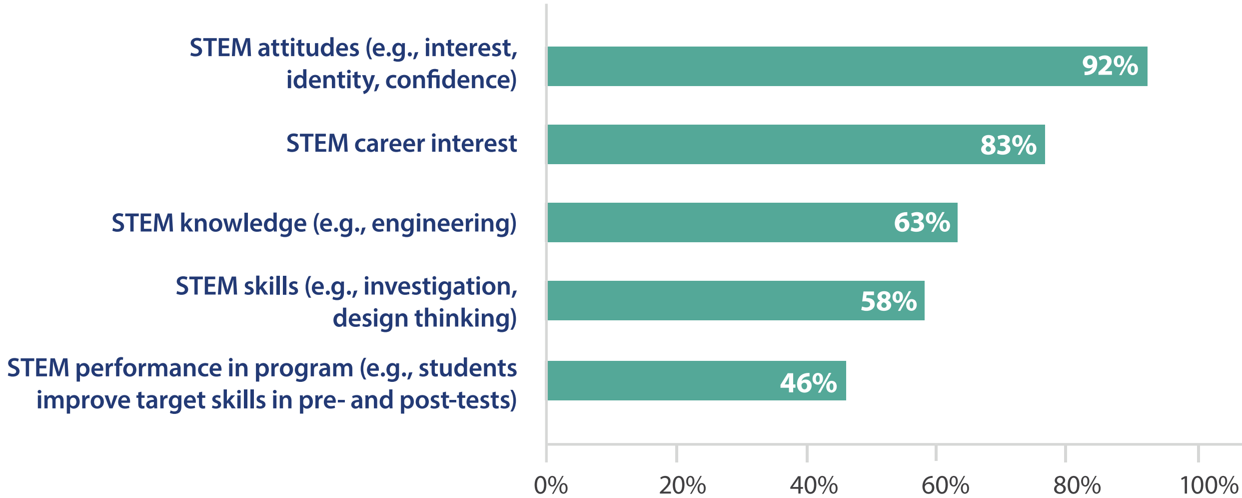
- ***Most programs measure students' STEM attitudes, career interest, and/or knowledge,*** but fewer measure school-based outcomes, such as math or science achievement and GPA.
- ***Programs most often use newsletters or events to foster family and community engagement.*** For programs that do encourage more active participation, more engage community members than families.
- ***Only a few programs measure educator, family, and community outcomes.***
- ***Most programs directly observe site implementation to determine quality,*** and about half use external evaluators.
- ***Program interviewees stressed the importance of using data for continuous improvement.*** In addition, key informants said data should be intentional and usable so that programs can adapt, as needed, based on their findings.

## Student outcome measures

Key informants, as well as program and YDO interviewees, said students' growth in their ability to solve problems and their overall confidence and abilities in STEM were the greatest benefits of including STEM programming in OST. In the survey, we asked programs to list the STEM outcomes they evaluate for students (figure 19).

Overall, 92 percent of programs measure STEM attitudes, including interest, identity, and confidence, and 83 percent measure STEM career interest. In addition, 63 percent measure STEM knowledge, but only 46 percent do so by measuring STEM performance in the program through pre- and post-tests or other means.

***Figure 19. Over 80 percent of programs measure STEM attitudes and career interest, and more than 45 percent measure STEM knowledge, skills, and performance (n=24)***

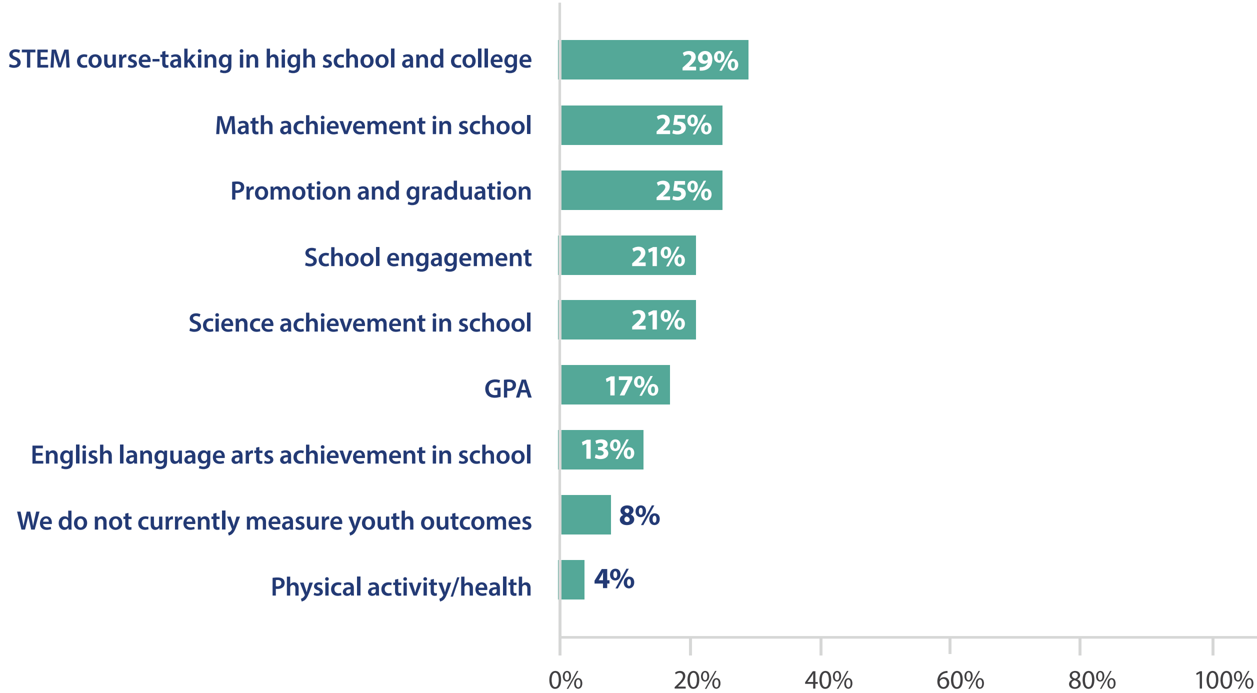



Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

We also asked programs what school-based outcomes they evaluate for students (figure 20). Overall, 29 percent of programs track STEM course-taking in high school and college; 25 percent track math achievement, as well as promotion and graduation; and 21 percent track school engagement and science achievement. Only 8 percent do not measure any student outcomes.

***Figure 20. Fewer programs evaluate school-based student outcomes (n = 24)***




Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

To collect these data, program leaders most frequently use youth surveys, which often include a pre- and post-test. A few programs employ other methods, such as gathering academic data, using an external evaluator, and conducting observations.

YDO interviewees also described their approach to evaluation. Many said their programs have formal evaluation structures in place either through partnerships with other STEM programs or as part of a larger evaluation of the student experience in their YDO. The former are more likely to focus on STEM, and the latter are more likely to focus on broad elements of the experience, such as problem-solving and sense of belonging.

## Educator outcome measures

As discussed in Chapter 3, a few programs consider deep learning among educators to be a critical element of educator engagement. For example, training and professional development offered by Camp Invention, GEMS, and Girlstart are designed to influence educators' overall teaching strategies (Changemaker Consulting LLC, 2014; Dubetz & Wilson, 2013; Girlstart, 2016). However, programs were limited in their evaluation of educator outcomes. In fact, many programs indicated in surveys and interviews that they did not measure educator outcomes. Those that do indicated they survey educators for either STEM knowledge, skills, and confidence or for feedback on their overall program experience.

## Family and community outcome measures

Family involvement plays a key role in building youth interest, achievement, and pathways in STEM. Promising family engagement practices include listening to and learning from families, as well as evaluating family outcomes (Kekelis & Sammet, 2019), but many STEM programs struggle to engage families in these ways. Our findings reflect this tension between the importance of and challenges with family engagement. Key informants described how family and community involvement was key for scaling programs. They also said this involvement—especially among parents and caregivers—was a key element for ensuring that scaled programs were properly adapted to the local context.

> ***"There was a teacher in Alaska who was using an engineering curriculum, and one of the parents had said, "Don't. I don't want my kids to learn engineering because they're going to leave me," thinking the kids would have to leave the community in order to be successful in a career. So, it's really important to tie those skills to the local community. Where could you use engineering? You're building a better boat or you're building a better fish-processing plant or a better transportation system, that these skills can be used locally, can be used to improve your community and your lifestyle. That it's not some far off Ivy League-only initiative. It's important to make it local."*** (Robert Noyce/Ellen Lettvin Informal STEM Education Fellow)

Although key informants discussed at length how family and community involvement was key for successful programming, this topic was addressed less frequently in program interviews. In the survey, a few programs indicated that they measure outcomes for families or communities, including surveying families and community partners for feedback. A few programs also indicated that they had done family surveys in the past but had run into challenges with response rates and decided to no longer conduct these surveys.

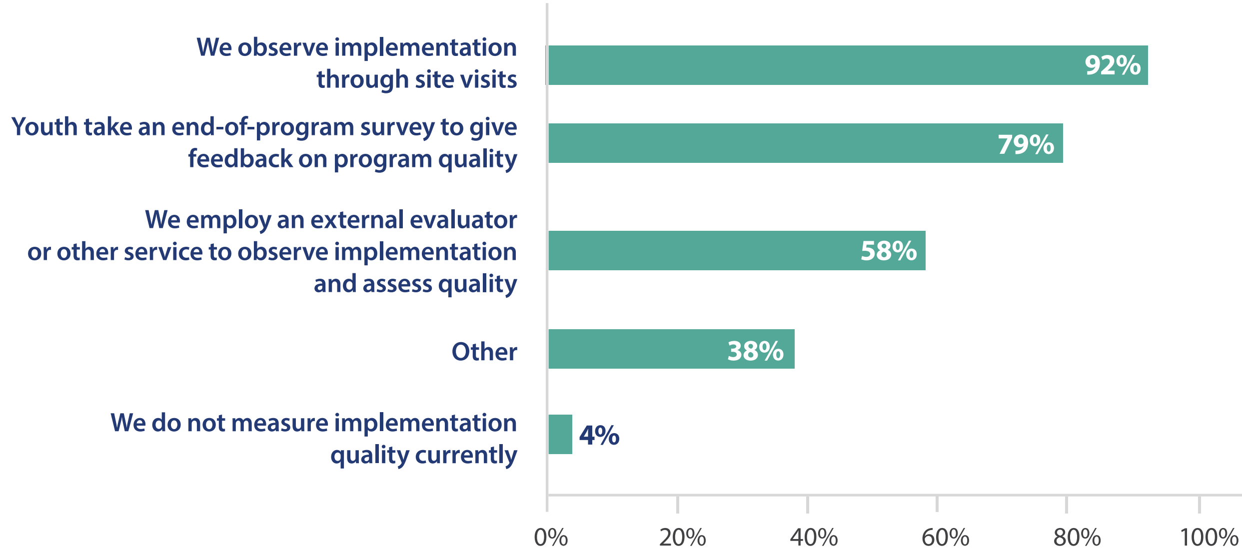
Some YDO interviewees said they expected families would be involved in STEM programming at sites that have taken it up, simply due to the level of involvement families normally have with their programming. However, they did not measure the level of family involvement.

## Program fidelity and quality measures

Program leaders were also asked to indicate how they measure the quality of the program as it is implemented in multiple locales (figure 21). Overall, 92 percent perform site visits to observe implementation fidelity at local affiliates, and 58 percent use an external evaluator. Other methods include administering educator surveys and having partners do their own implementation evaluation. One program said it used an external evaluator during key points in the development phase but does not evaluate new implementation.

> ***"We see the most successful implementations when those facilitators have ownership to adapt in order to fit their goals and needs, while they keep the integrity of our core design principles. We see that in site visits all the time in terms of facilitators who are able to embody the program."*** (FUSE)

*Figure 21. Most programs directly observe implementation to measure fidelity (n=24)*




Note: Participants could select all that apply.

*Source: Education Northwest analysis of OST STEM landscape scan survey data.*

## Using data for continuous improvement

Program and YDO interviewees were asked to describe their approach to data and evidence. Programs approach gathering, reviewing, and disseminating data and evidence differently. Some larger programs and YDOs have data teams, some use external evaluators, and others use both. Some programs rely heavily on direct staff members to collect data, and others collect data more centrally. Either way, programs emphasized the importance of gathering and using data for both continuous improvement and communicating their outcomes and impact to others, including funders. Many program interviewees described their program activities as "data-driven" and "evidence-based."

> ***"We've changed how programs are run, we've developed new programs based on data we received, and we've changed our registration process based on data we've received. I would say we are constantly looking at end-of-year surveys, end-of-year registration numbers, end-of-year feedback, and I think we're very good about not having a knee-jerk reaction to one negative comment. But if we see a trend, or we hear things over a couple of years, we definitely address it."*** (MATHCOUNTS)

> ***"Our tagline is that we use data as a flashlight and not a hammer and so ... when we have a question, it's like we're in a cave with this flashlight … and using data to navigate our path forward."*** (Higher Achievement)

Key informants also emphasized that to inform continuous improvement, the data should be intentional and usable so that programs can understand what adaptations are needed. A few key informants said overly cumbersome or prescriptive approaches to evaluation can leave site leaders without a clear path of how to make decisions based on the data they receive, thus making it hard to justify their efforts.

Finally, program leaders and YDOs were also asked to describe how they communicate findings both internally (to facilitate learning) and to external parties. Regarding the former, program leaders and YDOs both described holding meetings and internally circulating reports or blog posts to describe evaluation findings. Regarding the latter, social media and blog posts, annual reports, and occasionally conferences were used to disseminate evaluation findings.

# Chapter 5. Recommendations

This chapter provides specific recommendations for practitioners and funders seeking to scale OST STEM programming. These recommendations draw on the responses of programs to questions posed during the landscape scan, as well as the authors analysis of the data.

## Confirm that programs that are scaling fit the needs of the local community

- Conduct needs-sensing to ensure the program both fills a need in the local community and is a viable option for long-term investment in the community.
- Have the new site prepare funding and community partnerships ahead of implementation.
- Provide future sites with data and evidence that include sample characteristics so communities can understand the likelihood that the program will demonstrate similar success as it has in other locales.

## Ensure the program has the capacity it needs to scale

- Make sure the program is designed in such a way that program practices can be implemented in multiple settings.
- Support the scaling program at both the local and regional or national level through adequate funding, including funds designated to the administrative activities of scaling rather than funds solely for program delivery.
- Prepare policies and infrastructures in place at the regional or national level that can support sustainable scaling.
- Invest in deep learning among educators by providing training that builds more than just program knowledge (e.g. building positive youth relationships) and by building networks of support among educators. Consider a train-the-trainer model to build long-term capacity in educators.
- Develop strategies to reduce educator turnover in programs.

## Keep the program adaptable to community needs

- Provide opportunities for sites to build culturally responsive and socially meaningful experiences for youth by ensuring components of the programming are adaptable to the community and population being served.
- Coach educators on strategies for investigating and developing adaptable program elements. In addition, support activities for educators to increase ownership in their programming.
- Continue to measure "non-negotiable" elements (e.g., program materials, youth collaboration) for implementation fidelity.

## Support the use of data and evidence for continuous improvement

- Ensure the data collected are both relevant and useful for local sites, including information on how to improve the quality of service delivery and the outcomes the program provides for students, educators, families, and communities.
- Expand data and evidence beyond student outcomes in STEM to include academic outcomes, as well as educator, family, and community outcomes.
- Provide existing sites with feedback on data and evidence in a useable way and consider offering training on data use.

## Maintain consistent communication with stakeholders about the benefits of the program

- Spread the successes and opportunities of the program through formal and informal networking channels. In addition, invest in regular outreach to existing OST programs, schools, or districts.
- Ensure that there are sufficient communication channels in place to describe students' experiences to families.

# Appendix A. List of Programs and Interviewees

***Table A1. Programs identified through Education Northwest's landscape scan***

| | | |
|---|---|---|
| Bridge to Enter Advanced Mathematics (BEAM) | For Inspiration and Recognition of Science and Technology (FIRST) Tech Challenge | MATHCOUNTS |
| Black Girls Code | FUSE | MESA Schools Program |
| Botball | Girls Excelling in Math and Science (GEMS) | After-school Universe (a program of NASA) |
| Camp Invention | Girls Who Code Clubs | Pre-Freshman Engineering Program (PREP) |
| The Clubhouse Network | Girlstart (summer camp) | Science Action Club, California Academy of Sciences |
| CryptoClub | GirlStart (after-school program) | STEM Scouts |
| Engineering is Elementary and Engineering Adventures | Higher Achievement | Summer Engineering Experience for Kids (SEEK) |
| Eureka! (a program of Girls Inc.) | Imagine Science | Techbridge Inspire |
| FIRST LEGO League | Mad Science | Technovation Girls |

***Table A2. Key informant interview participants and their organizational affiliation***

| **Name** | **Organization** |
|---|---|
| Chris Neitzey, Jen Rinehart, and Leah Silverberg | Afterschool Alliance |
| Gil Noam | The PEAR Institute |
| Patti Curtis | Robert Noyce/Ellen Lettvin Informal STEM Education Fellow |
| Ron Ottinger, Teresa Drew, and Linda Kekelis | STEM Next Opportunity Fund |
| Jan Morrison | Teaching Institute for Excellence in STEM: TIES |

***Table A3. Program interview participants and their organizational affiliation***

| Name | Organization |
|---|---|
| Alaina Rutledge | Camp Invention |
| Gail Breslow | The Clubhouse Network |
| Jill Olson | Engineering Adventures |
| Jennie Mathur | Eureka! |
| Nancy Boyer | FIRST |
| Lizzie Perkins | FUSE Studios |
| Laura Reasoner Jones | GEMS |
| Tamara Hudgins | Girlstart |
| Lynsey Jeffries | Higher Achievement |
| Jim Chesire | Imagine Science/Bolster Mission Consulting |
| Kristen Chandler | MATHCOUNTS Foundation |
| Laura Herszenhorn | Science Action Club, California Academy of Sciences |

***Table A4. Youth development organization interview participants and their organizational affiliation***

| Name | Organization |
|---|---|
| Miriam Lund | 21st Century Community Learning Centers |
| Susan Ciavolino | Boys & Girls Clubs of America |
| Shawna Rosenzweig | Camp Fire |
| Lynne Tsuda | Girls Inc. |
| Karen A Peterson | National Girls Collaborative Project |
| Jane Kim | YMCA |

***Table A5. Intermediary, research, and funding organizations in the OST and STEM fields whose websites were used in the initial scan for programs***

| | |
|---|---|
| **Intermediary and Network Organizations** | Afterschool Alliance |
| | National AfterSchool Association |
| | Coalition for Science After School |
| | Every Hour Counts network |
| | ExpandED Schools |
| | National Girl's Collaborative Project |
| | STEM Ecosystems |
| | STEM Next |
| | Teaching Institute for Excellence in STEM: TIES |
| **Funders** | Center for Advancement of Informal Science Education |
| | National Aeronautics and Space Administration (NASA) |
| | Lemelson Foundation |
| | The Wallace Foundation |
| **Research Organizations** | David P. Weikart Center for Youth Program Quality |
| | National Academy of Sciences (NAS) |
| | National Institute of Out-on-School Time |
| | NSF resource centers (CADRE, STELAR, and CIRCL) |
| | The PEAR institute |
| **Other Organizations** | Education Development Center |
| | The Franklin Institute |
| | Mott Foundation |
| | WestEd – STEMWorks |
| | Youth Development Executives of King County |

# Appendix B: Literature Review Findings

## Methods

This review of OST STEM literature was a multistep process that increased in specificity as the review progressed.

1. Collect general/overview OST STEM literature
   a. Education Northwest researchers conducted an initial review of academic literature and white papers, as well as the websites and reports of key intermediary, research, and funding organizations in the OST and STEM fields to identify programs that may meet criteria for inclusion (see table A5).

2. Review general literature for mentions of OST STEM programs
   a. Education Northwest researchers reviewed this literature to find examples of data and outcomes related to specific OST STEM programs. We included only mentions and pieces of literature that were based on rigorous, data-based evaluations, such as randomized controlled trials, quantitative analysis, literature reviews, and research summaries. These mentions were catalogued and sorted into three categories: student outcomes, educator outcomes, and family and/or community outcomes.

3. Review programs to determine fit within Overdeck criteria[3]
   a. Simultaneously with a larger web review of OST STEM programs, we reviewed programs mentioned in the general literature for Overdeck's criteria to assess fit. We eliminated any programs that did not fit these criteria.

4. Find additional literature on selected programs
   a. Once the OST STEM program web review was completed, surveys were administered, and interviews with relevant programs were conducted, Education Northwest researchers returned to the literature review to find additional program-specific literature indicating program data collection and outcomes. These literature are often program evaluations conducted by program staff members or third-party researchers incorporating at least mixed-methods data collection and analyses. Like the general OST STEM literature, these pieces were also analyzed for student (see table 7) and educator (see table 8) outcomes.

[3] Overdeck's criteria for inclusion in this landscape scan are: the program must provide implementation support to sites and staff members; the program serves students ages 5–14 for about 20 hours or more; and the program has expanded to operate in at least more than one city—but preferably regionally or nationally.

This is not intended to be an exhaustive list of program outcomes. Instead, it provides an overview of the evidence available for identified programs.

***Table B1. Literature review findings for student outcomes for identified programs***

| Program | Reference | Research Type | Youth Outcomes | Youth Population[4] |
|---|---|---|---|---|
| Botball | Stein & Nickerson (2004) | Survey and focus group administration and analysis | **STEM attitudes** ("85% of [responding participants] have a more positive attitude about the usefulness of math and science than they had before participating in Botball." "51% of students surveyed reported a definite increase in confidence in being creative with technology, with 24% reporting somewhat of an increase.")<br>**STEM career interest** ("72% of students surveyed said they were interested in pursuing a career in engineering, science, or technology.") | Middle school youth |
| Camp Invention | National Inventors Hall of Fame (n.d.) | Summary of multiple evaluations | **STEM attitudes** ("Just one week of Camp Invention results in significant short-term and long-term improvements in creativity, STEM interest, collaboration and problem solving.")<br>**School engagement** ("Participating in Camp Invention during the summer has increased students' performance and engagement the following school year.")<br>**School attendance** ("Following one recent Camp Invention program, 56% of students with high-risk absence rates demonstrated excellent attendance.")<br>**GPA** ("Camp Invention contributes to better attendance, GPA and test scores – three key steps to ensuring a child takes a college path.") | K-6 grade youth |

[4] Where available, the youth population was determined based on the sample identified in the evaluation document. In documents where the sample was not described, the youth population was determined by the population the program serves.

| Program | Reference | Research Type | Youth Outcomes | Youth Population[4] |
|---|---|---|---|---|
| Engineering Everywhere | Higgins et al. (2015) | Pre- and post-program survey administration and analysis | **STEM interest** (Students scored significantly higher after participation on scales relating to the importance of engineering, desire to learn engineering, enjoyment/interest in engineering, and value of engineering to society.)<br><br>**STEM skills** (Students scored significantly higher after participation when asked to rank their agreement with the statement "Engineering is easy for me.") | Middle school youth |
| FIRST LEGO League | Center for Youth and Communities (2013) | Survey administration and analysis | **STEM interest** ("Over 90% of the FLL coaches reported an increase in team members' interest in computers and technology and their interest in how math and science were used in the real world. . . . 89% of participants wanted to learn more about science and technology, 90% wanted to learn more about computers and robotics, and 89% wanted to learn more about how science and technology can be used to solve problems in the real world.")<br><br>**STEM career interest** ("86% reported that their team members were more interested in jobs or careers in science or technology." "80% were interested in having a job that uses science or technology. Over two-thirds (67%) indicated that they want to be a scientist or an engineer.")<br><br>**STEM knowledge and skills** ("More than 90% [of participants] reported learning how science and technology could be used to solve problems in the real world" "97% learned that subjects they studied in school could help them solve real-world problems.")<br><br>**STEM attitudes** (Girls were more likely to report increased confidence in their math and science abilities.) | Youth ages 9-14 |

| Program | Reference | Research Type | Youth Outcomes | Youth Population[4] |
|---|---|---|---|---|
| FIRST Tech Challenge | Center for Youth and Communities (2013) | Survey administration and analysis | **STEM career interest** (80% of team members or more reported that…they wanted to learn more about science and technology, were interested in science and technology careers, and wanted to be a scientist or engineer." "[Participants] were substantially more likely to report an increased in interest in computer programming (91%).")<br><br>**STEM course-taking in high school and college** ("80% or more also reported that they…plan to take more challenging math or science courses and were more interested in going to college.")<br><br>**STEM knowledge** ("Team leaders also reported gains in team member understanding of basic science principles (90%+), computer skills (85%+), math skills (70%+), understanding of engineering design (95%), and potential careers in science and technology (85%+).") | Youth ages 7-12 |
| FUSE Studios | DiGiacomo, Van Horne, Salazar, Sultan, & Penuel (2016) | Survey administration and analysis, including Connected Learning items, and data from FUSE "learning challenges" | **STEM attitudes** ("Over 97% of students located themselves at the two highest levels of 'peer support' and 'interest discovery' during their experience at FUSE" "FUSE's support for interest discovery was associated with better attitudes toward engineering- and science.")<br><br>**STEM skills** ("Articulated benefits of using FUSE in their classroom were reported as providing students with a relaxed and fun space in a school setting to try things out, explore, learn that failure is okay, and authentically rely on peer-support in the learning process.") | Elementary, middle, and high school youth |
| Girls Excelling in Math and Science (GEMS) | Dubetz & Wilson (2013) | Pre- and post-program survey administration and analysis | **STEM attitudes** (GEMS "participant interest in science and math increase on average by 35 percent after attending a GEMS event.") | Middle school girls |
| Girls Inc., Eureka! | Reding et al. (2016) | Social network analysis (using periodic surveys) | **STEM attitudes and interest** (Participants report an increase in feelings of support, success, and connection with peers and more experienced students through program participation, which can build the "'opportunity freeway' for many underserved youth, especially girls and minorities in STEM.") | Girls ages 12-14 |

| Program | Reference | Research Type | Youth Outcomes | Youth Population[4] |
|---|---|---|---|---|
| Girlstart (Afterschool) | Girlstart (2016) | Quasi-experimental evaluation of program impact | **STEM attitudes and interest** ("92% [of participants] agree that, "if I try hard, I can be good at science." "85% [of participants] report 'I like science!'")<br><br>**STEM knowledge** ("82% of participants correctly identified all the steps of the engineering design process."; "Over two years, 71% of Austin ISD Girlstart After School participants passed the 5th grade science STAAR exam" compared with "48% of a comparison group of non-participant girls matched on key demographic indicators…")<br><br>**STEM course-taking in high school and college** ("82% [of participants] report a strong interest in taking more STEM courses in middle and high school." "97% [of participants] want more STEM at school." "After leaving Girlstart After School, participants enrolled in advanced and pre-AP math and science classes at a rate of 1.58 courses per girl (over 3 years), compared with 1.00 courses per non-participant girl in our comparison group.")<br><br>**STEM career interest** ("73% of Girlstart After School girls express a desire for a STEM career.") | Girls in grades 4-6, primarily low-income and minority |
| Girlstart (Afterschool) | Hudgins (2017) | Quasi-experimental evaluation of program impact | **Math and science achievement in school** ("85% of Girlstart After School participants 'met standard' on the fifth-grade State of Texas Assessments of Academic Readiness (STAAR) test in Math versus 70% of a matched comparison group of non-Girlstart girls." "71% of Girlstart participants "met standard" on the fifth-grade STAAR test in Science, versus 48% of non-Girlstart girls.")<br><br>**STEM course-taking in high school and college** (Girlstart girls "are more likely to increase their involvement in advanced STEM courses overtime, whereas nonparticipants' enrollment decreases over time.") | Girls in grades 4-6, primarily low-income and minority |

| Program | Reference | Research Type | Youth Outcomes | Youth Population[4] |
|---|---|---|---|---|
| Girlstart (Afterschool) | Girlstart (2016) | Quasi-experimental evaluation of program impact | **STEM knowledge** ("92% of participants demonstrated acumen in scientific knowledge and reasoning (e.g. using the scientific method.")<br>**STEM course-taking in high school and college** ("88% of participants reported a strong desire to take more STEM classes in high school.")<br>**STEM interest** ("89% of participants reported that they are MORE interested in STEM after attending Girlstart Summer Camp.")<br>**STEM career interest** ("78% of participants expressed a strong interest in entering a STEM career." "88% [of participants] say that they think developing games, robots, or apps would be a fun career.") | Girls in grades 4-6, primarily low-income and minority |
| Higher Achievement | Herrera, Baldwin Grossman, & Linden (2013) | Randomized controlled trial | **Achievement in school** (Participants achieved statistically significant gains in math problem-solving standardized test scores.) | Underserved youth in grades 5-6 |
| Imagine Science | Clark, Sirangelo, Washington, Vredenburgh, & Chesire (2017) | Survey administration and analysis (using STEM interest surveys developed by PEAR) | **STEM attitudes** ("70.7 percent of youth reported greater levels of STEM interest at the end of the program compared to the beginning." "Imagine Science middle school grade youth reported engaging in STEM activities and having greater STEM identity at statistically significant rates that are higher than national norms.") | Underserved youth |

| Program | Reference | Research Type | Youth Outcomes | Youth Population[4] |
|---|---|---|---|---|
| Mad Science | Char Associates (2006) | Randomized controlled trial | **STEM interest** ("Students participating in Mad Science experienced an increase of 12.22% in their interest in science vs. only a 2.3% increase experienced by comparison group students who did not participate in Mad Science" "Students participating in Mad Science showed an increase of 18.6% in their attitudes that "science is fun" vs. only a 1.5% increase for comparison group students that did not have Mad Science.")<br>**STEM knowledge** ("Students who participated in Mad Science experienced a gain of 41.3% in their science content knowledge vs. only 6.4% experienced by comparison group students who did not participate in Mad Science.") | Elementary school youth |
| MATHCOUNTS | Reid, Melia, Scott, Freedman, & Crystal-Mansour (2017) | Survey administration and analysis | **STEM attitudes** ("Over 80 percent of student competitors agreed that their confidence in math/STEM and their excitement for math/STEM have grown since participating in the MATHCOUNTS Competition Series.")<br>**STEM course-taking in high school and college** ("Students who participated in the MATHCOUNTS Competition Series for three years were significantly more likely to plan to take additional math classes in high school, attend postsecondary education, and pursue a degree in math or STEM.") | Youth in grades 6-8 |
| MESA Schools Program | Greenberg Motamedi, & Singh (2016) | Impact evaluation | **Math and science achievement in school** ("MESA students had higher grades in science and mathematics classes than their peers.") | Underserved youth in grades 6-8 |
| | Greenberg Motamedi, Serano, & Hanson (2020) | Longitudinal impact study | **Graduation** ("MESA students were significantly more likely to graduate from high school than their peers who did not participate in the program.") | |
| After-school Universe – NASA | Cornerstone Evaluation Associates (2012) | Pre-post knowledge assessments | **STEM attitudes** (Participants report greater science enjoyment and more positive attitudes toward science after participation.) | Underserved youth in middle and high school |

| Program | Reference | Research Type | Youth Outcomes | Youth Population[4] |
|---|---|---|---|---|
| Pre-Freshman Engineering Program (PREP) | Crown (2012) | Longitudinal analysis | **STEM course-taking in college** ("45% of PREP college graduates majored in STEM.")<br><br>High school graduation and college attendance ("99% of PREP students attend college.") | Hispanic middle and high school youth |
| Summer Engineering Experience for Kids (SEEK) | Knight et al. (2018) | Pre- and post-program assessment survey and analysis | **STEM achievement** (Participants' scores on math and engineering posttests are higher than on pretests.) | Black youth in elementary school |
| Techbridge Inspire | Krishnamurthi et al. (2014) | Mixed-methods evaluation | **STEM interest** ("Eighty percent of participants planned to take on additional STEM learning opportunities by electing advanced math and/or science classes.")<br><br>**STEM interest** ("Eighty-five percent reported they find engineering more interesting and 83 percent said they find science more interesting.")<br><br>**STEM career interest** ("Eighty-one percent said they can see themselves working in technology, science or engineering.")<br><br>**STEM achievement** ("Techbridge girls scored an average of 26 points higher (321 vs. 295) than non- Techbridge girls on the California Standards Algebra II test, and an average of 43 points higher (365 vs. 322) on the California Standards Biology test.")<br><br>**STEM school achievement** ("Techbridge girls have a higher weighted total cumulative GPA at high school graduation (3.32) than girls who have not participated in Techbridge (2.94).") | Black youth in elementary school |

***Table B2. Literature review findings for educator outcomes for identified programs***

| Program | Reference | Research Type | Educator Outcomes |
|---|---|---|---|
| Camp Invention | National Inventors Hall of Fame (n.d.) | Summary of multiple evaluations | **STEM teaching practices** ("Our program's influence on instructors' teaching strategies can make a positive impact on students beyond those participating in Camp Invention.") |
| FUSE Studios | DiGiacomo et al. (2016) | Survey administration and analysis | **STEM teaching practices** ("Facilitators report positive experiences with using FUSE in their classrooms, whether they chose to fully adopt FUSE as their course curriculum or integrate FUSE into their existing curriculum.") |
| Girls Excelling in Math and Science (GEMS) | Dubetz & Wilson (2013) | Pre-and post-program survey administration and analysis | **STEM teaching practices** (Teaching assistants in GEMS programs apply their learning in their own classrooms.) |
| Girlstart | Girlstart (2016) | Quasi-experimental evaluation of program impact | **STEM teaching practices** (STEM CREW training provides training for preservice teachers involved as counselors in Girlstart; "We prepare these future teachers for effective STEM teaching by providing them with the pedagogical and practical skills they will need to engage students in STEM." |
| MATHCOUNTS | Reid et al. (2017) | | **STEM attitudes and teaching practices** ("Almost 90 percent of coaches … reported that their confidence in teaching math/STEM has grown due to their participation in the program.") |

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