Afterschool Matters

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WELCOME

Parents, educators, policymakers, and the media express a lot of worry about what young people have lost during the pandemic. The concerns are real: Many students have struggled academically or simply dropped out of online schooling. Levels of depression and anxiety among youth, already higher than ever before, have climbed in response to the isolation, grief, and worry we have all experienced.

I don't want to minimize these losses. But I do want to point out that young people, and the professionals who work with them, have gained in ways we could not have imagined.

In March 2020, schools, teachers, and students pivoted in a matter of days from in-person to fully remote learning. There were some hiccups and some major gaps. But eventually most teachers, students, and parents mastered technology they had never experienced before. More importantly, they learned how to teach and how to learn in a new environment.

OST programs followed suit. Unlike schools, most programs had the luxury of taking time, before they relaunched, to figure out what to do online and how to do it. What followed was a burst of energy, creativity, and resilience that we could not have experienced in a less challenging year.

Many young people found a new voice in online environments. Nearly all OST providers can tell the story of one or more participants who are more expressive in online chat than they ever were in person. Some youth discovered new skills, often combining technology with artistic or academic learning in creative ways. Some found comfort in independent work; others benefited from more focused exchanges and deeper relationships with adult mentors.

Yes, moving through the pandemic has been stressful for all concerned. Yet program leaders, frontline staff, and young people have shown remarkable resilience. They have been formed new avenues of communication while working virtually. They have mastered new "spaces" where meaningful learning takes place. They have figured out how to share singing, dancing, theatre, cooking, and gardening without leaving their homes.

As the field steps forward this summer and fall to fill in for what has been lost, we should also celebrate what we and the young people we serve have gained. As we return to in-person programming, let's avoid the impulse to "go back to the way we were." What parts of what we learned in this hard, hard year are worth keeping?

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Disconnecting and Reconnecting

A Photovoice Workshop on Healthy Social Media Use

Linda Charmaraman, Catherine Grevet Delcourt, Cynthia Serrano Najera, Emily Vargas, Alyssa Gramajo, Amanda M. Richer, and Anna M. Adachi-Mejia

Educators, parents, practitioners, and mainstream media often raise concerns about the dangers of social media for teenagers. Frequent social media use and exposure to sites that emphasize anonymity may be risky for young adolescents (Charmaraman, Gladstone, & Richer, 2018). However, with healthy limits, social media can improve social connectivity, enhance a sense of belonging, and provide forums for self-disclosure and identity exploration (James et al., 2017).

Early adolescents often hear messages like "Don't spend too much time on your phone!" Yet little is known about how middle school youth regulate their smartphone usage. To help fill that gap, we held a

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week-long summer workshop to explore early adolescents' perspectives on positive and healthy social media usage.

We used a community-based participatory action research model to design our social media curriculum around one specific middle school community, beginning by gathering perspectives from students, parents, and staff. This work shaped our workshop curriculum, which we piloted in summer 2019 with 13 students from this middle school. The workshop activities engaged participants in reflecting on their social media habits, using a method called *photovoice* to empower participants to share the world through their lenses. In the process, they developed interest in becoming producers as well as critical consumers of social media. Our long-term goal is to incorporate these participants' voices into a user-centered design process to build an app, website, or workshop to support healthy social media use. Our photovoice project provides an example of how to engage in a research-community collaboration to learn which social media and well-being issues are most salient in a school community. It is also a model to show afterschool or summer program providers how to conduct their own photovoice workshop.

Youth and Social Media

Previous studies of social media interventions to promote health in adolescents have found some success in engaging youth in the process of creating content, including videos (Barrett et al., 2017). Researchers have also documented limitations in the ability of these interventions to maintain participant engagement; some young people were not interested in the specific social media platform used or in posting on social media generally, did not have easy access to a mobile device, or were too busy (Yi-Frazier et al., 2015).

In 2018, more than 10 million youth were involved in afterschool programs (Moss, 2018) and 90 percent of teens used social media (American Academy of Child & Adolescent Psychiatry, 2018), yet we found limited research on afterschool programs that engage young people in learning healthy uses of social media. Our search found only seven articles (Afterschool Alliance & MetLife Foundation, 2013; Barnett et al., 2014; Davis et al., 2017; Felt et al., 2012; James, 2013; Mills et al., 2018; Vickery, 2014) that studied how social media and technology can be meaningfully incorporated in afterschool programs. Of these, three articles studied afterschool programs for high school youth; the other four programs were for both high school and middle school participants. Research on this topic not only is limited but also can quickly become outdated, as social media and use of technology evolve almost daily.

Our workshop structure was informed by the limited prior work, capitalizing on three axes from these studies: identity construction, practice of safe social media use, and connections between science and participants' everyday lives.

The study focusing on the role of digital media in identity construction (Davis et al., 2017) described a program in which participants developed apps that others could use. In the process, participants were able to express their identities, navigate unfamiliar spaces, and connect their afterschool activities to their social contexts at home. This experience placed participants' interests at the center of the program, giving them freedom to express themselves and gain a positive sense of identity (Davis et al., 2017).

Another program taught middle school participants how to use social technology safely by practicing the tips they learned using an online safety skills program (James, 2013). The program leader who created the curriculum intentionally incorporated introductions to computer hardware and software into daily lessons to help participants master new technology skills, all while incorporating cyber safety suggestions. For example, the program reinforced a social network site with a safety feature that prevents users from using curse words.

The third study coupled a life-relevant science learning program with an integrated social media app to help learners connect science learning to their everyday lives (Mills et al., 2018). Participants created social media posts, including pictures, screenshots, and texts, that helped them explore rich connections between science and their lives, but only after they discussed their findings and questions. Researchers found that combining social media with practices such as prompting learners to discuss their posts and encouraging non-scientific posts revealed the rich contexts of participants' social media sharing (Mills et al., 2018).

Similarly, to harness the digital contexts with which youth already are familiar and provide hands-on activities related to their personal identities, our summer workshop used a research technique called *photovoice* (e.g., Wang & Burris, 2017). Photovoice projects invite participants to take photographs to define and communicate their unique perspectives in order to generate dialogue and initiate social action. For example, a photovoice project might showcase students' safety concerns in a school or highlight health issues within an ethnic group. Photovoice is often used in public health studies that seek to engage and empower vulnerable participants (Farrah et al., 2013), including young people, whose voices are not often represented in the design of campaigns intended to improve their health. Instead of viewing young people as passive players suffering from the all-consuming demands of digital technology, photovoice allows them to try new personas as active storytellers and advocates for change (Kia-Keating et al., 2017). Using photovoice with social media can engage young people in digital citizenship and in meaningful, broad discussions about individual and community health and well-being (Bugos et al., 2014; Kia-Keating, 2009; Wang et al., 1998; Wilson et al., 2006). This research method is particularly well suited to engage teenagers in reflection on their social media usage because teens already use photos in nuanced ways to express themselves online.

Pre-Workshop Research

We are an interdisciplinary research team with backgrounds in out-of-school time program quality, positive youth development, community health, and human–computer interaction. Our community-based collaboration was based on our positive track record of partnership with a large suburban middle school in Massachusetts. The project started with the "needfinding" stage described below, in which we analyzed the results of large-scale student surveys and other data. This contextualization work shaped the structure and curriculum of the summer workshop.

Student Survey

We used the results of two large-scale surveys we administered in Massachusetts middle schools to inform our workshop. The first survey, funded by Children and Screens: Institute of Digital Media and Child Development in 2017–2018, included 700 responses from youth ages 11–16 (Charmaraman, Richer, & Moreno, 2018). Survey results showed that this age group was highly connected: 84 percent of respondents had a smartphone, and 78 percent used at least one social media site.

Our subsequent study of 772 adolescents aged 11–15, conducted in 2019–2020 with funding from the National Institutes of Health, focused on the relationship between social media usage and well-being (Charmaraman, Moreno, & Richer, 2020; Charmaraman et al., in press). We found that the age at which a teenager starts using social media can affect future online behaviors. For example, joining Instagram or Snapchat at age 10 or younger was significantly associated with more unsympathetic online behaviors, online sexual harassment, and digital addiction than was joining these services at age 11 and up (Charmaraman et al., 2020).

This study included a survey that asked what topics would be most relevant for a summer workshop about social media and well-being. In general, respondents were interested in learning how to have more agency, as shown in Table 1. We used these responses to help us structure the curriculum.

School Staff Focus Groups

Our community-based approach included taking time to learn about the school in which we planned to hold the workshop. We hosted two focus groups, one with teachers and one with counselors, to learn about the school's social technology and student well-being needs.

The teachers shared that they had not received much training about use of social media in their classroom. They noted that social media incidents outside of school frequently caused conflict between students. Teachers doubted that students would feel comfortable sharing their true feelings about social media in a group setting.

Table 1. Survey Responses Used to Structure the Social Media Workshop

Possible Topic for a Summer Workshop	Percentage of Respondents (N = 772)
Making the world a better place	68%
Improving self-esteem	65%
Reducing loneliness and depression	61%
Taking more breaks from social media	59%
Providing social support to others	59%

The counselors overwhelmingly expressed negative perceptions of social media due to frequent incidents involving students, such as mean comments about peers and illicit photos of other (mainly female) students. Like the teachers, the counselors expressed concern that the workshop would not reach the students who could benefit most—those with behavioral problems related to social media use. In response to this observation, we made sure to recruit participants who were representative of the student body as a whole.

This information helped to inform our approach of incorporating photovoice activities into the curriculum. Learning from the teachers and counselors that photos had been used for cyberbullying and harassment while simultaneously learning from survey results that students were curating their photos on social media, we decided to feature activities to help participants understand how powerful photos are, especially when shared online.

Participant Pre-Workshop Survey

For the workshop, we recruited 13 participants, six girls and seven boys, who were entering grade 7, 8, or 9 in fall 2019. To recruit these participants, we contacted parents who had completed an online survey about their teen's social media use and had indicated interest in their teen participating in a summer social media workshop. The participants reflected the diversity of the larger school community: five were White, three Latinx, two Asian, and three Black or biracial Black.

In order to tailor the workshop content, which included computer topics as well as social media knowledge, we conducted a pre-workshop online survey with participants about their STEM experience and artistic inclinations. The most popular interest was in creative arts: visual arts, music, and poetry. Next was learning how to create a website or application. About a third of participants had learned how to code on their own or had uploaded their own YouTube content. Fewer had ever attended a STEM-focused afterschool program or camp. Most respondents already owned a smartphone; 58 percent had received their first smartphone at age 10 or younger. Half of respondents reported that they sometimes or always posted photos on social media; the other half rarely or never posted photos. More than half reported that they checked their social media at least every few hours, while less than half checked every few days or rarely. The most commonly used social media platform was YouTube, followed by TikTok, WhatsApp, Snapchat, Instagram, and a long list of less common sites. Only one-third of the participants reported that they often or always "like" or comment when a friend shares good news online. Most participants had attempted to raise awareness about a social issue through social media posts.

Photovoice Workshop Structure

Using the results of our large-scale surveys and of the participant survey, we developed the four-day curriculum in daily themes, described below. Each day the schedule was divided into a digital well-being unit and a STEM unit related to the daily theme. The workshop included a well-being objective and a STEM objective:

1. To engage participants in reflection about social media and well-being
2. To introduce participants to core computing concepts, such as bits and code, and to internet concepts such as identity and privacy

The workshop entailed a combination of lectures, whole-group and small-group discussions, interactive activities, guest speakers on health promotion and STEM careers, reflective exercises, a design-based project to develop an app for healthy social media use, and photovoice activities. Throughout the week, participants worked in small groups on their culminating project: a text-based slideshow or video recording offering advice to someone just starting to use social media.

Throughout the week, participants worked in small groups on their culminating project: a text-based slideshow or video recording offering advice to someone just starting to use social media.

This article focuses on our use of photovoice to engage participants in reflecting on social media usage and well-being. For the photovoice activity, participants took at least three photographs in response to prompts related to each daily theme. The photovoice prompts were introduced daily as homework for the following day's discussion. Generally we provided more than one option to appeal to as many participants as possible.

Before we sent participants out to take photographs, we established procedures with them, as recommended by Bugos and colleagues (2014), and taught them ethical practices in participatory photography. Following Wang's (2006) recommendations, we emphasized the responsibilities of the photographer, safety issues, and ways to minimize risk. Using guidelines outlined by Wang and Redwood-Jones (2001), we covered how participants could:

- Maintain their personal safety while taking photographs
- Use responsibly the power that comes with taking photographs
- Follow ethical practices and respect their subjects' privacy
- Approach potential subjects to ask for signed permission to take their picture (Wang & Redwood-Jones, 2001)

Once participants had captured their photographs, they prepared captions to share with the group, keeping in mind that their goal was to identify how they interpreted the day's prompt and potential solutions to the problem posed. We asked participants to examine their photographs using the SHOWeD acronym (Catalani & Minkler, 2010; Wallerstein, 1987):

- What do you See here?
- What is really Happening here?
- How does this relate to Our lives?
- Why does this problem or this strength exist?
- What can we Do about this?

This process led to in-depth ongoing dialogues about the dilemmas adolescents face around healthy social media use, how they can promote positive use in their online peer culture, and how they can use social media to raise awareness of social issues they care about.

After each day's discussion, workshop leaders conducted a thematic analysis of the discussion and a content analysis of the photographs. We clustered similar codes and then categorized them by preliminary categories created from the group discussion. We repeated the process for all transcript and photographic data, expanding, collapsing, and restructuring categories to fit the data until themes became evident.

Workshop Implementation

We implemented the workshop in person Monday through Thursday, 10 am to 2 pm, at the school. The program was free to participating families, and the school offered free lunches. Morning activities centered on discussions of well-being, reflections on the day's photos, and introduction of new photovoice prompts for the next day. The afternoons centered on STEM activities and project-based activities. Each day had a theme based on our pre-workshop research.

Day 1: Fear of missing out (FOMO). In discussing how they used their phones and social media, participants highlighted how easy it is to experience FOMO. For example, one said:

> Maybe your friends are doing something without you knowing, and you are sad they did it without you.... If you hear someone talking about it in the hallway at school or if you see it on social media, you could feel upset that you are left out.

In response to these concerns, we introduced the concept of online addictive behaviors, outlining how these behaviors begin and how young people can proactively protect themselves by being more reflective about their use of social media. The first photovoice prompt offered two questions from which participants could choose:

- In what ways do you experience FOMO?
- If you could not access your phone, TV, internet, games, or digital devices for one week, what would you do instead?

Day 2: Mental well-being. The group discussed how much depression and social anxiety may be related to social media use and how participants could track the digital footprint of their state of mind or mood by using apps over time. The photovoice prompt again offered two choices:

- What are triggering aspects of social media that foster social isolation or social anxiety?
- In what ways can you provide social support or boost someone's well-being on social media?

Day 3: Self-esteem. The group discussed self-esteem, social change, and use of privacy settings and positive feedback to promote health and well-being in online communities. The photovoice prompt was, "How will you make a positive difference in this world?"

Day 4: Synthesis. Participants showcased their final photovoice project, which offered the advice they would give to someone who is starting social media for the first time, using one of the well-being topics from the workshop.

Photovoice Themes

By the end of the workshop, the group had generated almost 100 images and captions. Workshop leaders categorized the images into five themes:

1. Providing social support online
2. Boosting self-confidence, self-esteem, and self-care
3. Managing technology in the family context
4. Avoiding FOMO
5. Addressing social issues

Theme 1: Providing Social Support Online

During the daily discussions, participants discussed the meanings they saw in the photos they submitted. Some mentioned helping others when they saw them struggling online, for example, "I see on other people's posts, usually they'll have something polite. I see those comments almost every day: 'Have a great day' or 'I hope you feel better.'" One participant emphasized that he would "support people if they needed help on social media or give them advice and try to make them laugh." One participant described a selfie he had taken while posting a greeting to his mom (Figure 1).

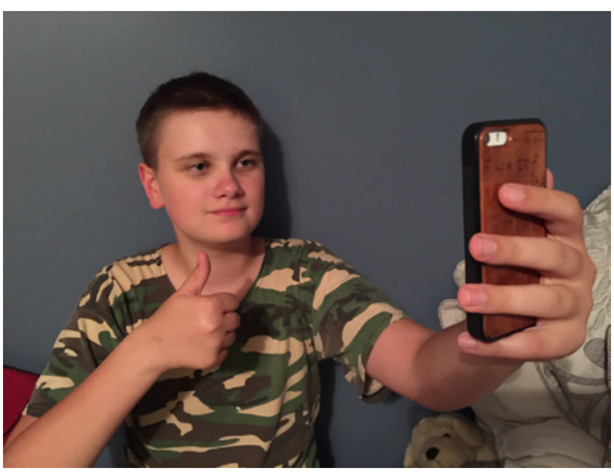

Figure 1. "I am helping my mom feel better by giving her a thumbs up on social media."

Participants often submitted memes or reposted inspirational quotes from other sources. For example, in response to the Day 2 prompt about how to boost peer well-being, one participant posted a meme that said, "Hey you! Just remember: You are capable…. You are strong. You can do this!" In the discussion, participants said that they often saw messages like this when people wanted to cheer up their friends.

Theme 2: Boosting Self-Confidence, Self-Esteem, and Self-Care

Many of the photos related to "getting off and getting out": putting down devices to experience the outdoors or try something new. Some recommended self-care activities, such as exercise, cooking, or practicing a musical instrument. Others suggested spending more time with loved ones: "Family and friends are more important than machines." One small project group wanted to include photos of different types of interests in the social media app they were designing in order to remind users of their nondigital worlds.

One participant mentioned that social media platforms that emphasize "likes" and comments can contribute to users' low self-esteem:

> On VSCO [a photo-oriented platform] … there are no likes, and you just post for fun…. I don't care how many likes I get on a post, but it makes some people not feel good if you don't get as many likes on Instagram. And [because] you can't like on VSCO, it makes you feel better.

Body image and self-esteem were recurrent issues. Several participants talked about promoting positive body esteem by appreciating others' photos and posts, for example, "My friend posts on Instagram, 'You look beautiful and you'll do great today!' And it makes me feel really happy." One participant revealed that body image was an ongoing issue on social media:

> I tend to compare myself with a lot more skinnier people. So then I look at myself and say, "Oh, my god, I'm so fat." And some days I feel good about myself, but some days it's just like I need to work on something.

By contrast, another participant proudly displayed the "natural" selfie shown in Figure 2.

Theme 3: Managing Technology in the Family Context

In group discussions, participants often talked about their family's role in socializing their technology use. They reflected on the roles family members—including parents, siblings, and even pets—played in how participants navigated their technology use.

Many participants said their parents often restricted their technology use. Some wanted parents to understand their motivations, because using their phones was not merely a waste of time. One said:

Figure 2. A participant finds her natural beauty.

> You can use your phone for good things too, not just social media. You could search recipes, research something, or use it for homework. But parents just think it's bad for you. And you're really bored if you're not on it, but they don't give you anything to do.

A recurring theme of the group discussions was that parents had difficulty disconnecting from their devices but expected their children to do so. Some of the photo captions reflected participants' perception that family members were too distracted by phones to spend time with them:

- "Mommy, get off your phone. I will pay to get our nails done."
- "Put down your phone when you go out to dinner, please."
- Mom, do something else, anything else."

In contrast to stories of competing with pervasive technology for parents' attention, other photos focused on family members with whom the participants spent quality time, with captions like these:

- "This is a picture of my siblings and I celebrating Christmas together!"
- "This is my family. We had to wear ugly sweaters for Christmas."
- "When I'm with my aunt, I rarely get to be on my phone."

A surprising proportion of photos included family pets, which seemed to distract participants from technology use. Several photos were of participants playing with or training their dog (Figure 3). One participant combined human family with pets in a photo whose caption read, "This is me at my aunt's farm. My aunt has a lot of dogs and one of her dogs had puppies. This is one of them!" Another participant combined pets with exercise, another recommended non-tech activity: "Take your dog on a bike ride? Here's a quick and easy way!"

Figure 3. A participant demonstrates training his dog, a non-technology activity he enjoys.

Theme 4: Avoiding FOMO

In the final day's culminating photo or video presentation, many participants focused on creative ways to avoid FOMO. One group recommended taking breaks from social media to avoid the discomfort of feeling left out: "When the summer seasons hit, most people will be going to a pool or a beach and will be posting about having fun. If you want to avoid feeling left out, don't go on social media during summer." Another group suggested focusing on digital content that can't inspire FOMO: "Instead of looking at your friends, you can look at memes so you just laugh instead of feeling lonely." Another recommended unfriending people who trigger negative emotions: "If people are boasting about how much fun they're having, just unfollow or block the people. Then you won't see all the people having fun without you."

In one photovoice video presentation, two middle school girls act out a FOMO scenario. One girl is talking on the phone about an upcoming party. When the other girl inquires, she is quickly told, "Sorry, it's for cool kids only." As the scene ends, the two participants join in encouraging viewers to avoid creating FOMO in others: "Invite everyone to your activities. You are all the same." In another video project, two middle school boys record an everyday middle school experience: walking the halls of their school. They encourage viewers to avoid FOMO situations by "including everyone and not posting pictures of you having fun because others will feel bad about themselves." They go on to suggest that "FOMO is mostly caused by social media." In a third video, a group of middle school girls discusses the meaning of FOMO and how to combat it. Instead of scrolling through social media sites, they suggest, young people can "go outside and play sports," "hang out with friends and family," "do chores around the house," or "go to the playground."

Theme 5: Addressing Social Issues

The Day 3 prompt asked participants to show how they wanted to make a difference in the world. Participants responded with photos and memes about issues that mattered to them. The most popular issue was the environment. For example, one participant shared a meme with the caption "Try not to use plastic straws 'cause they find their way into the ocean and can hurt marine life." The next most popular theme was animals and animal rights; see Figure 4. Another common theme was compassion or empathy for others, exemplified by a meme showing a girl with Down syndrome in a yoga pose whose caption had to do with changing how "the world defines and views disability."

Reflections and Feedback

On the final day of the workshop, we conducted a closing focus group with all participants to find out what they had learned during the week's activities. We asked what social media topics would be most critical to bring to the attention of the whole school in an assembly. Most participants chose FOMO. When we asked them to reflect on what they would take away from the workshop, 10 out of 12 referred to one of the well-being topics, particularly FOMO, addiction, and social isolation. Here are some sample comments:

- "I learned about fear of missing out and how to not be alone."
- "I learned that most kids are addicted to their phones, and there are ways to stop being addicted."
- "I learned that a lot of people will treat people different, but even though they are different we are all the same."

Figure 4. "Yesterday I was on a bike ride and I found a turtle trying to cross the road, but he was really slow and he might have gotten hit by a car, so I picked him up and brought him to the other side of the road."

In the post-workshop survey, most respondents agreed that they had discussed the workshop topics with their families and friends, planned to use the concepts they learned in a future class, and would be interested in participating in a follow-up workshop. These results encouraged us to continue developing this curriculum.

Implications and Future Directions

This workshop confirmed that photovoice is an effective method for engaging middle school participants in topics related to social media and well-being. Early adolescents generally are already avid users of photo-based social media platforms. The structure of our summer workshop gave participants opportunities to use photos and captions to create digital stories. In the process, they reflected on the images and comments they produce and distribute online and discussed how the transactional nature of social media can affect their own and others' well-being. Participant photos and captions reflected on the addictiveness of technology and envisioned strategies for self-care, including creative ways to disconnect from technology, often by reconnecting in real life with peers, family members, and pets.

Our long-term goal is to unpack how early adolescents see their online and offline worlds. Photovoice can provide fun yet educational activities on a topic in which young people are highly motivated to engage. The process of thinking about what photos to take, what to share, what to say about them to others, and what to do next provides an activity structure that can help to mobilize youth on a topic of interest. Our approach offers a structure for afterschool program staff to facilitate youth empowerment. The process can help participants think about ways to safeguard their own digital well-being and that of their peer and school communities.

Acknowledgments

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Integrating Arts with STEM to Foster Systems Thinking

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Interest is growing among out-of-school time (OST) educators in integrating the arts into STEM (science, technology, engineering, and mathematics) programming (e.g., Kelton & Saraniero, 2018). Arts-integrated STEM—or STEAM—programming now takes place in a wide variety of OST environments, from relatively institutional learning settings, such as a library, to emergent or fluid settings, such as a pop-up program in a housing development community room.

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Educators often consider OST environments to be conducive to creative and conceptually ambitious STEAM programming because these spaces have the potential to deconstruct rigid boundaries between disciplines that formal education often reinforces.

For the past several years, our team has been designing and studying STEAM programs in OST settings as part of the Health Education through Arts-Based Learning (HEAL) collaborative. The HEAL collaborative is a team of interdisciplinary researchers including university faculty and graduate students with diverse expertise in STEAM education, health sciences, human development, youth programming, educational psychology, and biomedical education. Our team includes a visual artist and several additional consulting visual artists. HEAL works in partnership with Latinx communities in rural-agricultural Washington to increase STEAM education opportunities that blend visual arts with health sciences. We develop programs that integrate art into STEM learning to promote expanded conceptual understanding of STEM content.

In this article, we discuss an OST STEAM program titled Zoom! that we designed and implemented in a summer camp in July 2019. Zoom! used visual arts strategies to support elementary-aged children in thinking about and communicating systems-level ideas related to the human microbiome—the community of single-celled organisms that live on and inside the human body. We start by elaborating on a key design conjecture informing Zoom!, namely, that blending visual arts and science can support systems thinking about complex scientific phenomena. We then describe the summer camp in which we explored this conjecture. Delving into the Zoom! curriculum, we describe the practical framework used to integrate visual arts with human microbiome science and offer examples of three representative activities, along with participants' artwork, that illustrate the potential for arts strategies to engage learners in systems thinking.

Although systems thinking is reflected as a cross-cutting concept in the Next Generation Science Standards, formal educational environments have historically offered few explicit resources for understanding complex systems.

Arts Integration and Systems Thinking

Educators cite a variety of reasons for blending STEM and the arts. Motivation for the STEM-to-STEAM movement includes evidence that arts integration can increase engagement in STEM (Diamond et al., 2015; Graham & Brouillette, 2016; Peppler & Glosson, 2013), improve access for groups underrepresented in STEM (Ludwig et al., 2017; Peppler, 2013), improve learning outcomes (Graham & Brouillette, 2016; Jacobson et al., 2016; Thuneberg et al., 2018), and create a platform for understanding and communicating about social and scientific issues (Allina, 2018; Peppler & Wohlwend, 2018; Sochacka et al., 2016).

This study explores the possibility that arts integration can support systems thinking. A crucial but challenging scientific practice, systems thinking involves the ability and propensity to make sense of complex scientific phenomena by attending to multiple interacting elements across micro to macro scales and exploring how these elements take part in a cohesive whole. For example, the human body is a complex system composed of multiple interacting subsystems—the digestive system, the circulatory system, and so on. These systems, in turn, are composed of multiple interacting organs, which themselves are composed of multiple interconnected parts. Systems have long been recognized as a major conceptual theme running through scientific disciplines (American Association for the Advancement of Science, 1993). Although systems thinking is reflected as a cross-cutting concept in the Next Generation Science Standards, formal educational environments have historically offered few explicit resources for understanding complex systems (e.g., Chi, 2005; Hmelo-Silver & Azevedo, 2006). Systems thinking includes many components (e.g., Hmelo-Silver & Azevedo, 2006; Penner, 2000; Resnick, 1996; Sabelli, 2006). In this article, we focus on three components:

1. Making distinctions and coordinating across scales of analysis
2. Understanding causal links across disparate scales and elements
3. Understanding underlying functions rather than focusing only on superficial structural features

Systems thinking is often described as an advanced skill. However, we took an assets-based view of elementary-aged children, assuming that they are capable of systems thinking. A small amount of research has offered a few inroads into appropriate supports for systems thinking. Jacobson and Wilensky (2006) argue that elementary students need exposure to systems through observable phenomena and everyday experiences. Others have explored systems-thinking pedagogies that emphasize immersive technologies, embodied movement and interaction, and play (Danish et al., 2011).

Calls for more research into systems thinking suggest developing pedagogical methods that blend multiple disciplines (Jacobson & Wilensky, 2006). In designing Zoom!, we were compelled by the possibility that using visual arts to consider scientific phenomena could address this call for a multidisciplinary approach. For example, science education researchers regard drawing detailed representations of the natural world, at both observable and unobservable scales, as a powerful science learning tool because drawing enables learners to think critically about complex causal relations and make their thinking explicit and specific (Ainsworth et al., 2011; Prain & Tytler, 2012). Similarly, art education scholars highlight how arts-based inquiry can be a form of reframing, recontextualizing, and shifting perspectives (Marshall, 2010) in ways that connect across seemingly disparate elements; this process is a core feature of systems thinking.

Summer Camp Program Context

We designed and implemented Zoom! as a four-day summer camp program for children ages 7 to 12. The program took place in a small, rural community in southeastern Washington with a predominantly Latinx population tied to the agriculture industry. Through Washington State University's rural extension system, members of the HEAL collaborative had an existing partnership with a community-based educational nonprofit organization. The partnership provided an opportunity to engage our target audience during an eight-week health and science camp held annually at the community education center. Zoom! met the local organization's need for novel educational programs to diversify its multiweek summer camp. HEAL delivered Zoom! during one of the camp's eight weeks, using the local organization's recruitment and communication systems. The community education center had a fully functioning school building, so it provided the classroom and open spaces we needed to deliver Zoom! through a variety of modalities. The local organization also provided material resources and staffing to support implementation. This support from our local partner allowed HEAL to focus on curriculum implementation rather than organizational and marketing considerations.

We used a team facilitation model in which all sessions included lead facilitators and several aides. Facilitators were members of the HEAL collaborative, and the aides included local community educators and teens from the community who were trained to facilitate programming with younger children. Having teen facilitators enabled us to create a community-connected, multi-age, and multi-generational learning environment. The teens also significantly bolstered the facilitation team's ability to provide a language-inclusive environment. Although many children in the camp were fluently bilingual, others, who were Spanish dominant or monolingual, benefited from the support of Spanish-speaking teens.

Zoom! Curriculum Overview

Broadly, HEAL aims to bolster systems thinking about health and disease, focusing on processes of disease transmission, infection, recovery, and immunity. The human microbiome, besides being a robust example of interconnected biological systems, is also a topic that engages personal experience. These two factors together make it a rich concept for integrating art and systems thinking. The specific scientific focus of Zoom! is the relationship between microbes—both beneficial and pathogenic—and human experiences of health and wellness. The title "Zoom!" was selected to reflect a practice emphasized throughout the program: zooming in and out of human body systems to investigate elements and interactions at different scales.

The human microbiome, besides being a robust example of interconnected biological systems, is also a topic that engages personal experience. These two factors together make it a rich concept for integrating art and systems thinking.

During the program week, continuous engagement in topics of art, systems thinking, and microbiology facilitated creation of a virtually seamless narrative of the phenomenon of getting sick. The first day of camp was devoted to introducing microbes in general and the human microbiome specifically, particularly in relation to the body in a healthy state. The next part of the program delved into microbial pathogens and the phenomenon of getting sick. Finally, we touched on the topic of immunity through activities that involved comparing beneficial and pathogenic microbes and understanding their interactions in the human body. Incorporated into the summer camp design were gallery walks in which participants shared their artwork with one another and a culminating art show where they shared their art portfolios with family and community members.

The conceptual understandings Zoom! aimed to foster include recognizing the ubiquity of microbes and microbial communities, connecting groups of organisms to an understanding of symptoms, bridging micro and macro systems, and understanding that not all microbes are bad for human health. Activities prompted participants to explore systems on both micro and macro scales. For example, on a micro level, activities explored characteristics of good (beneficial) versus bad (pathogenic) microbes and how infections can happen when bad microbes reproduce faster than good ones. Bounding this system at a micro level allowed learners to understand microbial interactions on a small scale before applying this understanding to larger-scale phenomena. Other activities encouraged learners to expand their systems thinking. An example of a macro-level activity is when participants created narratives of their experience of getting sick. Their stories included elements of larger related systems, such as the roles of families, rest, healthy food and beverages, and antibiotics.

> Zoom! curriculum designers used three of these approaches to engage learners in thinking and communicating about the human microbiome: depiction, reformatting, and metaphor.

Approaches to Integrating Arts for Systems Thinking

Zoom! used the arts to bridge the micro and macro levels of the phenomenon of getting sick. The program focused on two art modalities: narrative storyboarding, in the form of comic strips, and sculpture, in the form of clay modeling.

We used these modalities in deliberate ways based on Marshall's (2010) five approaches to integrating arts with other disciplines:

1. Depiction: direct representation through illustration, sculpting, and similar means
2. Extension or projection: speculation on or imaginative exploration of how things might be
3. Reformatting: representing subject matter from one discipline using a visual form from another discipline
4. Mimicry: engaging in or imitating disciplinary practices as part of an artistic creation or performance
5. Metaphor: conveying a relationship between seemingly disparate domains through arts media (Marshall, 2010)

Zoom! curriculum designers used three of these approaches to engage learners in thinking and communicating about the human microbiome: depiction, reformatting, and metaphor. These strategies for art integration often overlap; each includes concepts of "interpretation, reinterpretation and/or re-contextualization" (Marshall, 2010, p. 14). All represent ways in which artists reframe concepts by offering a different perspective, an important element in systems thinking instruction. This overlap made Marshall's framework a useful tool for designing an integrated STEAM curriculum. Each of the three Zoom! activities described below focuses on one of the three integration strategies we used.

Depiction + Sick Stories

Depiction, or direct representation, may be the most familiar strategy for integrating art and STEM. To create direct representations of their conceptual understanding, learners think in detail about how parts of a system work together and how these parts connect to other related systems. In the Zoom! activity Sick Stories, learners created a comic-style storyboard to depict their experience of getting sick.

Participants had already been introduced to concepts of scale and zooming in and out of the human body. In creating their six-panel storyboards, some learners addressed micro-scale elements of the phenomenon of sickness by, for example, showing good microbes and bad microbes competing in the human body. Others focused on macro-scale elements, showing the experience of resting or of seeking comfort and care from a family member. Others bridged multiple scales, depicting, for example, feeling sick, going to the doctor, and being prescribed antibiotics to kill the microbes that are causing the illness. Many, that is, adopted the practice of zooming into the human body to explain symptoms and zooming out to portray their experiences. Depicting their personal sick stories encouraged learners to attend to detailed elements of sickness, which they may not have noted with traditional approaches to displaying their understanding, while also connecting these elements through a narrative thread.

Sick Stories offered a context in which learners could directly represent components of sickness and coordinate them at various scales. In the first panel in the comic in Figure 1 (with panels denoted by creases in the paper), the frowning character is visibly upset. The second panel begins to zoom in on the character's body. The third panel continues to zoom into the character's body, where "hero" (beneficial) and "villain" (pathogenic) microbes interact. The symptoms resulting from this microbial interaction are depicted in the fourth panel, where the character is throwing up. The fifth panel depicts another character making a phone call and medicine being prescribed. In the final panel, the main character is clearly feeling better. In this sick story, the young artist depicted co-occurring phenomena in the human microbial system at micro and macro scales. The comic storyboard format enabled the learner to make sense of the phenomenon of getting sick by moving from the internal interactions among microbes to the external experience of having symptoms and receiving treatment.

Recognizing that arts-integration strategies do not exist in isolation (Marshall, 2010), we designed Zoom! to incorporate multiple approaches. In addition to depiction, Sick Stories can be viewed as a practice of reformatting: representing subject matter from one discipline using a visual form from another discipline. Storyboards, a format that is not typically used to depict scientific understanding, can enable learners to see content in a way that may be more meaningful to them than text-based presentations. When learners organize and interpret their experience in different ways, new light may be shed on scientific concepts they are learning (Marshall, 2010).

Reformatting + Microbial Heroes and Villains

Microbial Heroes and Villains explicitly used reformatting as an arts integration strategy. Participants constructed cards, like Pokémon or sports trading cards, to depict beneficial and pathogenic microbes. The target idea is that not all microbes influence the human microbial system negatively. Facilitators encouraged participants to blend real scientific facts and imaginary statistics to represent microbes in the human body as heroes or villains.

Figure 1. Comic narrating the experience of getting sick and being restored to health

This activity is an example of reformatting because trading cards are not a typical format for depicting microbes in scientific discourse. Through this artistic medium, learners both acquired and communicated new understanding of microbes and extended their representation to include other levels of systems thinking. They engaged with causal facets of systems thinking as they highlighted micro-level changes that result in macro-level responses. The trading cards had the additional advantage of being culturally familiar to many participants.

In the trading card depicted in Figure 2, the young artist incorporated real and imaginary elements of microbes to represent a hero microbe. By naming the microbe after English soccer player Callum Hudson-Odoi, the artist brought in personally relevant interests. The illustration also shows understanding of the characteristics of microbes and demonstrates connections among system levels. Specifically, this microbe "creates a barrier for the body that protects from bad microbes" and "can't be destroyed from antibiotics." This second descriptor connects a macro-level system—seeking medication for illness—with the micro level, where the imaginary hero microbe is unaffected by antibiotics. Reformatting allowed this learner to move between imaginary and real characteristics and to attend to different system levels simultaneously.

Other examples of reformatting with trading cards are featured in Figures 3 and 4. Both young artists reference how vitamins are synthesized by beneficial microbes and protect against harmful microbes. The hero microbe in Figure 3 is named "Vitamin Power," an imaginary descriptor afforded by the trading card format. Imaginary elements gave participants personally meaningful ways

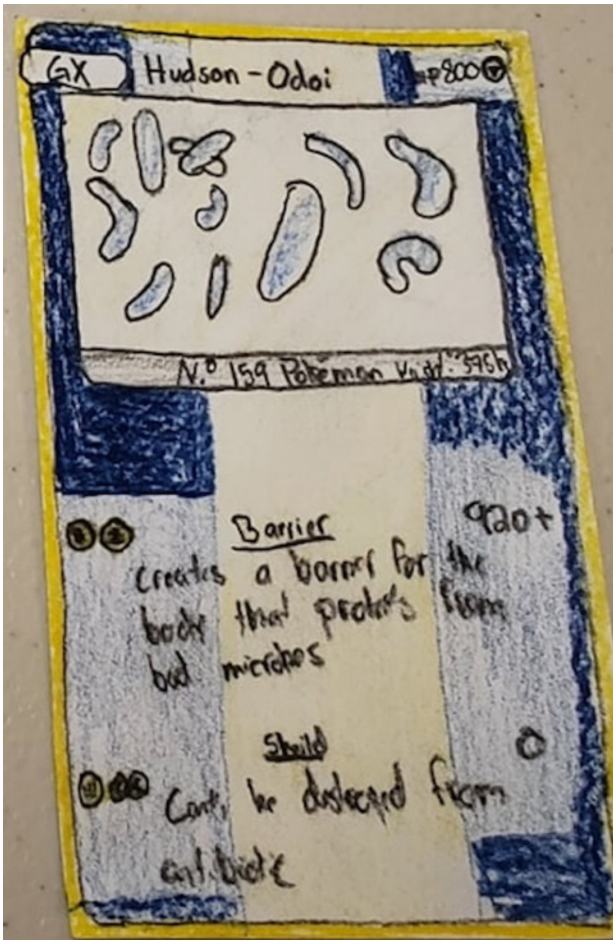

Figure 2. Trading card including imaginary and real elements of microbes

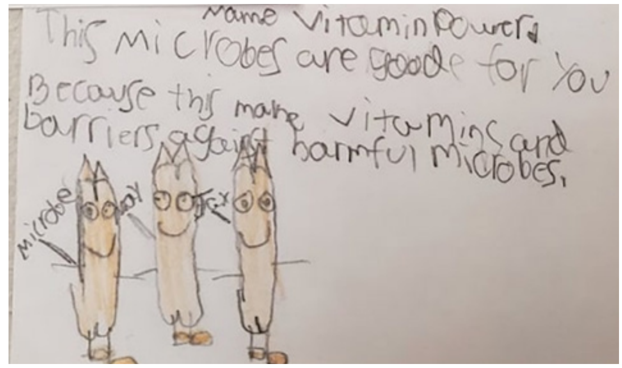

Figure 3. "Vitamin Power" trading card

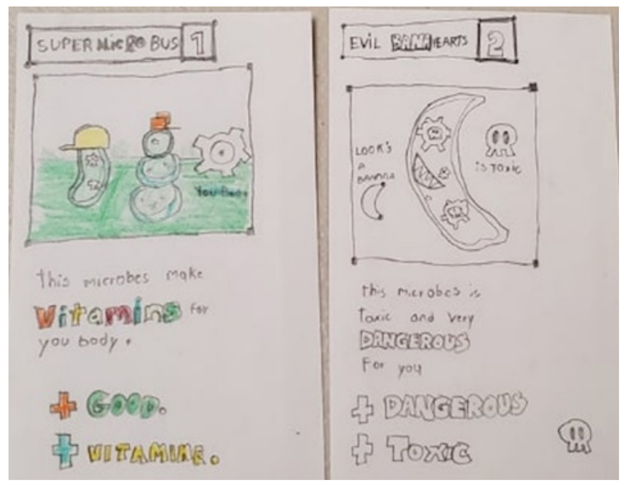

Figure 4. Trading cards highlighting the roles of beneficial and pathogenic microbes

to describe the qualities of the microbes they represented. The name "Vitamin Power" highlights a primary function of many microbes; the description connects this function to interactions with pathogenic microbes.

Many participants opted to depict heroes, or beneficial microbes, in their trading cards. A target understanding for Zoom! was that many microbes have beneficial functions that are necessary for human health. Reformatting in trading cards enabled participants to see these beneficial functions and to explore the interactions between beneficial and pathogenic microbes. They also recognized causal links within and between systems, an important facet of systems thinking. They attended to the ways in which micro-level causes, such as microbes making vitamins, influence the macro level, where microbes are "good for you" (Figure 3) or "very dangerous for you" (Figure 4).

Microbial Heroes and Villains includes Marshall's (2010) approaches of depiction and metaphor as well as reformatting. Depiction is evident in participants' drawings and descriptions of real and imagined qualities of microbes. The metaphor of heroes and villains provided a context in which participants could evaluate the relationships of beneficial and pathogenic microbes to human health and disease.

Metaphor + Body Habitats

Body Habitats aimed to engage participants with the core concept that the human body is a habitat for microbes. We assumed that children would be more familiar with habitats in relation to macro organisms, like people, rather than microbes, which are often viewed as intruders in the human body. To shift this perception, we used Marshall's (2010) metaphor strategy, which she defines as a way to "describe one thing in terms of another," where the linked entities have "similarities and differences and there is a remote connection" between them (p. 17). We designed Body Habitats to support learners in connecting, on the one hand, their everyday and cultural experiences in their homes with, on the other hand, the human body as a habitat for microbes.

In Body Habitats, facilitators gave participants a collection of microscopic images of tissues from the human small and large intestine and from the trachea and other parts of the respiratory system. They asked learners to create dioramas, using shoeboxes and diverse art materials, to communicate that the human body is a home for microbes. The program had already developed some foundational knowledge about the diversity and quantity of microbes in the human microbiome.

Marshall (2010) presents metaphor as an art integration strategy suitable for middle or high school students. However, the elementary-age participants in Zoom! successfully integrated metaphor with scaffolded support. We gave learners the metaphor of their own bodies as homes for microbes, so they didn't have to develop the metaphor themselves. Rather, they used their dioramas to expand on the metaphor, transferring their existing understanding of what comprises a home to their exploration of how microbes reside in the human body.

Participants took varied approaches to the activity. For example, the art in Figure 5 shows microbes inhabiting the human trachea. This participant has used depictive strategies to represent components of the trachea by, for example, sculpting the cilia as orange clay protrusions. Trachea microbes take the form of purple, red, and blue pom-poms with googly eyes. This young artist has taken up the metaphorical intent of the activity by incorporating features of the everyday experiences of macro-organisms (that is, family members—complete with eyes) cohabiting a place.

Figure 5. Diorama of the trachea with googly-eyed microbes

Figure 6 shows three dioramas in which young artists used a different strategy, incorporating material components of human homes in their dioramas. They connected human homes with microbial habitats by creating detailed scenes of rooms with couches, televisions, beds, showers, and rugs. In one of the scenes,

Figure 6. Dioramas with human furniture

pom-poms again depict microbes, this time lounging in the corners of a living room.

Educational researchers identify as a sign of complex systems thinking the ability to move from thinking solely about structural features of a system, such as the shape and location of cilia in the trachea, to understanding the functions of system components in relation to one another, for example, depicting cilia as part of a habitat for microbes (Hmelo-Silver & Pfeffer, 2004). In Body Habitats, participants used metaphorical connections between familiar and unfamiliar places to make that connection.

As with the other Zoom! activities, Body Habitats incorporates not only metaphor but also other art integration strategies. Many dioramas used depiction, directly representing microbes within the habitat. Reformatting was apparent in the recontextualization of a microbe habitat into a diorama.

Arts Integration to Promote Systems Thinking

STEAM integration allows both real and imagined recontextualizations and connections that have potential to support systems thinking. Employing arts-integration strategies, such as depiction, reformatting, and metaphor (Marshall, 2010), may support young people to make distinctions between and coordinate among multiple scales of analysis. They can also help learners to understand causal links across disparate scales and elements and to attend to underlying functions rather than focusing solely on superficial structural features.

The Zoom! activities Sick Stories, Microbial Heroes and Villains, and Body Habitats were designed to bridge STEAM disciplines. Our interpretation of the resulting artwork illuminates a potential mutualism between arts-integration approaches and systems thinking. Each activity demonstrated potential to support at least one facet of systems thinking. Collectively, these activities may have helped participants develop complex systems thinking that considers multiple interacting levels.

Our assets-based approach engaged elementary-aged children through observation of everyday phenomena, interaction, and play. In line with arguments made by scholars such as Danish et al. (2011), we found that these children could engage with systems thinking through arts integration with appropriate scaffolding and support. Responding to calls in science education for detailed representations of observable phenomena and in art education for reframing, recontextualizing, and shifting perspectives, Zoom! sheds light on the ways in which arts integration can foster development of systems thinking.

A primary challenge that emerged in our study was the difficulty of evaluating learners' systems thinking from their art alone, without other data such as participant interviews. Interpretation of how the artwork communicated understanding of the human microbial system rested solely with the observers—that is, with us, the curriculum designers, facilitators, and researchers for the project. Conclusions about children's thinking require inferential leaps; conclusions from artworks alone require bigger leaps. The challenge, as in evaluating any artwork, is to separate intent from what is actually presented. The interpretations of participant artwork in this article are not clear windows into the young artists' minds but rather suggest what the art might communicate to a viewer. Others who study art integration for systems thinking may consider including annotations, dialogue bubbles, or mini video presentations to allow learners to elaborate on their artistic intent and the scientific ideas they hope to communicate.

A potential concern with non-depictive arts integration strategies like reformatting and metaphor is that they might lead to scientifically inaccurate understandings—that microbes have googly eyes or that human body systems have living room furniture. Our assets-based view of children acknowledges their ability to understand the difference between literal and imaginative meanings. To be sure of our interpretation, we also used traditional learning assessments. Results of a pre- and post-participation questionnaire showed statistically significant gains in learners' understanding of microbial science. Though their artwork portrayed imaginative recontextualizations of scientific phenomena, participants translated these concepts and practices into accurate understanding of scientific content.

The design of Zoom! was based on one key conjecture: that blending visual arts and science can support systems thinking about scientific phenomena. Our observations of program participants' artwork, together with the results of the pre-post content assessment, suggest that elementary-aged children in OST settings can engage in systems thinking through STEAM activities. The conjecture deserves continued exploration. As children are increasingly exposed to complex socio-scientific phenomena, OST environments may play a key role in prompting systems thinking through creative, interactive, and fun approaches.

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Undergraduate Motivations for Participating in Afterschool Programs

A Case Study of The STEMinist Program

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Undergraduate students are a critical resource for university-community programs that provide enriching learning opportunities for school-age youth who have limited exposure to science, technology, engineering, and math (STEM). Many universities offer afterschool outreach programs that enable youth to interact with science faculty, and many such programs depend on undergraduates as facilitators. However, education research has focused on the youth served rather than on the undergraduates who facilitate the outreach programs.

To study why undergraduates participate in youth programming, we conducted a qualitative exploration of the experiences and perspectives of women undergraduates who facilitated an afterschool program that engages girls and nonbinary youth with scientists and engineers of similar gender identities. We focused on identifying the motivations and interests of these undergraduate facilitators in an effort to understand their views about the potential benefits of participa-

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tion. Our study sheds light on undergraduates' reasons for devoting time and energy to university-community STEM programs. Our findings may help other university-community programs grow in their support of undergraduate facilitators.

Study Rationale

University-community partnerships leverage the resources of various stakeholders—including research faculty, graduate and undergraduate students, and community leaders—to strengthen the K–12 STEM pipeline through the interactions of research, policy, and community practices (Denner et al., 1999). As afterschool programs have moved to the forefront of efforts by national educational policymakers to increase the cultural and linguistic diversity of college STEM majors (Granger & Kane, 2004), university-community partnerships have arisen to develop afterschool programs (Hudson & Hudson, 2008). Reported motivations for engaging school-age youth in afterschool programs include reducing societal discord (Newman et al., 2000), promoting personal well-being and social skills (Durlak & Weissberg, 2007), and informing or inspiring future career choices (Tyler-Wood et al., 2012). The positive youth outcomes from university-community partnership programs stem from interactions between youth participants and undergraduate facilitators (Cole & Distributive Literacy Consortium, 2006). Although research has shown that the interactions between undergraduate facilitators and youth may be mutually beneficial, relatively few studies have examined the potential benefits for the facilitators (Nelson et al., 2017).

Although research has shown that the interactions between undergraduate facilitators and youth may be mutually beneficial, relatively few studies have examined the potential benefits for the facilitators.

Because university-community afterschool programs depend on undergraduate facilitators, supporting these students' development should be a priority for program developers and coordinators. For example, they can encourage the development of professional skills that undergraduate facilitators can apply to future educational or career opportunities. The National Association of Colleges and Employers (2014) reported that over 70 percent of employers sought leadership, teamwork, positive work ethic, and communication skills in their future employees. However, employers reported that many college graduates lacked such leadership and organizational skills (Dostis, 2013). Research suggests that undergraduate mentoring experience is a predictor for strong work skills. For example, Good et al. (2000) found that undergraduate mentors who tutored youth had strong critical thinking and problem-solving abilities, as well as heightened communication and leadership skills. However, these studies have not focused on the perspectives of the undergraduates themselves, who have been largely overlooked in research on youth programs.

Program Context and Undergraduate Facilitator Roles

The STEMinist Program began in 2016 through a partnership between a Southern California university and two local Girls Inc. chapters. The program exposes girls and nonbinary youth (ages 9–11) and teens (ages 12–18) to women and nonbinary scientists through STEM activities in the hope of increasing participants' interest and confidence in pursuing STEM studies and careers. The program follows a design-based research framework (Barab & Squire, 2004): Program components are subject to annual revision informed by all key stakeholders, especially participating youth (Nation et al., 2019). Our study focused on the 2019–2020 school year, which was the fourth year of the youth program and the second year of the teen program. The design called for undergraduate facilitators to work with their participant groups for one hour each Wednesday for 20 weeks.

Roles of Undergraduate Youth Facilitators

During the first program session, 12 undergraduate facilitators worked with 26 young people aged 9–11 at a local Girls Inc. site to explore a hands-on science activity in small groups. The facilitators worked with small groups of students to lead a science exploration. They guided safe material use and distribution, encouraged discussion, supported sense-making, and acted as peer mentors to the program participants. They also took turns with individual participants to conduct 10- to 15-minute pre-program semi-structured interviews focused on participants' ideas about science, their interests, and their expectations for the program.

The following week, the program moved to the university campus. Pairs of facilitators were each assigned a group of four or five participants, with whom they worked for the rest of the program. During this first visit to the university, the facilitators developed and led icebreaker activities, guided the creation of team names and flags, and worked with participants to develop interview questions to use during visits to scientists' labs. The third and fourth weeks featured lab visits. Facilitators met with their small groups to orient them to the expected roles for that day, as groups rotated the responsibility of documenting the lab visits. Once the small groups were ready, a scientist led the whole group through a lab tour, during which participants asked their interview questions and conducted a hands-on science activity. The undergraduate facilitators participated as co-learners, encouraged active participation by group members, documented the visit through photos and video recordings, and monitored participant behavior for safety in the lab. At the end of each visit, the facilitators guided their groups to create a short video diary.

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During the fifth week of the program, the facilitators led icebreakers they had developed and then worked with participants to reflect on their first two lab visits and revise the interview questions for the next visits. Weeks 6–9 continued with lab visits to a new scientist each week. Under normal circumstances, facilitators would have spent the remaining 10 weeks of the program working with participants to develop a book for young readers (see Arya & McBeath, 2018) and would have conducted final post-program interviews. However, due to the COVID-19 pandemic, the program was placed on hold.

Roles of Undergraduate Teen Facilitators

Like the youth facilitators, the four undergraduate teen facilitators spent the first week at the Girls Inc. site leading participants through a science activity and the interview process. During the second week, after some community-building activities, the facilitators worked with the teens to identify goals for the program. Their culminating event was to be the first annual Youth Summit, an event in which several university-community afterschool programs, including The STEMinist Program, would showcase their efforts in environmental awareness. Because the teen group had only seven members in 2019–2020, the entire group worked together rather than breaking into small groups.

Participants spent four of the next seven weeks working to support the Youth Summit by selecting, designing, and ordering logo-branded merchandise and promotional materials, such as T-shirts and buttons. Undergraduate facilitators supported these efforts by providing resources, collaborating on ideas, and guiding teens through the process of organizing an event. The other three weeks were spent visiting campus scientists and research groups. During these visits, the facilitators served as co-learners while documenting the experience and encouraging participation. This program, too, was cut short by COVID-19, and the Youth Summit had to be postponed.

Program Support for Facilitators

Youth and teen facilitators met with program coordinators 30 minutes before each session to review the day's objectives and discuss ways to support the participants. After each session, the facilitators debriefed, focusing on successes, limitations, and moments of surprise or excitement. Each facilitator also completed digital field notes after each session.

Facilitator Study Informants

A total of 26 undergraduate facilitators supported the 2019–2020 STEMinist program. Of these, 17 worked with the participants as detailed above; the other nine worked as researchers to collect and analyze data and to produce program materials. Our study focused on the 17 undergraduates who worked directly with participants; 13 of them agreed to participate in the study.

Demographic data were collected at the beginning of the program through a digital survey administered by program leaders for funding reporting purposes. Of the 13 study participants, 12 were juniors or seniors and one was a lower-level undergraduate. Three identified as multiethnic, three as White/Caucasian, one as Chicanx/Latinx, and one as Native Hawaiian or other Pacific Islander; five did not disclose their ethnicity. All identified as women.

All participating undergraduates had the option of receiving class credit for their work with the afterschool program. Of the 13 facilitators, two volunteered their time but received no class credit, five received independent research credit, and six received class credit through a community-based learning practicum class, which included a lecture component that the independent study credit did not have.

Data Collection and Analysis

Facilitators were interviewed using a semi-structured interview protocol (Longhurst, 2003) that aimed to understand their background in STEM, their previous experience in facilitating youth STEM programming, and their motivations and expectations for participating in The STEMinist Program. Interviews were conducted by undergraduate research assistants to reduce the effect that age and perceived authority can have on informant responses (Ehrlich & Riesman, 1961).

We used a coding scheme derived from two studies. The first, conducted by Lewis and colleagues (2018), used expectancy-value theory as a framework to investigate the motivations of mentors in a youth engineering program. The authors identified six emergent themes in the motivations for mentors:

1. Positive influences for young girls
2. Influencing younger generations
3. Enjoyment of teaching
4. Joy of engaging in science
5. Teaching encouragement through mentor role
6. Enhanced professional opportunities (Lewis et al., 2018)

As our program participants consisted of girls and nonbinary youth, we discarded motivation 2, influencing younger generations, as a code in favor of motivation 1, positive influences for young girls. We then reworded this code to reflect the wide age range and gender variations among our participants: "positive influences on young STEMinist members."

Lewis and colleagues (2018) situated these themes within the four values of expectancy-value theory outlined by Eccles and Wigfield (2002):

- **Attainment value:** the applicability of performing a task in relation to one's values and identity
- **Intrinsic value:** the fulfillment one receives from performing a task
- **Utility value:** one's understanding of how useful performing the task is to the fulfilment of current and future goals
- **Cost value:** the opportunity cost of performing the task relative to the time and energy required to complete the task

Lewis et al. (2018) did not document evidence of cost value in mentors' motivations. Led by their example, we did not code for cost value.

The second study that informed our coding scheme was conducted by McGuire et al. (2016), who investigated the motivations of youth to join afterschool programs. They captured one motivation not mentioned by Lewis et al. (2018): support for personal goals. We added this motivation to our coding scheme under utility value.

Table 1 outlines how our coding scheme fits within expectancy-value theory and shows the definitions we used to guide our coding process. Four researchers independently coded all 13 interviews using deductive coding methods. Where they disagreed, they deliberated until they reached consensus.

During these discussions, a new theme emerged: lack of STEM programming experience as a child. To situate this new code within the framework, we turned to Eccles and Wigfield (2002) and their expectancy-value theory framework. The best fit for this new code seemed to be attainment value, defined as "the relevance of doing a task that aligns with an individual's beliefs and identity" (Eccles & Wigfield, 2002, p. 4). A lack of childhood STEM experiences seems likely to contribute to an individual's lack of STEM identity as a youth. In the interview responses that fell under this code, facilitators' lack of early STEM experiences led them to believe that young people should have ample opportunities, like the ones afforded by The STEMinist Program, to engage in STEM.

Undergraduate Motivations to Be Youth Program Facilitators

Our analysis of undergraduate facilitators' interview responses about their motivations is organized by the three lenses of expectancy-value theory. Because of the small number of study informants and the limited research on this topic, we did not attempt to identify which motivations were more important than others. Names have been altered to protect informant anonymity.

The Intrinsic Value of Facilitation

Undergraduate facilitators found intrinsic value in their enjoyment of teaching and their joy of engaging in science in The STEMinist Program.

Table 1. Facilitator Motivation Coding Scheme

Value	Code	Definition
Intrinsic	Enjoyment of teaching	Facilitators valued working with youth as educators.
	Joy of engaging in science	Facilitators valued the practices of science and wanted to further their engagement.
Utility	Teaching encouragement through mentor role	Facilitators valued the ways in which participation gave them firsthand experience and expertise as educators.
	Support for personal goals	Facilitators valued the opportunity to further their personal development.
	Enhanced professional opportunity	Facilitators valued the opportunity to further their education or career goals.
Attainment	Positive influences on young STEMinist members	Facilitators valued imparting beneficial skills, opinions, and sentiments to participants.
	Lack of experience in childhood	Facilitators valued creating a STEM experience for youth that they did not have in their childhood.

Enjoyment of Teaching

Four of the 13 interviewees said that The STEMinist Program gave them an opportunity to exercise their enjoyment of teaching or working with youth. When asked why she decided to join the program, Maggie answered, "I just like to educate little kids." Theresa said that she likes "working with little kids a lot." While these two informants emphasized their current enjoyment of working with children, Aaliyah referred to her background in teaching: "I've worked with children for a long time, and [The] STEMinist [Program] is both children and STEM, and I [thought] that's perfect for me." She felt that the program would offer her the opportunity to express her enjoyment of teaching in a content area she also enjoyed. All of these respondents were majoring in science fields, not education.

Joy of Engaging in Science

Five informants said that the intrinsic joy of engaging with science and scientists was a motivation for joining The STEMinist Program. This motivation is not directly related to helping youth engage in STEM; rather, these facilitators saw the program as an opportunity to engage in STEM themselves. The hands-on activities and lab tours were of particular interest to some facilitators. For example, Maggie said that she was "looking forward to going into the labs and helping in that way, because I really do like the idea of seeing hands-on scientists." Pippa explained that she was excited, "because I do like STEM. I'm just not a STEM person." Though she may not embrace a STEM identity, Pippa nevertheless sought to engage in the sciences as an afterschool program facilitator. In addition to the activities and lab tours, undergraduate facilitators expressed enthusiasm for engaging with the university scientists. For example, Tabitha said that she wanted to "know about other scientists … and other people who are experienced in different fields of science."

The Utility Value of Facilitation

Undergraduate facilitators found utility value in the way their mentoring role encouraged them to pursue careers as educators. They also appreciated the support for personal goals and enhanced professional opportunities in The STEMinist Program.

Teaching Encouragement Through Mentor Role

Five of the 13 facilitators said that they valued the education-centered experience they would gain from participating in the program. Some responded similarly to Jean, who said that she was looking forward to "learning more about teaching strategies. I've always been interested in teaching." Others joined the program with clearly defined learning objectives for educational practices. For example, Aaliyah stated, "I'm actually really interested in seeing how we're going to incorporate the Next Generation Science Standards into writing the curriculum."

These informants viewed participation as an opportunity to enhance their teaching ability in preparation for future careers. Of the five facilitators who said they valued opportunities to improve their teaching skills through their role as mentors, only two planned to pursue education careers. The others wanted to become a public health specialist, a medical doctor, and a professional sports player. Still, they valued the educational experience the program offered. Maggie, the aspiring public health specialist, said that a motivation for her was "improving my skills in education…. I don't want to be a teacher, but … I want to do public health and learn more about the education aspect of it."

> Of the five facilitators who said they valued opportunities to improve their teaching skills through their role as mentors, only two planned to pursue education careers.

Support for Personal Goals

Another motivating factor, mentioned by 10 of the 13 facilitators, was the support The STEMinist Program offered for the pursuit of personal goals, particularly improving their ability to work with young people or their ability to communicate clearly. The most common goal was an improved ability to work with youth. Several echoed the statement made by Elena, who said, "I'm excited to get more exposure to working with kids." Theresa stated, "I just want to keep honing on my skills on how to interact well with kids." Eliza was more specific, saying she wanted a "different perspective on how to deal with kids, how to manage them in different situations."

Some informants said that they wanted to improve their communication skills. Barbara emphasized improving her communication skills specifically with youth, stating that she had "never worked with teenagers" and thus wanted to improve her interactions with them. Maggie had a different emphasis, saying that her goal was to "broaden my own understanding of science and how I can communicate that with others who may not understand, because sometimes you get so fixated on the direct term that you don't know how to explain that to someone who doesn't understand."

Enhanced Professional Opportunity

Almost half of our informants identified future professional opportunities as a motivation for joining The STEMinist Program. Several echoed Aaliyah, who said she wanted to gain "some more experience with working with children and working with children in STEM specifically. I would like to go into education someday. I'm hoping this would be a way to dip my toes in." Nannie mentioned that she had experience only with preschool children; she "wanted to experience working with teenagers since … that's where I want to work in the future."

The desire for professional development also applied to informants who did not want to pursue careers in education. Barbara, who planned to attend medical school after college, commented that The STEMinist Program was a better fit for her career goals than other organizations: "I've tried different organizations where I realized that I don't think this would help much for [pursuing] medical [careers]." Unlike facilitators who joined this program to improve their teaching skills, Barbara felt that her participation would strengthen her journey toward a career in medicine.

The Attainment Value of Facilitation

Undergraduate facilitators found attainment value in The STEMinist Program in their positive influence on younger girls and in their own lack of personal STEM experience when they were younger.

Positive Influences on Young STEMinist Members

Nine of the 13 informants saw their roles in the program as a way to impart beneficial skills, opinions, and sentiments to youth participants. These facilitators indicated that their desire to have a positive impact on younger people was a driving factor in their participation. When asked about her motivations, Eliza, for example, said that she hoped "to make a positive impact on at least one of the girls." Nina was one of several who suggested that a positive impact could result from a close relationship with program participants; she said, "[I] just hope that I make personal connections with some of the girls and [that] they're positively impacted from this and I have something to do with that."

Within the theme of having a positive influence on younger girls, a sub-theme emerged: increasing diversity and representation in STEM fields. Informants noted that they wanted to support girls' involvement in historically male-dominated fields. For example, Laura said, "I want to support mainly young ladies or young girls, especially if they want to get into a major or into a program that's basically all male dominated… so any way I can support that, I'll do [it]." Facilitators also mentioned that they could be a bridge to STEM for program participants. Ruby said that she wanted "to share my own experiences working with science and tell them what I like about it, and hopefully they like [to] be open to that too."

"[I] just hope that I make personal connections with some of the girls and [that] they're positively impacted from this and I have something to do with that."

Facilitators identified various ways to support the diversification of STEM fields, such as building young people's confidence or fostering their interests. Part of the positive influence Elena wanted to have on program participants was to help them develop confidence. She said her main message was to show "young girls that you can do these things. Like, you don't have to pursue a career in STEM, but you shouldn't feel like you can't just because of who you are." Theresa furthered this idea of building confidence in youth participants, saying that "they need a lot of encouragement and confidence in themselves—especially right now, when they are little. It's when you are little that affects you when you grow up." Several informants echoed this sentiment about involving children in STEM at a young age to foster future interests and careers.

Lack of Experience in Childhood

During the coding process, a new theme emerged that did not fit into the coding framework established by Lewis et al. (2018). Of the 13 informants, four identified a lack of childhood STEM experience as a motivator for joining The STEMinist Program. For example, Tabitha said, "I never got to really experience a cool program like this where I get to talk to scientists and stuff. That's … why I decided to say yes to the facilitator job." Maggie expanded on this idea, explaining that she and her friends in elementary school had tried unsuccessfully to raise money to go to a science camp. Maggie therefore felt a strong desire to provide program participants with the chance she had missed as a child to engage with STEM.

Reflections and Program Recommendations

The rising need for STEM-literate citizens who can address scientific and technological challenges has brought a surge of informal science programs designed to increase young people's interest in STEM. University-community STEM outreach programs typically rely on undergraduate facilitators to be successful. We investigated the motivations of 13 such undergraduate facilitators. By considering the reasons undergraduates choose to participate in STEM programs, program coordinators can give these students targeted opportunities to explore their motivations and build on the values that matter most to them. Below we outline some of the ways The STEMinist Program has addressed intrinsic, utility, and attainment values. Other programs may adopt some of these tactics while exploring other avenues as well.

Building Intrinsic Value

To support facilitators motivated by their enjoyment of teaching, The STEMinist Program gave each facilitator several opportunities to lead group activities. For example, for the second program session, facilitators were asked to plan an hour's worth of activities for their small groups, in which participants would get acquainted, read about the scientists they would be visiting, and develop interview questions to ask on their visits. Program coordinators provided each pair of facilitators with the goals for the session and supported each pair in developing team-building activities. The facilitators created lesson plans and could serve as the lead educators for these sessions.

In response to the findings of this study, in combination with the unprecedented circumstances caused by COVID-19, we invited facilitators who expressed interest in teaching to develop virtual lessons. This new effort positioned undergraduate facilitators as lead teachers. Program coordinators then offered targeted feedback to help facilitators improve their skills in curriculum development.

Facilitators motivated by the joy of engaging in science have been naturally supported by being positioned as co-learners alongside the youth in visits to scientists' labs.

Building Utility Value

Informants who cited utility value as a motivation indicated that program participation enhanced their professional trajectories and supported personal goals. Like those who valued teaching as an intrinsic motivator, some facilitators found opportunities in The STEMinist Program to hone their skills as educators. They practiced and developed their teaching skills through trial and error while receiving weekly feedback and suggestions from program coordinators.

One support for facilitators motivated to hone their teaching skills was the half-hour sessions before program participants arrived, in which program coordinators and facilitators discussed pedagogical strategies and ways to work with youth. After each program session, program coordinators and facilitators met again to reflect on strengths and areas for further development. These metacognitive activities and guided discussions supported the development of strong teaching practices.

By considering the reasons undergraduates choose to participate in STEM programs, program coordinators can give these students targeted opportunities to explore their motivations and build on the values that matter most to them.

In response to the findings from this study, we have restructured what became, during the pandemic, biweekly virtual meetings, adding breakout sessions in which facilitators received tailored tasks and information corresponding to their professional goals. For example, facilitators who were interested in education careers had the option to create at-home science activities, such as one that built understanding of the uniqueness of fingerprints. Facilitators who were interested in graduate school and research careers received information on designing individual research projects and were encouraged to pursue their graduate school interests.

Building Attainment Value

We designed the pre- and post-participation interviews with youth as a way to discern growth among program participants. However, we discovered that, because the undergraduate facilitators conducted these interviews, the interviews could catalyze mentoring relationships between individual facilitators and participants. The post-participation interviews, again intended to be conducted by facilitators, asked the young people to reflect on their time in the program, with an emphasis on the effects on potential career trajectories, STEM interests, and STEM identities. Collecting these data on participants' perceptions of the effects of the program enabled facilitators to see how they have influenced the youth.

To further support undergraduates motivated by a desire to have a positive influence on youth, we decided to extend our programming. Traditionally, we began in January and ended the program in June of the same year. We intended to extend our programming into the fall quarter, to start as early as October, but the pandemic has put plans on hold. Instead, undergraduate facilitators have worked remotely with teen participants as near-peer mentors, supporting participants in the application process and in building a vision for their university life.

Strengthening STEM Outreach Programs

The STEMinist Program was developed with the goal of exposing girls and nonbinary youth to STEM fields in hopes of cultivating STEM interests and identities. However, program coordinators also have a responsibility to support undergraduate facilitators' growth and development. Using the facilitators' motivations for joining the program as a guide, program leaders can better target their efforts to support undergraduates in reaching their goals. We hope this effort will improve outcomes both for undergraduate facilitators and for youth participants in their leadership growth and future aspirations.

Our findings, though derived from undergraduate experiences in a STEM program, may also help non-STEM afterschool programs strengthen their support for undergraduate facilitators. Many of our informants' motivations, such as enjoyment of teaching or having a positive influence on young people, are not unique to STEM. Even STEM-specific motivations, such as joy of engaging in science and lack of STEM experiences in childhood, are likely to be applicable in other disciplines. Any afterschool program that relies on undergraduate facilitators can consider facilitators' motivations in order to enhance their experience.

Our study has some noteworthy limitations. First, although participation in The STEMinist Program was voluntary, some facilitators were part of a community-based practicum class that required participation in a youth program. Six of our 13 interviewees were part of this practicum, and three mentioned it as a factor in their involvement. Still, these facilitators chose The STEMinist Program out of six program options, so the data on their expectancy-value theory motivations are still useful. In addition, during our time working with facilitators, we noticed underlying motivations that were not mentioned in the pre-program interviews, such as sorority volunteer requirements and a desire to build a strong résumé. Other university-community programs may encounter similar influences for their undergraduate facilitators. Within The STEMinist Program, future research efforts should include more extensive data collection, such as observational notes, to investigate the prevalence and importance of motivational factors beyond the three expectancy-value theory lenses used in this study.

Despite these limitations, our study can help university educators and youth program coordinators maximize the benefits for undergraduate facilitators. By identifying undergraduates' motivations to participate in STEM programming for youth, afterschool programs can evaluate and improve their support for these vital program volunteers.

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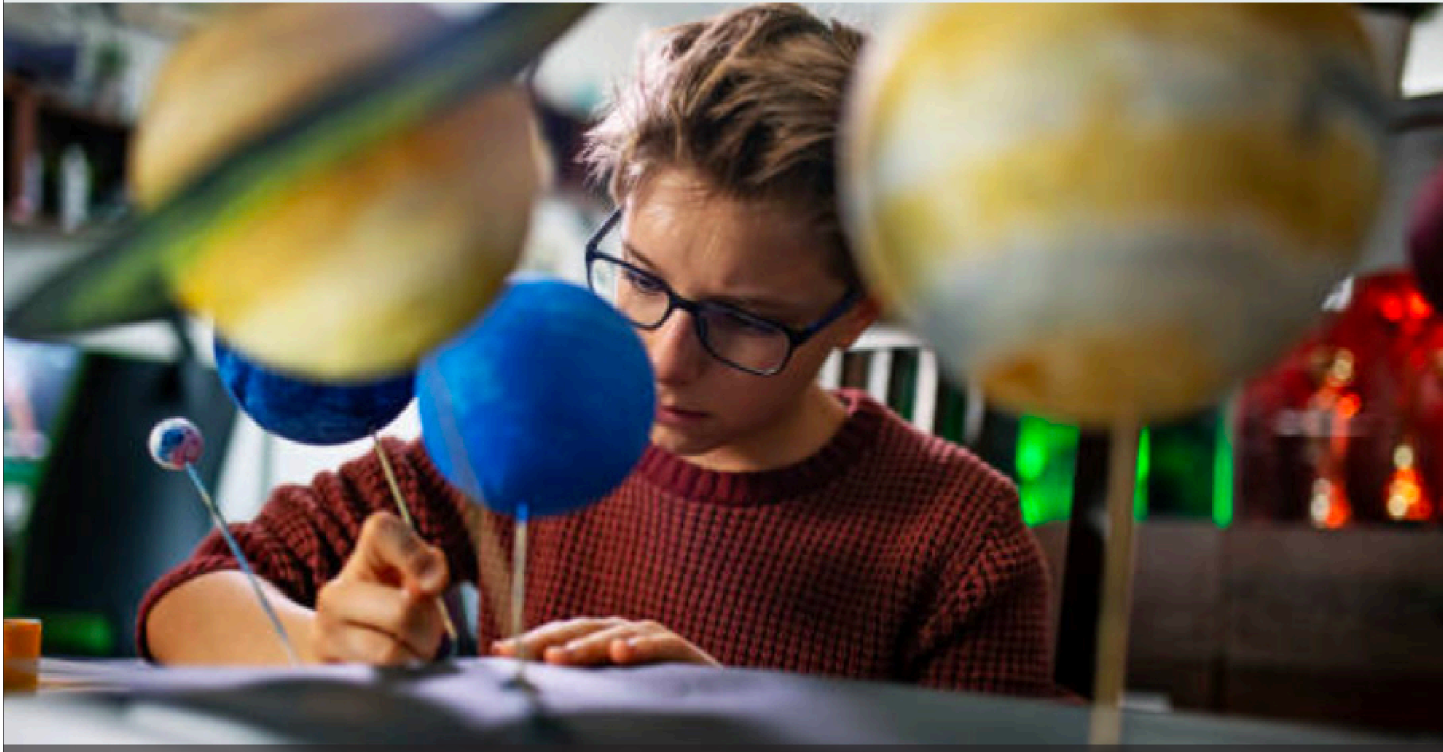

Designing Professional Development Resources to Meet the Needs of OST STEM Educators

Joëlle Clark, Nena Bloom, Lori Rubino-Hare,
Courtney Barnes, and Sean Ryan

Flexibility, opportunities for exploration, and a focus on 21st century skills make out-of-school time (OST) programs an ideal environment for authentic learning in science, technology, engineering, and mathematics (STEM; Committee on STEM Education, 2013; Noam & Shah, 2014). In addition, because OST programs serve significant populations of young people who are underrepresented in STEM, they may be able to reduce the opportunity gap for these youth and help to enhance youth learning and engagement.

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Efforts to design high-quality STEM curricula and educator professional development resources help to increase opportunities for youth to engage in STEM in OST. However, each OST educator has unique professional needs depending on their program. Therefore, a strong STEM curriculum must include professional learning support for OST educators. Few OST educators have formal education training or teacher certifications (National Afterschool Association, 2006). According to the National Afterschool Association's national survey (2006), most workers had little experience or education directly relevant to afterschool programs and received no paid time to pursue training.

Research demonstrates strong connections between OST professional development and benefits realized by program participants (Bowie & Bronte-Tinkew, 2006; Garst et al., 2014; Palmer et al., 2009). Professional development, especially in STEM content, can improve the content knowledge of OST educators and help OST programs meet their goals (Afterschool Alliance, 2011; Allen et al., 2017; Chi et al., 2008; Chun & Harris, 2011; Freeman et al., 2009). As Freeman et al. (2009) point out, "transforming the existing cadre of afterschool instructors into effective facilitators of STEM learning will require significant attention to and investments in staff development" (p. 5). Specialized staff development in STEM should include new strategies and must address the diverse needs of OST educators. Ideally the professional development strategies will provide information, skills, and support precisely when educators need them most.

This article presents one approach to the design and development of professional learning resources for OST educators as they implement a high-quality STEM curriculum. The resources we developed as a team, based on our research into the STEM professional development needs of OST practitioners, constitute a form of self-driven professional learning. The tiered system of professional development resources we developed may guide other OST STEM programs toward providing the professional learning resources OST educators need to facilitate quality instruction.

[W]e noticed substantial curricular negotiation at play in the sites we studied. In implementing the written curriculum, the adults involved had to see to what extent it would work in this time, in this place, with these girls.

The PLANETS Program

The OST STEM professional development resources we designed are part of PLANETS, a NASA-funded OST program for educators and youth in grades 3–8 that provides STEM learning with an emphasis on NASA planetary science and engineering, particularly for underserved audiences. The PLANETS program consists of three curricular units: Remote Sensing (grades 6–8), Water in Extreme Environments (grades 6–8), and Space Hazards (grades 3–5). The units engage teams of youth in the disciplinary practices and processes of scientists and engineers through open-ended activities, as recommended by the National Research Council (2009). Learners analyze scientific data, make and refine design choices, reflect on their learning to solve problems set within a NASA planetary science context, and communicate what they learn with their families in a community showcase. The program also includes professional learning resources, which are available on the PLANETS website.

To find out what other professional development resources OST educators might need, we conducted a national needs assessment and case study research. We then devised a tiered system of educator resources to provide just-in-time support.

The PLANETS curriculum and professional development resources are available free of charge at www.planets-stem.org

Determining the Needs of OST STEM Educators

Before we designed professional development resources, we wanted to find out what kinds of resources OST STEM educators need and what constraints they face. To do so, we first conducted a national needs assessment survey and interviews with OST educators. Then we conducted case study research consisting of observations of OST educators implementing PLANETS activities. The evidence from both studies informed the subsequent development of tiered professional learning resources.

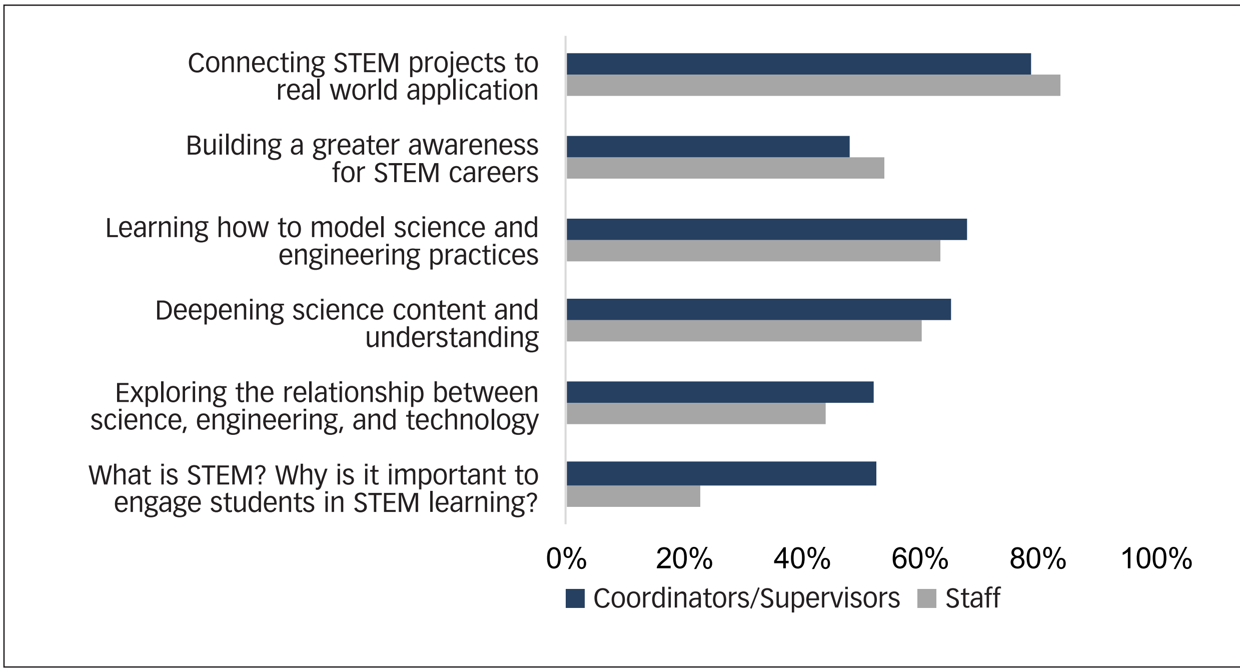
PLANETS National Needs Assessment

The primary goal of the national needs assessment study was to understand the limitations and opportunities for STEM in OST and identify the gaps between the self-identified abilities of OST educators and the abilities that effective OST educators should have (Bloom & Clark, 2017). The needs assessment included a literature review, a national online survey with a convenience sample of 314 OST staff and supervisors, and in-depth interviews with 12 OST supervisors.

The findings of the study indicated that OST professional development should be directly applicable to content being taught. OST educators said that professional development was most useful when they learned about activities they would use immediately with youth participants, expanded their content knowledge, or learned about relevant resources for learners or for program development. Professional development must be accessible to staff in a variety of settings, including in rural locations where opportunities are often scarce and attending face-to-face professional development is costly. Because OST staff have a range of professional preparation and experience as educators, they have varied content and instructional needs. Thus, OST educators indicated that they prefer to customize and self-select their professional development sessions based on their immediate needs. They noted that they are willing to use online or hybrid methods, particularly video (Bloom & Clark, 2017).

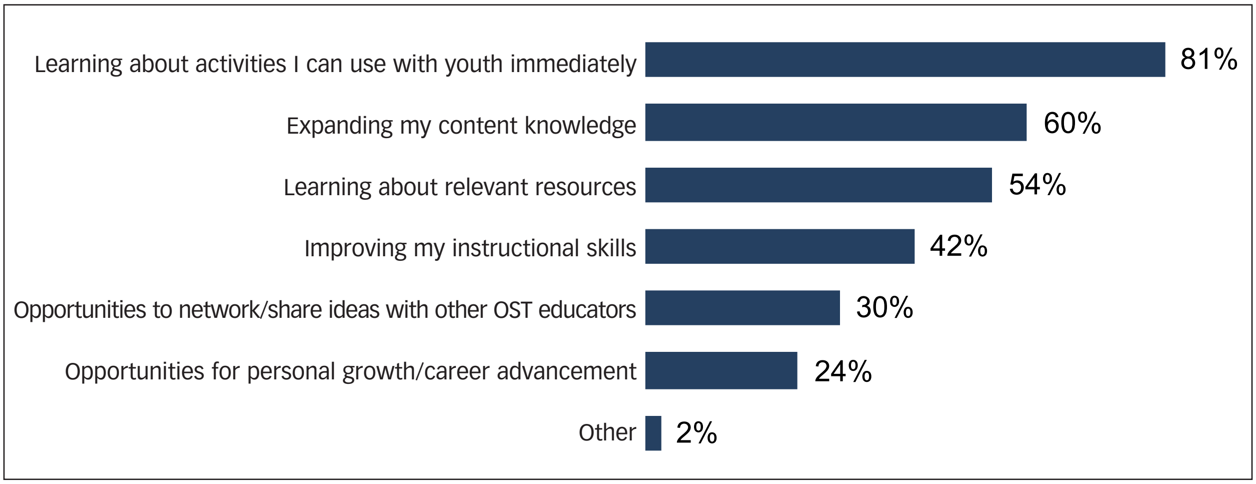
When asked how they currently received professional development, almost three-quarters of the OST staff respondents said that they were required to participate in some form of professional development. Most said they participated in less than five hours per year. Time and funding were the biggest barriers. Although staff said they felt confident to teach many important STEM areas, supervisors reported that most staff lacked preparation in these areas and would benefit from STEM professional development. Respondents indicated that, in order to improve STEM programming, they needed curricula, hands-on materials, strategies for engaging youth collaboratively, and complementary resources to extend learning (Bloom & Clark, 2017). Figure 1 shows the learning needs identified by staff and supervisors, including connecting STEM projects to real-world applications, modeling science and engineering practices, and deepening their own science understanding.

Figure 1. STEM Professional Development Needs Identified by Staff and Supervisors



Top pedagogical needs identified by respondents included facilitating collaborative groups, obtaining materials, promoting youth development and identity, accessing and providing STEM career information, and engaging families and communities in STEM learning. Respondents said that professional development is most useful when educators learn about activities to use immediately with youth, expand their content knowledge, and learn about relevant resources (Figure 2).

Figure 2. Factors That Make Professional Development Useful



The needs assessment illustrated that OST educators would benefit from professional development that is short, provides opportunities to focus on the STEM content being taught, delivers immediate support for planned activities, and can be accessed easily as needed. Resources for making career and real-world connections, as well as extension activities, were also identified as important for meeting youth development goals.

PLANETS Case Study Research

Another body of evidence that contributed to understanding professional development needs involved systematic observations of OST educators and youth participants during implementation of PLANETS units (Bloom et al., 2019). The purpose of the case study research was to examine how the OST materials affected learners' engineering attitudes and thinking and how the educators supported STEM learning. The study involved four middle grade school OST settings and a total of 52 young people. Two PLANETS units were implemented; each activity was videotaped and later transcribed for analysis. In addition, educators and participants completed surveys and were interviewed. On examining the case study data, we identified three strategies that would enhance OST educators' understanding of STEM content and implementation of STEM practices:

1. Visualizing the overall purpose of the STEM unit and the articulation of activities within the unit
2. Developing knowledge related to the specific STEM content of the unit
3. Supporting specific pedagogical strategies used to enhance STEM learning

Visualizing the purpose of the unit and how its activities contribute is important because STEM activities and ideas build on one another. Youth attendance in OST programs is often inconsistent; OST educators create consistency by reviewing the purpose of activities and their connection with unit goals at every session. For PLANETS, educators must frequently describe how the activities, which involve using science and engineering to solve problems, build on one another. In case study observations, we noted that some educators did not routinely share the purpose of the unit with participants. As a result, some learners did not see the connections among activities. For example, in the Water in Extreme Environments unit, learners collect data on the properties of filter materials in a set of activities. Then they use these data to design a water filtering process to be used in an extreme environment. In our observations, the learners did not always connect the need to test filter materials with the goal of engineering an optimal design for their water filtering process. These learners needed their OST educators to emphasize the learning goals for each activity and how those goals applied to the later engineering challenge. The OST educators in the case study suggested that a detailed unit map would help them guide learners to see the purpose of the individual activities in relation to the whole unit.

The rigorous STEM content in the PLANETS units was outside the typical content knowledge of many educators. Educators are more successful in guiding learners if they have some content knowledge specific to the activity. For example, in the Remote Sensing unit, the planetary science content emphasizes how engineered devices are used to collect data on the topography and mineral content of planetary bodies using technologies such as light detection and ranging (LiDAR) and spectroscopy. In one of the engineering activities, learners use plastic straws to represent how LiDAR beams are used to map the surface of a planet for landing sites. Educators and program participants alike had trouble making the connection between the straws and LiDAR because they did not understand how LiDAR works. Although the educator guide provides written information about this activity, some educators did not have the time to read the information before teaching, as they focused on preparing materials. As a result, we observed educators searching the internet during the program session for background knowledge they could share with learners—often without success. If educators modify activities because they find the content challenging, fidelity of implementation is limited.

Finally, observers indicated that educators might benefit from a deeper understanding of STEM pedagogical strategies, such as the importance of failure in engineering design and the need for closure and reflections following an activity. Many young learners get easily frustrated if their designs do not work the first time or work only partially. Helping educators understand that innovation and problem solving inherently involve an iterative process of testing and improvement will help them support youth development. OST STEM is an opportunity to help develop STEM habits of mind including persistence, collaboration, and problem solving.

Designing Needs-Based STEM Professional Development Resources

The needs assessment and case study suggested several specific ways to supplement existing PLANETS resources to make professional development more effective and support implementation of the curriculum. The PLANETS written curriculum guides provide many types of support: background content; learning cycle processes of engagement, exploration, application, and reflection; engineering design process; materials needed for activities; tips and facilitation strategies for learners in groups; suggested question prompts to guide learners; and additional fun facts to share with participants. What the needs assessment and case study research revealed was that the OST educators needed different types of support at different junctures during implementation of the curriculum. Building on the needs assessment finding that providing a variety of learning resources online is a flexible way to support OST educators, we designed a tiered system of professional learning resources to meet their needs.

To do so, we enlisted OST educators nationally to co-create the resources. We conducted working sessions with OST frontline staff and site leaders to review the findings of the needs research, to examine the PLANETS curriculum, and to brainstorm ideas on how to support OST educators as they implement the curriculum. The working sessions further illuminated the demands and issues faced by OST educators, including lack of time for preparation and competing OST program priorities. The participating OST educators emphasized that professional learning resources must be clear, explicit, short, easy to digest, and designed for the specific unit being taught. Table 1 provides a sample of the types of professional learning resources developed as a result of the co-creation process with OST educators and leaders.

Tier 1: Immediate Needs

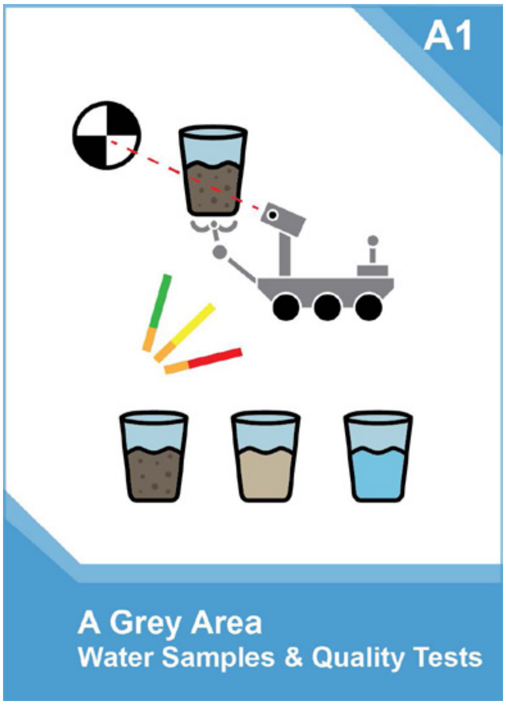
One of the biggest concerns of the OST educators was support in setting up STEM activities, a task that often focuses on the necessary materials. Busy OST educators typically have little time to fully read the curriculum guide and prepare activities before program participants arrive. As they rush through last-minute preparations, they may miss key steps. To mitigate this challenge, we developed the first tier of support, which meets immediate setup needs by providing short how-to videos and “back pocket” activity overviews. The videos demonstrate materials preparation step by step and provide other quick tips on setup and implementation. The back-pocket activity essentials, like the one in Figure 3, provide an overview of each activity at a glance, including the activity purpose, timing, key terms, and preparation reminders. These overviews are available on the PLANETS professional development website and can be viewed on mobile devices or printed.

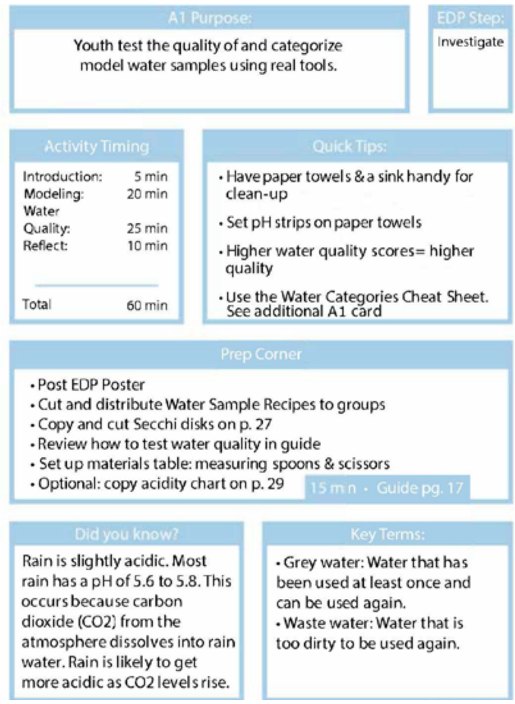
Another resource we developed to help with immediate activity implementation is unit maps of learning progressions like the one shown in Figure 4. These unit maps visually show the flow of the lessons and the purpose of each so that educators can quickly see where each activity fits into the unit, why the activity occurs at that point in the sequence, and how the activity supports learners to succeed in the final design challenge. The learning progressions are color coded into three types of activities: preparation lessons that introduce background knowledge, common vocabulary, and the

Table 1. The PLANETS Tiered System of Professional Development Supports

Tier of Support	Description	Identified Needs	Sample Resources
1. Immediate needs	Resources to help OST educators get started on facilitating the unit: What do I need to do today? How do I organize the learning? How do I set this activity up?	• Unit overview connecting the purpose of each activity • Activity preparation and materials setup	• Unit maps (PDF) • Learning progressions (PDF) • How-to videos • Quick reference guides for each activity on purpose, preparation, and implementation time (PDF)
2. STEM content and practices	Resources to help educators understand the STEM content: What does this term mean? What do I need to know about this specific planetary science concept to help participants succeed in these activities?	• OST educator background in specific STEM content	• Short, targeted background content videos
3. Pedagogical support	Strategies that help educators support STEM learning and development of STEM habits of mind: How do I get kids to work collaboratively and share their ideas? How can I help them work through the frustrations of a failed design so they are motivated to make improvements? How can I relate this activity to their lives?	• Promotion of STEM habits of mind • Youth development skills • Connections between STEM and real-world relevance	• Explanation of STEM habits of mind (PDF) • Questions to ask during an engineering design process to promote 21st century skills (PDF) • Strategies to reveal the relevance of STEM (PDF)
4. Unit or activity extensions	Extensions of learning to connect youth to STEM careers, NASA missions, and other STEM learning opportunities	• STEM careers • Extended learning opportunities	• Annotated hyperlinks to recommended videos, digital interactive sites, and resources to support STEM careers and family engagement

Figure 3. Sample STEM Activity Back Pocket Essentials




A1 Purpose:
Youth test the quality of and categorize model water samples using real tools.

EDP Step:
Investigate

Activity Timing

Introduction:	5 min
Modeling:	20 min
Water Quality:	25 min
Reflect:	10 min
Total	60 min

Quick Tips:
- Have paper towels & a sink handy for clean-up
- Set pH strips on paper towels
- Higher water quality scores= higher quality
- Use the Water Categories Cheat Sheet. See additional A1 card

Prep Corner
- Post EDP Poster
- Cut and distribute Water Sample Recipes to groups
- Copy and cut Secchi disks on p. 27
- Review how to test water quality in guide
- Set up materials table: measuring spoons & scissors
- Optional: copy acidity chart on p. 29

15 min · Guide pg. 17

Did you know?
Rain is slightly acidic. Most rain has a pH of 5.6 to 5.8. This occurs because carbon dioxide (CO_2) from the atmosphere dissolves into rain water. Rain is likely to get more acidic as CO_2 levels rise.

Key Terms:
- Grey water: Water that has been used at least once and can be used again.
- Waste water: Water that is too dirty to be used again.

problem to be solved; investigation activities in which program participants gather data to inform final designs or decisions; and culminating activities in which youth communicate final decisions and solutions. Unit maps enable educators to help learners understand the *what, why,* and *how* of each lesson.

Tier 2: STEM Content and Practices

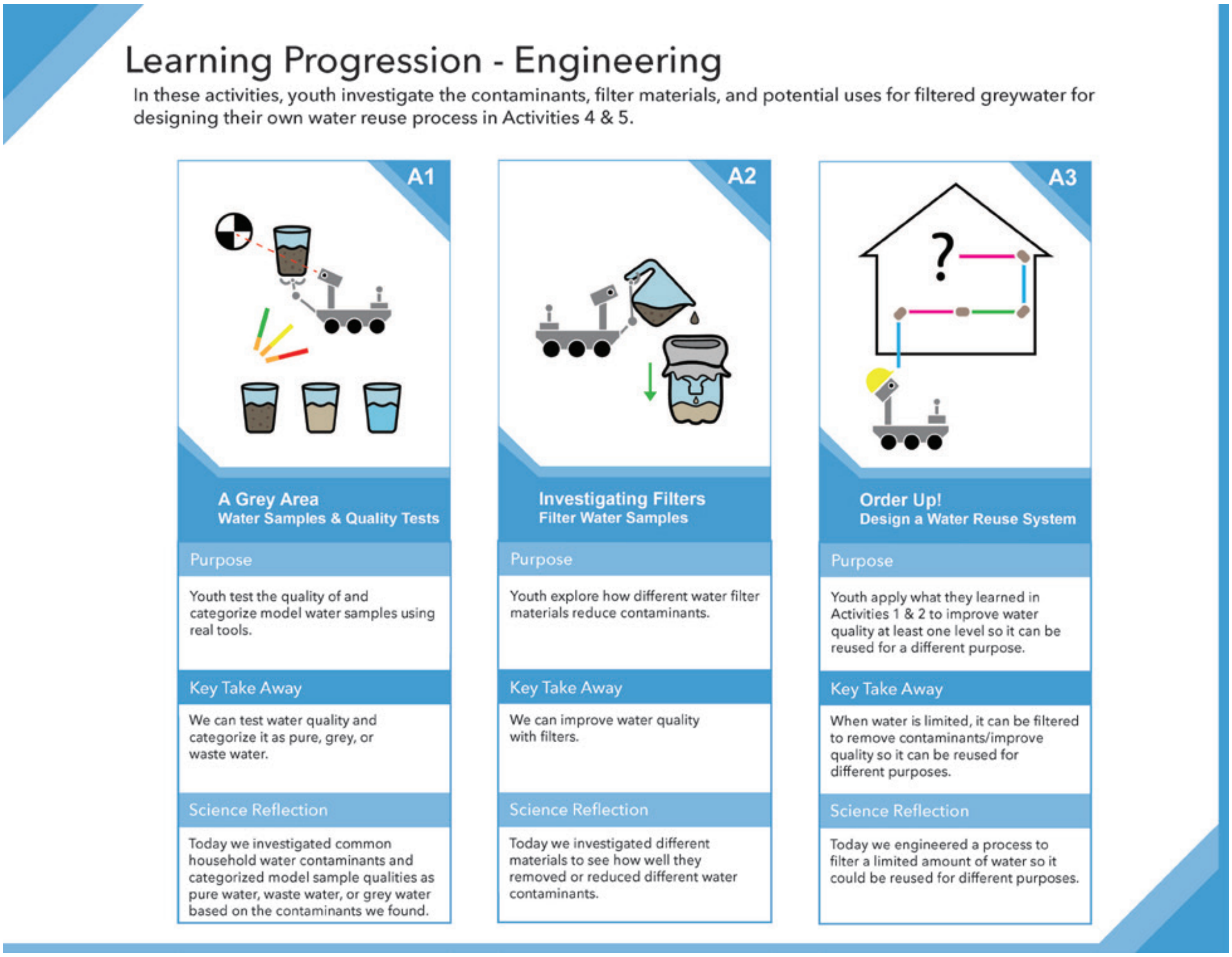
Once OST educators settle into the nuts and bolts of how to prepare activities for learning, they can devote time to the unit's science content and engineering practices. The needs assessment and case study research suggested that OST educators may need support to understand the key science and engineering concepts in the STEM units they are leading. Case study educators identified terms and topics for which they needed succinct summary resources. They suggested that we create an easy way to access the STEM content knowledge related to the concepts and practices of a given unit or activity. The OST educators in the co-creation sessions also suggested that the content should be short and digestible in easily accessible formats.

To meet this need, we produced short content videos that directly address the science and engineering concepts and practices behind each unit. For example, the central learning goal of the Remote Sensing unit is for learners to understand how light can be used to study the surface of planetary objects, like Mars, so they can design devices to explore the planet and find a safe landing zone. We saw in observations that, when educators did not fully explain the relevant concepts, learners built models in the engineering design activity, such as the LiDAR straws model, without knowing how or why their models could be applied to planetary science. The short professional development video we designed for this activity defines the relevant properties of light and shows examples of LiDAR remote sensing technologies. When educators themselves understand key science and engineering concepts, they can build context and meaning for program participants as they work to meet engineering challenges. For the three units, we created eight videos, ranging in length from 40 to 75 seconds. Using these videos, educators can get a basic understanding of key science and engineering concepts for a whole unit in five or ten minutes. Before they facilitate a day's activity, they can easily go back to access the video on that specific topic.

Tier 3: Pedagogical Support

As OST educators become more comfortable with managing activities and content, they can turn their attention to supporting youth development. The third tier

Figure 4. Sample STEM Activity Learning Progression



of professional learning helps OST educators incorporate effective strategies to foster 21st century skills, social and emotional development, youth agency and identity, and STEM habits of mind.

The needs assessment revealed that many OST educators are focused on building 21st century skills, including communication, critical thinking, collaboration, and leadership skills. Tier 3 resources help with this effort. One document offers open-ended questions aligned with the steps in an engineering design process. For example, when learners are investigating materials that might be used in an engineering design solution, the document states that the goal of this activity is to clarify language and help learners develop a common vocabulary for evaluating the properties of the materials. An OST educator might therefore ask, “What do you mean when you say this material is ‘squishy’? Does anyone have additional words to describe that property?”

To give OST educators strategies for building STEM habits of mind, we created downloadable resources to build understanding of these habits and suggest strategies for fostering them. The documents provide suggested strategies and questions to encourage learners to envision multiple solutions, negotiate design decisions collaboratively, design and follow fair scientific processes, persist through failure, and celebrate successes.

Still in development for Tier 3 are resources to help OST educators connect STEM learning to young people’s real-world experiences and build their STEM identities.

Tier 4: Unit or Activity Extensions

When OST educators have their basic needs met, so that they can to successfully facilitate activities and teach content, they are ready for the fourth tier of support: resources for unit or activity extensions. NASA offers a rich assortment of planetary science and engineering resources for educators and learners, including videos, lesson plans, fact sheets, career opportunities, image libraries, interactive digital learning platforms, and simulations. These resources can be sorted by missions, by themes, or by learning subjects and scientific concepts such as math, art, astrobiology, or geology.

Rather than recreate similar resources, PLANETS provides a filtered set of links to NASA resources related to the three curriculum units. Educators can use these resources as unit or activity extensions. For example:

> To connect young people to diverse STEM careers, educators can use short video clips about NASA careers like this one on Women in STEM: https://nasaeclips.arc.nasa.gov/video/smee/sme2-women-in-stem
>
> To make science and engineering learning relevant to young people's lives, educators can use the NASA Home & City interactive website to show how space exploration and research have affected daily life: https://www.nasa.gov/directorates/spacetech/new_interactive_website_homeandcity
>
> To delve deeper into unit content, PLANETS recommends resources like the interactive visualization of Mars at https://trek.nasa.gov/mars

Implications for Designing OST STEM Professional Development Resources

Effective OST educators can inspire STEM learning by supporting young people's curiosity and sensemaking—without offering too much guidance, which can stifle learning (Fenichel & Schweingruber, 2010). OST educators need resources at different levels of STEM implementation in order to support young people in their own STEM learning. The PLANETS tiered approach to STEM professional development resources provides multiple options and entry points for OST educators so they can quickly and easily obtain the support they need just when they need it to implement the curriculum. This approach meets the immediate needs of OST educators in implementing STEM curriculum, supports their content and pedagogical needs in ways that are useful and directly applicable, and provides resources for further exploration beyond the curriculum. The web-based, modularized resources are available in short snippets to meet the needs of busy OST educators.

There is no "one size fits all" STEM professional development that will meet all the needs of OST educators. Each OST educator has unique environmental factors, content knowledge, experiences, interests, and skills that affect how they engage youth in learning STEM. They therefore need multiple options for specialized professional development resources. The PLANETS tiered approach is one approach to self-driven professional development. Though its effectiveness needs further investigation, the model may be adaptable for application with other OST STEM curriculum and professional development initiatives.

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Black Girls Create

Developing a Culturally Responsive Maker Program for Black Girls

LaShawnda Lindsay

Afterschool programs are a significant vehicle for increasing STEM interest, confidence, and capacity in underrepresented students (National Research Council, 2009). According to the Coalition for Science After School (2007), effective afterschool programs provide relevant, hands-on opportunities for underrepresented youth to interact with relatable scientific role models, content knowledge, and resources.

This article describes the development and pilot implementation of a culturally responsive maker afterschool program for Black girls. The pilot of Black Girls Create used social history, culturally responsive pedagogy, and mentoring to engage Black girls in maker-based activities as they learned about Black "Her-STEM" figures: women who made significant impacts in STEM. By the end of the program, girls had used their new maker skills to design and create cultural artifacts and to conduct digital fabrication demonstrations. This article highlights the program design, pilot program outcomes, and successes and challenges associated with the pilot implementation.

The Status of Black Girls in STEM

The National Assessment of Educational Progress reports that African American students and girls in all grade levels consistently score lower than their white and male counterparts, especially in the sciences (National Center for Education Statistics, 2010). Local schools in urban neighborhoods in Boston, where Black Girls Create was implemented, mirror the national trend of underperformance in math and science

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(Massachusetts Department of Elementary and Secondary Education, 2020). For Black girls, low performance in science and math and on standardized tests of all kinds poses obstacles for high school graduation and entry into college, thus foreclosing their participation in STEM fields in adulthood (National Science Foundation, 2013; Perna et al., 2009).

Research shows that Black girls do not significantly differ from other students in their aptitude for learning science and math content (Campbell, 2012; Crenshaw et al., 2015; Grossman & Porche, 2013). However, they do differ in their interest and confidence in STEM subjects, and this difference negatively affects their performance. Poor performance in science and math has both direct and indirect implications for Black girls' future career options; it limits access to competitive colleges and universities, influences college major selection and college persistence, and precludes entry into the STEM workforce (Campbell, 2012).

Student identities such as race, gender, and class, as well as teacher responses to these identities, are shaped by broad social trends and realities beyond the classroom (Campbell, 2012). Society often perpetuates false beliefs about how race and gender negatively influence students' ability to learn math and science. Moreover, the belief that math and science ability is innate and related primarily to one's gender or race poses threats to Black girls' interest and confidence in these subjects (Davis, 2019). Negative stereotypes can raise doubts and anxieties in Black girls' minds, thereby limiting their confidence in their ability to learn science and math (Grossman & Porche, 2013). Using 893 cases from the 2002 National Education Longitudinal Study, Campbell (2012) examined Black girls' perceptions of math and how those perceptions affected teachers' recommendations for higher-level math courses. In this study, 91 percent of Black girls believed that people could learn to be good at math; however, 53 percent did not view themselves as capable math learners (Campbell, 2012). Low confidence in their own ability may explain why 51 percent of these Black girls indicated that they did not participate during math class.

Black girls exist at the intersection of two social identity groups that are underrepresented in STEM. That intersectionality is an essential lens through which girls process their experience in STEM education (Crenshaw et al., 2015). Black girls' inability to identify with STEM is due to myriad factors, including the absence of role models from their communities, consistently alienating experiences in science and math classes, unengaging class instruction, and the lack of connection between the content and their daily lives (Calabrese Barton & Tan, 2018; King & Pringle, 2018). By attending to the psychological meaning and experience associated with being a Black girl in out-of-school STEM education, afterschool practitioners can help Black girls perform better in math and science (Ireland et al., 2018).

Approaches to STEM learning that are culturally relevant and caring (Parsons, 2008) and that validate and use students' cultural resources (Calabrese Barton et al., 2017; Tan et al., 2013) have been shown to strengthen Black girls' engagement in STEM learning. Afterschool programs designed to create meaningful, engaging STEM learning opportunities for Black girls can bridge the gap between STEM learning and confidence in STEM. Programming that enables Black girls to see people like themselves working in STEM is another factor that afterschool programs can address (Archer et al., 2015; Davis, 2019; Kang et al., 2019).

Project Rationale

Unlike many STEM programs (Calabrese Barton & Tan, 2018), Black Girls Create addresses issues of equity, inclusion, and relevance for Black girls by providing a curriculum and a learning environment that incorporates girls' cultural and intellectual histories and expands the meaning and purposes of STEM learning.

A unique aspect of Black Girls Create is that it focuses on making and maker culture. Maker afterschool programs in which girls learn about digital fabrication and engage in STEM in meaningful ways are associated with improvements in their STEM interest and self-efficacy (Techbridge Girls, 2020). Making can involve traditional craft and hobby techniques, such as sewing or woodworking. It often incorporates digital technologies in either manufacture or design. For example, manufacturing processes might use laser cutters or 3D printers; designs might

Black girls exist at the intersection of two social identity groups that are underrepresented in STEM. That intersectionality is an essential lens through which girls process their experience in STEM education.

use microcontrollers or LED lights for specific effects (Martin, 2015). Digital fabrication involves the design and manufacturing of products using advanced technology. Common forms of digital fabrication are computer numerical control (CNC) machinery, 3D printing, and laser engraving and cutting.

Maker spaces and related activities give young people who have disengaged from formal STEM instruction opportunities to design, tinker, and build in nontraditional ways, thus enhancing their confidence and interest in STEM (Calabrese Barton & Tan, 2018). Making gives youth access to sophisticated digital tools they can use to build, create, and think (Martin, 2015). Maker learning can engage underrepresented youth and broaden participation in STEM by centering on digital fabrication activities that make sense specifically to learners from a particular cultural background (Searle & Kafai, 2015).

Culturally responsive making is an emerging field in both research and practice in informal STEM learning environments (Searle et al., 2017). For this project, culturally responsive making is operationally defined as tapping cultural knowledge and maker technologies to engage young people in creating, designing, and producing artifacts related to a particular concept, theme, or person. It connects with learners' interests and activities along a spectrum of cultural practices, from traditional to vernacular. It also engages youth in cultural affirmation and sociocultural critique. Making situated in an appropriate cultural context can broaden participation by young people from underrepresented groups and address identity gaps that prevent these young people from seeing themselves as capable STEM learners and future STEM professionals. For example, Searle and Kafai (2015) examined how participating in culturally responsive making shaped Native American girls' sense of agency in STEM. The findings suggest that introducing girls to making and engineering concepts in ways that feel familiar can expand their ideas about what they can do.

The combination of making, social history, cultural responsiveness, and mentoring addressed the participation gap and identity gap experienced by Black girls in ways designed to lead to more positive racial and gender identities.

Black Girls Create engaged Black girls in digital fabrication to increase their interest in STEM and their confidence in their ability to learn STEM. Its culturally responsive pedagogy focused on Black women's contributions in STEM. The combination of making, social history, cultural responsiveness, and mentoring addressed the participation gap and identity gap experienced by Black girls in ways designed to lead to more positive racial and gender identities.

Incorporating culture into program design and implementation was a critical feature of Black Girls Create. Culture is the mechanism through which people learn how to be in the world, how to behave, what to value, and what gives meaning to their lives. Culture is the context for learning, whether in formal or informal settings. Acknowledging and incorporating participants' culture helps them create meaningful connections to academic subjects—particularly when they are members of underrepresented groups who may believe that certain subjects are unrelated to their current or future lives. For example, many Black girls and young women believe that science and math are not interesting and that the content is too difficult for them to master (Bowe et al., 2015; Campbell, 2012). As a result, many of them disengage from learning and fall behind in these core subjects. Decades of research show that situating learning within students' cultural context and connecting academic subjects to their cultural knowledge produce better academic outcomes. When these connections are made, especially in science and math, learners are more likely to show interest in the subject, engage in all aspects of the learning process, and master the content (Aronson & Laughter, 2016; Gay, 2000; Ladson-Billings, 1995).

Guiding Principles and Curriculum Development

Black Girls Create is a research project I conducted at Wellesley Centers for Women, Wellesley College. To design and implement the program, I developed the five research-based guiding principles outlined in Table 1.

Using these five principles, I designed the curriculum outlined in Table 2. A network of STEM professionals, makers, educators, and youth program specialists reviewed the program goals, principles, and curriculum to ensure that all aspects were aligned. After addressing these professionals' concerns, I pre-

Table 1. Black Girls Create Program Principles

Principle	Application in Program Development and Implementation
STEM capacity building	STEM capacity building is an approach to academic and career development that acknowledges psychological and performance factors that shape learners' interest in STEM content and their confidence in their ability to master that content. In this project, the psychological domain of capacity building focused on understanding participants' individual, relational, and collective selves and how those identities related to STEM learning. The performance domain focused on enabling participants to use science and math skills to create graphic designs and produce digitally fabricated cultural artifacts.
Culturally responsive informal learning	The project's safe, culturally responsive informal learning environment encouraged Black girls to develop interest and confidence in STEM by building on their cultural knowledge, prior experiences, and performance styles. Situating math and science learning in the context of participants' cultural history helps Black girls develop academic STEM knowledge and intellectual tools in ways that legitimize what they already know and have an interest in (Gay, 2000).
Her-STEM (historical female STEM models)	Conducting research about Black women who made significant contributions to STEM encourages Black girls to identify with STEM and make meaningful connections between STEM learning and historical figures. By learning about Black women in STEM, participants were expected to develop positive attitudes about their STEM learning capacity and to become invested in gaining the knowledge and skills necessary to design and create cultural artifacts.
Mentorship	Interacting with and learning from relatable STEM mentors is an integral aspect of Black Girls Create. Access to mentors can foster interest and confidence in STEM. In Black Girls Create, a mentor informed curriculum design, delivered content, and cultivated relationships with participants.
Self-reflection	Learning to identify and reflect on beliefs that either support or inhibit STEM interest and confidence equips girls to process and combat current and future STEM education barriers.

sented the program components to my advisory board for approval in fall 2018.

Program Implementation

Black Girls Create began as a pilot program in fall 2018. A pilot of a new educational program helps developers identify strengths and weaknesses so they can address any problems before full implementation. To implement the pilot, I established a partnership with Lena Park Community Development Corporation in Dorchester, Massachusetts. Lena Park is a multi-service center developed for and by community residents; programs range from early childcare and afterschool education to recreation and job training. Lena Park is part of the international network of approximately 1,000 Fab Labs, which nurture STEM education in collaboration with local nonprofits, K–12 schools, and higher education institutions. Before choosing Lena Park, I investigated three Fab Labs located in metropolitan Boston neighborhoods where many Black families live. Lena Park Fab Lab met the program's needs, in part because it is equipped with a full array of technical tools for digital and traditional fabrication.

I facilitated the pilot of Black Girls Create with two groups: Group 1 had seven participants and Group 2 had eight. Group 1 began in November 2018 and concluded in February 2019; Group 2 ran from April 2019 to June 2019. The age range of participants was 11 to 14, with an average of 12.2. I recruited participants from the local public charter school, an Afrocentric shopping bazaar, and social media. Using a video, flyers, and posters, I talked during grade-level morning assemblies at the school with students and teachers in grades 6 through 8. I also posted digital flyers on Wellesley Centers for Women's social media pages and shared them with my own social networks. This information was organically shared by at least 25 different people, thus widening the posts' reach; several pilot applicants were recruited this way.

Table 2. Black Girls Create Curriculum

Unit	Objective	Activities	Competencies
STEM capacity building	Participants develop the attitudes, knowledge, and skills needed to create artifacts using digital fabrication.	Participants begin to learn use of digital fabrication tools, including vinyl cutter, laser cutter, and 3D printer.	Computer-aided design Problem solving Math and spatial reasoning Vector design Ordering, sequencing, and visualizing Creativity
Research and design	Participants develop positive attitudes about their STEM learning capacity and invest in learning the knowledge and skills necessary to design and create artifacts.	Participants research their assigned historical figures and write their figures' histories, including career pathways and significant STEM contributions.	Awareness of STEM fields and careers Storytelling, creative thinking Data gathering, fact-checking, data analysis, reporting Oral communication
Making	Participants learn to use digital fabrication tools and develop their graphic design skills.	Participants use their graphic design and digital fabrication skills to create an artifact representing their selected historical figure.	Safety and operational procedures for use of digital tools Computer-aided design Problem solving Math and spatial reasoning Ordering, sequencing, and visualizing Creativity
Community demonstration	Participants demonstrate what they have learned. The long-term success of efforts to address participants' attitudes about STEM depends on their families, who may also benefit from activities that challenge their beliefs about STEM.	Participants demonstrate their knowledge of maker skills and of their assigned Black female STEM pioneer during the closing meeting. Participants demonstrate how to use digital fabrication tools.	Critical thinking, analytical skills Self-reflection Metacognition

Potential participants completed an online application, which collected demographic information and verified participants' availability for all program sessions and caregivers' availability for the parent orientation. I received 15 applications for Group 1 but could accept only nine applicants because the site had only nine desktop computers and because funding permitted the hiring of only one group mentor. From the 15 applications, I selected seven participants for Group 1 who indicated that they were available to attend all program meetings and that their caregivers would attend the orientation. Participants in Group 2 emerged from a partnership between Lena Park Fab Lab and Harlem Lacrosse, an afterschool sports program. I implemented a modified version of the 12-week program with Group 2.

All Black Girls Create activities were held at Lena Park Fab Lab. I collaborated with an undergraduate African American female mentor to conduct weekly two-hour work sessions with each of the two groups. Group 1 participated in 12 weeks of programming, and Group 2 had seven weeks. Work sessions centered on specific learning outcomes associated with the general outcomes of the program.

Each session began with a recitation of the Black Girls Create pledge, which was created by program participants during the first session. The pledge helped to foster participant ownership of the program. Then participants shared information about their Her-STEM figures and brainstormed ideas for their final projects: digitally fabricated cultural artifacts representing those historical figures. Next, I taught the day's STEM capacity-building skills, which then were demonstrated by me or the undergraduate mentor. For example, on the day when the group made Black Girls Create T-shirts, participants needed to learn about two-dimensional design and about safe operation of the vinyl cutter and heat press. After watching the demonstration, participants practiced what they had learned to produce a product, in this case, a T-shirt. Every work session included work with digital fabrication equipment. At the end of each session, participants recorded in their journals what they had learned and enjoyed that day. Each work session was designed to build the confidence, knowledge, and skills participants would need to create their final projects.

Each work session was designed to build the confidence, knowledge, and skills participants would need to create their final projects.

The primary program outcome for this pilot study was the completion of the final project. Participants selected a Black Her-STEM figure, conducted research about that figure, designed (with support) an artifact to represent that figure, produced the artifact using one or more of the digital fabrication tools in the Fab Lab, and presented the artifact to their families during the last program session. Leading up to the final project, program activities helped participants develop the skills necessary to plan, design, and create their artifacts. For example, in addition to using the vinyl cutter and heat press to create customized T-shirts, participants also used the vinyl cutter to design and create stickers for their journals and used Inkscape graphic design software and a laser cutter to create a two-dimensional image of a Black girl.

Of the 15 participants in the two groups, 10 completed the final project: four of the eight in Group 1 and six of the seven in Group 2. The program schedule was a significant factor in Group 1's completion rate. The weekly work sessions began in November and ended in February; in the middle was a two-week winter break in which no sessions were held. Some participants stopped attending after the break.

Although participants learned how to create both two- and three-dimensional designs and to use a vinyl cutter, 3D printer, and laser machine, most used the laser machine to create their final projects. Only one used the 3D printer; she created three-dimensional animal figures to represent the first black female zoologist, Dr. Roger Arliner Young. Other participants created key chains, wall art, earrings, pendants, and other items to represent Her-STEM figures and their contribution to STEM. For example, the participant who conducted her research on Dr. Shirley Jackson, the physicist who invented caller ID and call waiting, designed and digitally fabricated a wooden iPhone with Dr. Jackson's name and a phone number on the screen. All participants who completed the program demonstrated their creativity, their knowledge of digital fabrication, and the results of their Her-STEM research.

Lessons Learned

In addition to program outcomes, the pilot implementation of Black Girls Create yields valuable information about the successes and challenges of designing and implementing afterschool programs for Black girls and other marginalized youth. Two factors that were key for this innovative afterschool STEM program were effective partnerships and intentional recruitment strategies.

When I visited the three Boston-area Fab Labs located in largely Black neighborhoods, I considered many factors, including the availability of equipment, the lab's accessibility to the surrounding community, and the extent to which the leaders expressed interest in serving Black girls. A critical factor was how welcoming the organization's leaders were to me, a Black female researcher and educator, and to other outsiders. Meanwhile, I already had established relationships with the Fab Foundation (the parent organization of local Fab Labs), Lena Park, and the charter school from which I recruited participants. My ongoing involvement as a maker in local cultural events had earned credibility that helped me gain access to key stakeholders and institutions in the community. My presence in the community before, during, and after the pilot project helped create the organizational and community buy-in needed to run a successful afterschool program.

Another key to success was intentional recruitment. Before reaching out, I created culturally representative recruitment materials, including a video in which I shared information about Black Girls Create as well as posters and flyers using culturally representative photos. The middle school I visited to recruit girls is more than 50 percent Black. Social media was another important recruitment tool, as was my own established visibility in the community.

The two main challenges of the pilot implementation were lack of available mentors and participant attrition. The college students who expressed interest in serving as program mentors faced the challenge of traveling the 30 miles from the college campus to the project site, a three-hour round trip by bus. The mentor who did commit to the program despite the long commute grew up near the project site and was eager to serve her community through this project.

Another key to success was intentional recruitment. Before reaching out, I created culturally representative recruitment materials, including a video in which I shared information about Black Girls Create as well as posters and flyers using culturally representative photos.

Problems with attendance affected participants' ability to fulfill the program requirements. Several participants dropped out due to competing responsibilities and involvement in other extracurricular activities. Group 1 had more attendance issues than Group 2, likely because of the difference in program length: 12 sessions over four months for Group 1 and seven sessions over two months for Group 2. Some Group 1 participants dropped out after the winter break, which was not a factor for Group 2.

Implications and Future Directions

Maker-based learning environments provide spaces for youth who are disengaged from STEM to engage in designing, tinkering, and building in ways that foster their confidence and interest in STEM learning (Calabrese Barton & Tan, 2018). These spaces engage students in STEM-based activities that make sense in their world and help them develop maker identities consistent with their cultural identities. Black Girls Create exposed participants to STEM in a nontraditional way and gave them access to digital tools that would otherwise be out of their reach. Culturally responsive making has the potential not only to broaden participation of Black girls in STEM but also to address identity gaps that can prevent girls from seeing themselves as capable STEM learners and future STEM leaders (Searle et al., 2017; Searle & Kafai, 2015).

My research contributes to the body of knowledge in informal STEM education by examining how a culturally responsive maker program was designed to influence Black girls' interest in STEM and their multiple identities. This project built on culturally responsive educational theory and research, which consistently show how culture, interest, and identity affect student learning. Black Girls Create and similar programs leverage experiences with gender-specific and culturally embedded curricula to strengthen Black girls' interest and confidence in STEM and their related racial and gender identities (Scott & White, 2013; Scott et al., 2015). This and similar innovative, collaborative approaches have the potential to broaden participation among a population that is grossly underrepresented in STEM fields.

I plan to conduct further research to develop a conceptual model for engaging underrepresented groups in informal STEM learning spaces in the context of making, sociocultural history, and identity development. Further research on the impact of culturally responsive maker programs on Black girls' STEM interest, STEM confidence, and multiple identities can help K–12 teachers, informal STEM educators, educational researchers, and institutions of higher education to develop strategies to broaden STEM participation and thereby contribute to a diverse, globally competitive STEM workforce.

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VOICES FROM THE FIELD

Mind the Gap

The Overlap Between Public Libraries and OST Learning

Brittany R. Jacobs

On any given day you can find a revolving assortment of wildly eclectic items adorning my desk, including dinosaurs, arachnid specimens, sugar skulls, and galaxies. I'm not a paleontologist, entomologist, cultural scientist, or astrophysicist, but my job does require me to know a little about all those things and more.

In my official job description, I'm charged with being an "explorer, wizard, and genius." I'm an educator, but not a formal teacher. I work with children, teens, and families after school, on weekends, and throughout the summer, but I'm not part of the out-of-school time (OST) profession. I am a 21st century public librarian at Anythink, a revolution of Rangeview Libraries.

Anythink is a future-leaning library in Denver, Colorado, that has revolutionized the way libraries function. For example, we've done away with the Dewey Decimal System, opting for a user-friendly Word Think cataloging system—think of organization by genre, as in a bookstore. We use new language to reintroduce libraries to the community; for example, I'm a "guide," not a "librarian." Everything we do is modeled around the idea that *everyone* is an "explorer, wizard, and genius." At Anythink, we're all about learning through hands-on experiences. That's why an eccentric collection of materials adorns my desk at the Perl Mack neighborhood branch, where I work.

As someone who has previously worked in the OST field, I noticed many similarities between what

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afterschool programs offer and what I offer as a public librarian. I've also noticed overlap in the populations served by OST and public libraries. As libraries shift from a data-centered mindset to a human-centered one, we're starting to mirror OST sites by offering snacks, homework assistance, classes, and other activities during the OST hours. Along with these striking similarities between OST and libraries are some significant differences—differences that are necessary in order for both kinds of organizations to maintain their unique roles in their communities. If we mind the gap—attending both to the overlap between the two fields and their differences—we can appreciate how both OST and libraries offer unique opportunities for children and teens.

Data-Centered vs. Human-Centered Librarians

This century has ushered in transformations that have permanently changed our society. None have been so drastic as the shift to a new idea of knowledge. The mechanistic view of learning from the 18th, 19th, and 20th centuries revolved around static knowledge; information changed slowly, if at all. Mechanistic learning, which required the intervention of a teacher, upheld elitist and hierarchical systems of knowledge acquisition. Libraries were very much involved in promoting this hierarchy. Librarians acted as guardians of information, much of which was acquired through reading and rote memorization. "Many approaches to learning in the twentieth century did, in fact, work but largely because of the glacial rate of change that characterized the era" (Thomas & Brown, 2011, p. 43).

In the rapid-pace world we live in now, knowledge is fluid and quick to change. Just over 50 percent of the global population has access to limitless information—and misinformation (Kemp, 2019). In this environment, learning institutions are having to pivot quickly, assessing their pedagogy and realigning themselves with the new era of learning. Libraries have come under scrutiny. Many people believe that Google and similar tools have rendered libraries and librarians moot. However, one glimpse into a public library during OST hours tells a different story. To keep up with the times, libraries and librarians are shifting from being data-centered to being human-centered.

If we mind the gap—attending both to the overlap between the two fields and their differences—we can appreciate how both OST and libraries offer unique opportunities for children and teens.

Figure 1. The Data-Centered Librarian

Figure 2. The Human-Centered Librarian

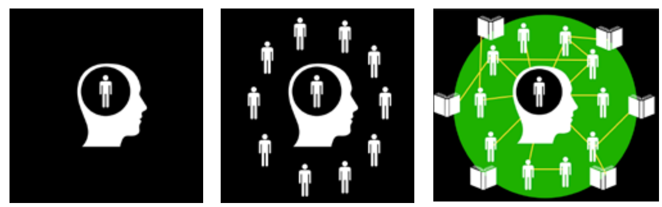

Figure 1 shows the disconnect of the data-centered librarian, who prioritizes the collection and then has to mediate between it and the public. Books, data, and resources—particularly those found in a library, where they are cataloged into a very specific order—represent organization. People represent chaos and destruction. This mindset explains why the first libraries were private. The elitism that controlled access to information prioritized resources over people. This mindset still motivates many in the field today.

Figure 2, by contrast, showcases the human-centered librarian: one who thinks first about patrons and connects them with the resources they need, including not only books, but also other people. A few lines in the diagram go straight from the librarian to a patron and no further. These lines represent services provided immediately to people in need, as the librarian administers Narcan to prevent a narcotic overdose, offers free lunches in partnership with a local food bank, or helps a job seeker with a résumé.

Librarians play an active, though often unintentional, role in the OST field. Libraries are safe spaces, resource hubs, and community centers for children and teens during OST hours; they are places for young people who otherwise might not have anywhere to go. As young people pour into libraries in the afternoons, on weekends, and during school breaks, librarians find themselves by default participating in OST programming, though not all are trained in child development, educational programming, or behavior management. They experience a disconnect between what they trained to do in their work toward a master's degree in library and information sciences (LIS) and what they are expected to do on a day-to-day basis.

I looked at the required coursework for five highly respected LIS master's programs. Not one of them required a class that explored human development, behavior management, or informal learning, all subjects that would help LIS students prioritize people over collections. Librarians are still being trained to operate in the slow-moving and static world of information, when the reality is that knowledge is now ever shifting, and access means facilitating connected learning.

Knowledge-seekers now are their own guides. Knowledge acquisition—particularly for young learners—looks more like hanging out, messing around, and geeking out, also known as HOMAGO (Ito et al., 2009). HOMAGO, or interest-driven inquiry supported by peer interaction, is at the heart of many libraries' maker spaces and programs. In these environments, learners set their own pace; librarians are there to support, troubleshoot, and redirect when needed.

Libraries and OST Programming

Youth librarians—those who specialize in managing collections, spaces, programs, and events for children from birth through age 18—are fostering environments that look more and more like traditional OST programs. Consistent programs at libraries may, for example, offer snacks, homework help, or STEM programming. The Literacy Enrichment Afterschool Program at the Free Library of Philadelphia is a great example of an organized OST program within library walls; it offers daily literacy activities, maker projects, health and wellness programs, homework assistance, computer literacy, and library skills for students in grades K–12 (Free Library of Philadelphia, 2020). Other library systems offer drop-in programs after school, ranging from robotics club to cooking class, homework help, and beyond. At Anythink Perl Mack, we offer classes ranging from deejaying with the Denver DJ School (Figure 3) to a monthly woodshop class (Figure 4). Such programs give children and teens opportunities to experience activities and develop skills that might not otherwise be available to them.

Figure 3. Monthly DJ school at Anythink Perl Mack

Figure 4. Monthly woodshop class at Anythink Perl Mack

In 2006, a conference for librarians on afterschool programming, entitled Learning in Libraries, posited that "public libraries may have been the original afterschool providers, but they must step up their efforts if they are to be players in the fast-growing Out-of-School Time movement" (Barber & Wallace, 2006, p. 39). Fourteen years have passed since that call to action. Because of the many similarities between OST and LIS, I set out to see whether and how intentional work and partnerships are being fostered between the two complementary but different professions. I gathered literature that incorporated both LIS and OST terminology. The overlap between the two fields seems obvious, yet the information, academic and otherwise, surrounding librarians and libraries as active players in the OST field is slim. Most research published on OST and libraries is from the OST perspective: Reports from Lights on Afterschool, Afterschool Alliance, and the like recognize the family engagement and educationally aligned programs libraries offer to young people outside the classroom.

The most telling of the documents I reviewed is perhaps the National Research Agenda for Library Service to Children put together by the Association for Library Service to Children (ALSC, 2019), a subsection of the American Library Association. This call for research highlights how little information is out there about learning in libraries. It recognizes the need for further research into six key areas, one of which is "learning and development for school-age children and their families" (ALSC, 2019, p. 5). This priority area focuses on encouraging and emphasizing research into how libraries support OST learning for school-age children and their families, specifically calling for study of "summer reading/learning, community engagement, particularly around family engagement, and outreach for school-age children" (ALSC, 2019, p. 5). However, the article never implies that libraries are OST spaces in and of themselves.

According to a study done by the Afterschool Alliance, the Space Science Institute's National Center for Interactive Learning, and the American Library Association, "74% of afterschool programs have worked with a public library before" (Afterschool Alliance, 2017). Of the afterschool programs surveyed, most reported that partnerships with public libraries took the form of participation in summer reading programs (65 percent) and library visits (58 percent). This survey pulled responses from 39 states, with the majority coming from California, Minnesota, New York, and Oregon (Afterschool Alliance, 2017)—all of which have large multi-branch library systems. This report shows that OST professionals have positive impressions of their local public libraries. Far-reaching and geographically broad as the report is, it completely leaves out the perspectives of libraries and librarians. The implication is that libraries are not operating within the realm of OST but rather provide peripheral experiences for participants in sanctioned OST organizations.

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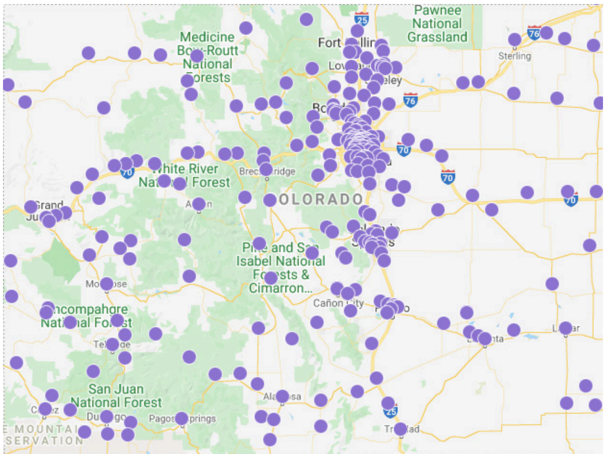
How Libraries Fulfill the Need for OST in Colorado

According to the Colorado Afterschool Partnership (n.d.b), in 2019, "146,856 school-age children (17 percent) in Colorado [were] alone and unsupervised during the hours after school." However, it would be more accurate to say that 17 percent of school-aged children in Colorado were not enrolled in any formal afterschool program. The correlation between afterschool hours and juvenile crime is often touted as one of the things that afterschool programs actively fight against, as "they keep kids safe and help them realize their full potential" (Afterschool Alliance, 2017). That mission sounds awfully similar to what I and thousands of my fellow youth librarians do when the kids rush to the library after school.

In January 2020, during the dead of winter, the seven branch Anythink libraries across Adams County, Colorado, offered 274 programs for kids and teens, with over 6,000 participants. In June 2019, 299 programs were offered, and more than 10,000 people participated, without having to pay a dime (Sandlian Smith, 2020). Programs at Anythink are always free, as we strive to create equitable access to our learning environments. The participant numbers don't include incidental users—the children and teens who come to the branches to hang out in a safe space without participating in programs. Thus, it is fair to surmise that a sizable number of the 17 percent of children who are "alone and unsupervised" (Colorado Afterschool Partnership, n.d.b) are in fact spending their afterschool, weekend, and summer hours with us at the library.

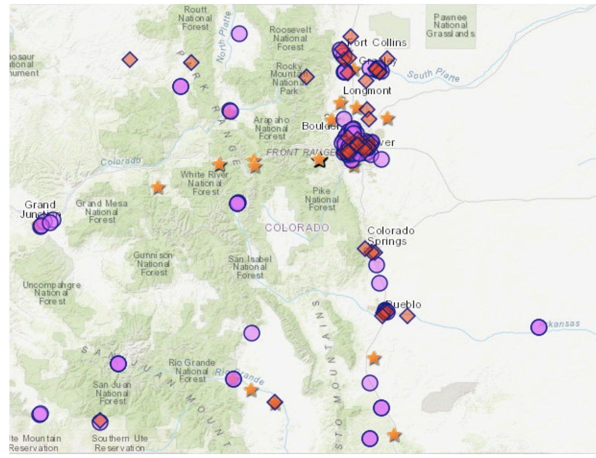
Public libraries in Colorado, mapped in Figure 5, far outnumber formal afterschool programs, shown in Figure 6. These libraries create a net of spaces for children and teens that are safe, free of charge, and often bustling with educational programs and events—not to mention the Wi-Fi access and the thousands of books, movies, and recordings at kids' disposal. Yet libraries don't qualify as OST centers, according to the Colorado Afterschool Partnership (n.d.b) and Colorado Depart-

Figure 5. Public Libraries in Colorado



Source: Colorado Department of Education, n.d.

Figure 6. Afterschool Programs in Colorado



Source: Colorado Afterschool Partnership, n.d.a

ment of Education (n.d.), because they don't hit the benchmark of 12 hours of organized programming per week.

I've personally seen that libraries are key players in the lives of children and teens during OST. As a public librarian and a participant in the NIOST fellowship, I've noticed the gap between LIS and OST. Research to justify and validate libraries as participants in the OST field is yet to be conducted. Perhaps, rather than trying to close the gap by aligning libraries with the parameters of traditional OST, we should *mind* the gap: acknowledge the differences between OST programs and public libraries, but not dismiss the two settings as completely unrelated.

A New Category of OST Entities

By recognizing the valuable role public libraries play for thousands of children and teens every day, we can paint a broader picture of what OST looks like here in the US. Libraries can offer a unique perspective on OST. They can be points of refuge for children and teens who are not able to attend formal afterschool programs for one reason or another. Perhaps a new category of OST entities is in order, one where libraries are free to remain true to their nature while simultaneously qualifying as legitimate OST sites.

In order for this to happen, data needs to be collected on OST from librarians' perspectives and through the lens of LIS. Librarians need to be aware both of the role they play in OST and of the OST world at large. The similarities between OST and LIS are many, but none is greater the desire to help kids stay safe and succeed.

As Urban Libraries Council Executive Director Martín Gómez is quoted as saying at the Learning in Libraries conference, "We can't take our place at the out-of-school table for granted. We must be intentional. And we must develop systems that will help us demonstrate our impact" (Barber & Wallace, 2006, p. 39).

Human-centered librarians are already knee-deep in the OST world. We recognize the ever-growing need for children and teens to have a space to go after school where they are seen, kept safe, and encouraged to explore their interests and discover new ones. The dinosaurs, sugar skulls, and arachnid specimens on my desk are not there because I'm deeply interested in them. They're there because I've followed my young patrons' interests to create programs and collect resources that will help them explore themselves and their world. Notes, tokens of appreciation, and gifts from kids and their parents also adorn my desk—small reminders that offering a free and safe space for kids to go, where magic is still alive and anything is possible, is an important role in the community.

In 2019, 256,263 students were waitlisted for afterschool programs in Colorado, and "the demand for programs is so great in Colorado that 1 out of every 10 applications cannot be funded" (Afterschool Alliance, 2020, p. 1). Contrary to popular opinion, libraries are not a dying entity. We're innovative, and we're transforming ourselves to meet the needs of our communities. As a public librarian, I ask you to reach out to your local libraries to share resources, stories, and best practices. But please—mind the gap.

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Overcoming Barriers Through Collective Impact

A Case Study

José Mendez

With an increase in the number of enrichment options available in out-of-school time (OST), young people can explore topics generally passed over in a typical school day. Parent perception of afterschool programming is beginning to shift from a simple necessity of the work week to a conscious choice about the daily experiences of their children. Public school districts are leaning heavily on afterschool programs to complement the school day by incorporating academic components to help close the achievement gap.

In light of these shifts, limited resources and waning support for OST organizations require solutions that go beyond the traditional strategies of fundraising and networking. Although these components are still critical, many are finding that fundraising and networking are not enough to sustain high-quality enrichment experiences for young people whose families do not have the financial means to pay. With dwindling resources and myriad needs to be met, many providers feel compelled to go beyond their mission statements to meet the unique needs of their communities while being nimble enough to respond to crisis. The idea that any individual organization can meet community needs through its own isolated intervention is slowly becoming a perception of the

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past. Community organizations need to create deeper relationships with each other while leveraging and maintaining limited resources.

Collective impact is one model for bringing about systemic change. Collective impact is "a framework for achieving systems-level changes in communities through coordinated multi-sector collaborations" (Christens & Inzeo, 2015). The collective impact model enables community organizations to go beyond the small constituencies with whom they regularly work, reframe their efforts, and magnify their reach. Kania and Kramer (2011) write, "Collective impact is not merely a matter of encouraging more collaboration or public private partnerships. It requires a systemic approach to social impact that focuses on the relationships between organizations and the progress toward shared objectives."

This case study investigates how collective impact can increase equitable access to high-quality OST programming by encouraging independent organizations to adopt a common agenda to solve systemic issues. In pilot programs in Somerville, Massachusetts, application of the collective impact model increased the number of OST slots available to serve local youth and is on track to transform the OST landscape.

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OST in Somerville

Somerville, Massachusetts, is the 17th densest city in the United States. At just over four square miles, it has 75,754 people (U.S. Census Bureau, 2019), making it the most densely populated municipality in New England. White people make up nearly 70 percent of the population, Latinx people almost 11 percent, people of Asian descent 10 percent, and African-American people 7 percent (U.S. Census Bureau, 2019). These statistics stand in stark contrast to the demographics of children in the public schools. During the 2019–2020 school year, Latinx students made up 42 percent of the student population; White students were 39 percent, African-American students 9 percent, and Asian students 6 percent (Massachusetts Department of Elementary and Secondary Education, 2019).

Although population demographics are not necessarily a sign of gentrification, the median household income in Somerville has risen from $67,118 in 2013 (Data USA, 2017) to over $91,000 in 2018 (U.S. Census Bureau, 2019). In the past 10 years, the average home sale price has more than doubled, averaging over $900,000 in 2019 (Tamela Roche, 2020).

As the cost of living has increased, so has the cost of doing business for OST providers. Skyrocketing rents and leasing agreements have forced many providers to increase their prices dramatically, essentially making their services unaffordable to people making less than the median income unless they receive financial assistance. Providers operating in public school facilities have the luxury of focusing revenue on higher salaries. Although higher salary ranges are an obvious benefit to staff in those programs, the inevitable consequence is a wage deficit. Recent job postings for frontline staff in Somerville showed a difference of as much as five dollars per hour for staff in the same roles depending on whether the providers were operating within or outside of the school district. In addition, organizations in facilities outside of school buildings contend with rising costs for property maintenance, utilities, and transportation from schools. All this is taking place while the professionalization of the OST field and the demands of high-income households have increased expectations of an academic focus.

Somerville's density provides some unique challenges for OST organizations and families alike. Issues include a general lack of publicly owned open space and limited public and private funds. These challenges are exacerbated in various ways if the organization is licensed to provide childcare. Many organizations focus on enrichment programming, which does not require state licensing but also does not allow them to access a number of state grants and funds from private foundations. Relatively few OST providers in Somerville are childcare programs, defined in this study as organizations that provide enrichment programming for school-aged youth, grades K–8, throughout the school year from the end of the school day until at least 5:30 pm. Only six entities in Somerville fall within that definition. They enroll approximately 1,300 participants out of the 3,800 children in grades K–8 in Somerville Public Schools. Only three of the six have more than one site; only one operates in all eight public schools. Each organization has its own unique mission, with metrics and pricing scales to match. None currently shares data with any of the others or cross-references participant outcomes with public school metrics.

Outside the confines of the childcare definition are more than 80 public and private organizations that provide a wide spectrum of enrichment opportunities, from reading clubs to physical education. Many have their own special niche and a dedicated neighborhood following that allows them to charge premium prices. The quality of these programs is generally high. However, they are limited in their capacity to offer equitable access through scholarships or to reach beyond high-income households to the youth who most need enrichment outlets.

Initiating Collective Impact

As part of the city's effort to focus on the achievement gap and create equitable access for all, the Somerville Children's Cabinet was formed, consisting of city officials, school district leaders, and representatives from community organizations. With support from the Education Redesign Lab at Harvard Graduate School of Education, the cabinet shares the goal of Harvard's By All Means initiative to build "comprehensive child wellbeing and education systems that help eliminate the link between children's socioeconomic status and achievement" (Harvard Graduate School of Education, 2016). The cabinet aims to "create a stable, cross-sector network that supports positive outcomes for children, youth, and families in Somerville" (City of Somerville, 2017).

As with many broad initiatives with lofty goals, Somerville Children's Cabinet needed to create understanding, starting in this case with the necessary conditions for collective impact, which were outlined by Kania and Kramer (2013). In addition to the aims of the By All Means initiative, the cabinet adopted a common agenda to concretize goals so that members would have tangible action steps toward which to work. Identifying positive outcomes would enable cabinet members to quantify progress and produce shared measurement. Shared metrics would then enable "evidence-driven approaches to the work" (City of Somerville, 2017).

Collective impact work is owned by a group of stakeholders, in this case, the school district, the city, and community organizations. However, the Somerville Children's Cabinet, in keeping with the conditions of collective impact (Kania & Kramer, 2013) also needed a "backbone" organization to organize and administer the work. The SomerPromise Division of the city's Health and Human Services Department fulfills that function, playing a significant role in maintaining the conditions for collective impact. With no formal authority to manage cabinet members, the backbone organization serves as liaison between member organizations and offers guidance on enacting "mutually reinforcing activities" to "optimize positive life outcomes for children and youth" (City of Somerville, 2017). The Somerville Children's Cabinet meets monthly; its meetings are informed by separate meetings of stakeholder groups, including the initiative's OST Task Force and ad hoc committees formed to support specific projects.

Stakeholders can adapt the collective impact model to local conditions. In keeping with this principle, the Somerville Children's Cabinet added an equity lens to guide its strategies and implementation (City of Somerville, 2017). By formalizing and adapting the conditions of collective impact, the cabinet leverages what Kania and Kramer (2013) call "the rules of interaction that govern collective impact." These rules "lead to changes in individual and organizational behavior that create an ongoing progression of alignment, discovery, learning, and emergence" (Kania & Kramer, 2013).

Choosing OST as one of its primary focus areas, the cabinet created a new position: OST coordinator. As the first person chosen to fill this position, I lead a cross-sector collective impact initiative that includes Somerville's OST program providers, the city's Department of Health and Human Services, Somerville Public Schools, Somerville families, and other stakeholders. We work closely together to develop and implement an accessible system connecting children and teens with high-quality OST programming that supports their learning and well-being and meets their families' childcare needs. Part of my role is to flesh out how the collective impact model can be implemented among the city's OST providers. I also help build systems to bridge the school day and afterschool, maximizing learning opportunities and continuity of services.

Case Studies in Collective Impact Modeling

My initial efforts focused on identifying partnerships that reflected the conditions required for collective impact: a common agenda, shared measurement, mutually reinforcing activities, continuous communication, and a backbone organization (Kania & Kramer, 2013). One such partnership is being led by Somerville's Elizabeth Peabody House (EPH) afterschool program. EPH is a small community-based nonprofit whose family support services include a preschool and school-aged afterschool program. However, the organization was not able to operate a summer camp program for school-aged program participants. Rather than creating a program from scratch, the organization partnered with Everwood Day Camp, a for-profit day camp about 40 minutes away by bus in rural Sharon, Massachusetts. Everwood offers nine weeks of summer day camp for children from pre-K to Grade 12, along with family events throughout the year. The common agenda in this partnership was to expand summer programming to socioeconomically disadvantaged youth served by EPH.

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Like many small nonprofits, EPH has a long history of supporting local residents. At a time of transition in executive leadership when new revenue streams were needed, the EPH board agreed to lease a parcel of land it owned in Sharon to Everwood Day Camp. In lieu of cash payments for the lease, Everwood agreed to make a certain number of weeks of camp available to children enrolled in EPH school-year programs. The rates EPH charges families are as much as 50 percent less than Everwood's full price.

In this partnership, the collective impact model:

- Enables EPH to provide high-quality summer enrichment programming to its constituency
- Enables Everwood, a for-profit entity, to act in part as a social service agency by providing clinical support and access to high-quality enrichment during the summer
- Allows both organizations to engage in restorative justice and reflect on unconscious bias

The relationship between EPH and Everwood prompted the development of multiple new programs. One of these, piloted in 2019, provided OST programming during the February school vacation week—a "gap period" when fewer childcare slots are available because many providers do not offer full-day programming. Conversations in the network of providers known as the OST Task Force brought together a number of providers and Somerville Public Schools to tackle the issue of access during this gap period. The Somerville Health and Human Services department served as the coordinating entity. Under the collective impact model, the OST providers, each with its own distinct mission and philosophy, leveraged limited resources to increase the total number of childcare slots. The partnership developed 36 new full-week childcare slots, over half of which were subsidized by the city. Participants aged 6 to 13 engaged in a wide variety of activities.

The success and importance of the program was not in its size but in the paradigm shift it represented. By collaborating under the framework of the collective impact model, the pilot program demonstrated that:

- Contrary to common perception, youth-serving organizations do not have to compete for the same resources. A small subsidy from the city enabled several organizations to develop 36 childcare slots, many with sliding-scale fees.
- Youth-serving organizations that do not consider themselves to be childcare organizations can provide programming that fills the need for full-day coverage.
- Subsidized programming can include experiences that are beyond the scope of what programs could offer alone. For example, one program combines media production combined with Parkour and coding.
- Sliding-scale fees can facilitate equitable access to programming. Of the 36 participants, only nine paid full price. A hypothetical expansion to 100 participants could reduce the subsidy, as shown in Table 1.

A second pilot program, dubbed Somerstart, covered another gap period: the first two weeks of summer vacation. Some of the larger afterschool programs go offline during these two weeks because they need to transition staff, funds, and resources to prepare for summer camp. The Somerstart program aimed to address the well-being of children from low-income communities by connecting them with the

Table 1. February Vacation Pilot Program and Hypothetical Expansion

	Pilot Program	Hypothetical Expansion
Number of participants	36	100
Sliding-scale fees	$400: 9 children (25%) $250: 3 children (8%) $200: 4 children (11%) $125: 2 children (6%) $0: 18 children (50%)	$400: 25 children (25%) $250: 8 children (8%) $200: 11 children (11%) $125: 6 children (6%) $0: 50 children (50%)
Revenue from fees	$5,400	$14,950
Program cost	$9,435	$14,152*
Subsidy required	$4,035	–$798

* 50% increase to accommodate the larger number of participants

natural world. In keeping with this purpose, a nearby outdoor youth development program with extensive grounds administered the program. Somerstart received a much higher subsidy from the city than the February program did. This subsidy artificially created short-term access—almost doubling the number of participants to serve 45 young people—while lowering the cost per participant.

The program's objectives were to increase access to summer programming, connect youth with their environment, and take advantage of partnerships with specialty providers such as the Harvard Museum of Natural History and others. Participants learned through a specialized curriculum that was based in exploration of environmental science and that reinforced social and emotional competencies. Effects of collaboration under the collective impact model in this pilot program included the following:

- Collective outreach enabled the providers to recruit participants who would not normally have access to programming.
- Partners with disparate themes and goals coordinated their curricula to reflect a connection with the natural world.
- Program quality was maintained while the cost per child was reduced. For the February vacation pilot program, the cost per child for the week was $455. For Somerstart, the cost per child per week was reduced to $383; thus, the program more effectively supported disadvantaged families. Thanks to the city subsidy, more than half the children participated for free.

The outcomes produced by the pilot program indicate that the program could be scaled up to serve more participants at lower cost to the city. Table 2 compares the original pilot program with a hypothetical expansion that serves 100 participants. The expanded program:

- Maintains sliding-scale fees
- Lowers the percentage of full-scholarship slots to 51 percent
- Offers free tuition to 19 more participants than the pilot program did
- Reduces the municipal subsidy by $4,865

In addition, cost savings could be realized by centralizing transportation. In the pilot, busing was required to and from the primary program location each day. Establishing a single program site would dramatically reduce the cost of transportation. This reduction is not reflected in Table 2.

Adapting Collective Impact to Support OST in Crisis

Two years into the role of the OST coordinator, the collective impact model in Somerville has brought forth new partnerships, a network of OST providers, major annual events, municipal funding specifically for OST providers, and the beginnings of a paradigm shift in the city. Local elected officials used afterschool as part of their campaign platform. OST providers and public schools have begun to share data. By developing a common agenda with the support of the city Department of Health and Human Services, Somerville Public Schools, and many other stakeholders, the collective impact model continues to prove itself by enabling the network to leverage limited resources.

In times of crisis or uncertainty, the collective

Table 2. Somerstart Pilot Program and Hypothetical Expansion

	Pilot Program	Hypothetical Expansion
Number of participants	45	100
Sliding-scale fees	\$500: 2 children (4%) \$250: 7 children (16%) \$175: 2 children (4%) \$100: 2 children (4%) \$0: 32 children (71%)	\$500: 9 children (9%) \$250: 22 children (22%) \$175: 9 children (9%) \$100: 9 children (9%) \$0: 51 children (51%)
Revenue from fees	\$3,300	\$12,475
Program cost	\$17,240	\$21,550*
Subsidy required	\$13,940	\$9,075

* 25% increase to accommodate the larger number of participants

impact model proves its efficacy. As I write, the current crisis is the COVID-19 pandemic. As during any crisis, the collective impact model offers solutions through the development of a common agenda and the efforts of a backbone organization to use relationships with multiple organizations to direct resources. Although most OST programming in Somerville has been closed during the pandemic, this time has provided an opportunity to develop new strategies and leverage online platforms. Concerns over meeting payroll and making lease payments have given way to a focus on connecting with youth through online programs and on advocating intensely with local and state elected officials. Regular online access to enrichment for youth has become a weekly, if not daily, occurrence.

As part of Somerville's continued effort to broaden access to enrichment opportunities, the collective impact model was employed again during the April 2020 vacation week. Over 70 hours of online programming from a variety of partners was made available online at no cost to more than 450 participants. Considering the short time we had for preparation, the program was a success. We learned some key lessons:

- Enrichment "by appointment" according to a fixed program schedule is a construct of face-to-face programming. To broaden accessibility, online programming must be recorded and archived.
- Lack of consolidation and difficulty of access are stumbling blocks to participation. Limiting the number of pages where resources are located is essential for success.
- Lengthy registration can be a barrier. Limiting the amount of information collected makes access more equitable.
- Not all families have internet access. Those that don't have it are not likely to be able to pay for it.

Lack of language capacity and technical literacy have consistently hampered the well-intended efforts of many organizations to reach families who need the most assistance. The Somerville network used several outreach strategies to improve access during this crisis.

- Personal phone calls were a critical outreach tool.
- Live translation was available for 12 of the 70 hours of online programming provided during April vacation.
- Practice log-ins with translation support facilitated access for families with limited technical literacy.
- Somerville Public Schools partnered with an internet service provider to give free internet access to families in need.
- The OST network providers have been added to several city and school district mass mailing lists to streamline communication.
- OST providers have accessed and developed online tools to deliver content directly to families.

Some of the better-known software platforms, including Zoom, require expensive subscriptions to access full functionality, such as real-time translation. As speed and access have become more important, so has security. OST providers are giving input into development of new health and safety protocols for managing risk and liability related to online access. Using the collective impact model, we created a common agenda that is powering the development of pilot programs to solve these systemic issues. We will continue to employ the model as new systemic issues arise.

The Future of Collective Impact and OST

In the likely event of continued financial instability and waning public support, the collective impact model will continue to be needed to galvanize the OST field. Adults will be able to maintain their current employment, seek out new employment, or acquire education to develop marketable skills only if OST programs are available to care for their children. Backbone organizations that are already providing support to widespread networks should be at the center of coordinating these efforts. Networks like the OST Task Force in Somerville will meet with local officials with the common agenda of creating a childcare affordability fund. Although local government funding may prove elusive, in-kind support may be a possibility if advocacy is consistent and unified. The collective impact model has successfully demonstrated its ability to create opportunities for providers and communities alike. This model could be easily adapted to serve the needs of communities in a variety of contexts for true systemic change.

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The Magic of Afterschool

Raising the Next Generation of Resilient Unicorns

Katie Svaicer

As I was observing an afterschool program, I was struck with the ease of which a group of elementary-age children transitioned from one plan to another because of a last-minute room change. I myself had just experienced frustration with the same change merely because it meant I had to move my belongings to another space.

In contrast, these children moved quickly, with no apparent signs of frustration, anger, or anxiety, from their usual classroom to another room. They were unfazed, even without their supplies or familiar setup, without assigned seats, and with their regular schedule already interrupted. Then I watched their instructor walk in, relaxed and unflustered. She was clearly ready to amend her plan, though she didn't have her supplies in this room. The children were smiling and laughing; they had adapted and were eager to continue their photography class. They were as ready and excited to learn as their instructor was to teach.

That moment was an example of resilience, one of the key attributes of afterschool programs, educators, and participants. The instructor smoothly embraced the last-minute change, calmly modified her plans, and didn't let the change impede her ability to teach a great lesson. She modeled resilience for program participants in a real-life situation that was happening to them as well. Then those participants also practiced

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resilience as they adapted without aggravation or hesitation. They didn't let the sudden change interrupt their learning, their enthusiasm for photography, or their plans for the rest of the afternoon. This last-minute setback became a learning opportunity. None of it was planned or rehearsed. And yet the schedule change became an opportunity to learn how to move on, keep one's composure, and maintain positivity—in a word, a lesson in resilience. It was pure afterschool magic!

Resilience as a Key Social and Emotional Competency

As we nurture a new generation of youth into the leaders of the future, we are learning more and more about the importance of social and emotional competence. Social and emotional learning (SEL) is a hot topic in teaching philosophy—the latest "it girl" of education. In today's world, every person must be able to work with and live among all different kinds of people from all walks of life. Social and emotional competence is what enables individuals to function and thrive among people different from themselves. It gives them resilience to overcome obstacles, no matter how large or small, to reach their highest potential.

Children learn critical SEL skills through their experiences. A child who skins their knee while learning to ride their bike gets back on to try again, even though the fall was painful and scary. Another child realizes, perhaps for the first time, that not everyone will like them and that some people may not be their friend. With help, they can learn that, as long as people can be respectful to each other, not being friends is OK.

As society comes to understand the importance of SEL, schools and afterschool programs are working to incorporate deliberate activities to help students sharpen social and emotional competencies, including resilience. Sometimes it seems like we're trying, for external reasons, to check specific boxes on our list of popular and necessary skills we need to teach. For schoolteachers, those boxes may include how they are evaluated, how the school or district looks at such issues as suspensions and expulsions, and what their administrator or community expects of them. For afterschool professionals, the boxes that need to be checked may be tied to securing grant money, showing school principals the legitimacy of our work, or accumulating favorable data to present to funders. We sometimes spend so much energy proving ourselves through the deliberate practices we incorporate to achieve SEL outcomes that we forget the skills we demonstrate and promote in our work every day.

The beauty and nuance of our work lies in the inherent qualities that make afterschool magic. Afterschool is where everything comes together, like the last piece of a giant, complicated, politically charged, under-resourced, underestimated, barely funded puzzle. This is where the big picture is finally visible: a landscape where young people learn through new experiences that are unlike what they get during the school day, thanks to flexible programs that allow them to explore subjects that interest them and that don't have the underlying pressure of performance or grades attached. The afterschool program schedule values peer interactions and classroom comradery as well as youth-led decision making. The environment is ever-changing because it adapts to the needs and wants of each group of young people. The adult leaders, who aren't necessarily traditional teachers, aim to build relationships with participants and support them in their needs.

> We sometimes spend so much energy proving ourselves through the deliberate practices we incorporate to achieve SEL outcomes that we forget the skills we demonstrate and promote in our work every day.

In this magical environment, which is designed to enable participants to strive at their own levels, opportunities for social and emotional growth abound. Even in programs that focus on academic support, the pressures of school-day tests, expectations, and performance are removed. Afterschool has the freedom and flexibility to offer a wide, diverse range of programming in innovative and nontraditional ways that are rich with opportunities for participants to sharpen their SEL skills through practice. For example, programming is often planned and led by participating youth. Young people in different age groups have the unique opportunity to learn and play together, and participants may have the option to focus on their hobbies and passions. In their everyday afterschool interactions, participants may be observing and absorbing more real-life SEL skills than they do in deliberately planned SEL activities.

One SEL skill that afterschool programming is particularly good at nurturing is resilience. Research has shown that young people often learn resilience through informal relationships with community members. As Bonnie Benard (2004) said, “One of the major findings from resilience research is the power of informal mentors—neighbors, friends, parents, teachers, or anyone who takes the time to care.” For children in afterschool programming, some of those relationships are with their afterschool mentors and instructors. Because these relationships are based in programming that focuses on enrichment, encourages interaction, and is often driven by youth voice, the opportunity to model resilience is intrinsically embedded in the core of afterschool programming.

Why Afterschool Is So Good at Resilience

Afterschool gives adults frequent opportunities to model adaptability and resilience, simply because the afterschool environment is constantly changing. Think about the general structure of many afterschool programs: Space is often limited and may be assigned by an outside entity; supplies are often donated; programming is often inspired by youth and planned and led by vendors or staff; participants may come and go at different times every day; staff retention may be difficult; and funding can come and go in yearly, monthly, or even weekly cycles. Successful professionals in the field of afterschool programming must be flexible and able to multitask, solve problems creatively, and carry on with the mission under adverse conditions. In other words, we must be resilient.

I love to refer to afterschool professionals as *unicorns*. I was introduced to this comparison in a training years ago conducted by Leslie Beller, founder and CEO of MHA Labs in Chicago. She uses the word *unicorns* for afterschool professionals because we are workhorses who perform magic daily. No matter how busy and demanding this job can be, we find ways every day to make it work for participants. If that isn’t resilience, I don’t know what is!

To be successful in this field, we must be able to change spaces at the last minute to accommodate schedule conflicts. We must be able to facilitate projects with the supplies we have rather than the supplies we want or even need. We must be able to create programming that meets the unique needs of a specific community, school, grade, or class—or sometimes even an individual child. We must create an environment that is not disrupted when participants leave early; projects must be flexible enough to accommodate fluctuating attendance. When staff members are absent or quit unexpectedly, program managers must be able to move staff around, and frontline staff may need to work with different groups. Program leaders must be able to run programming with less funding than they expected. All these tasks require resilience.

Not everyone can handle the rapid changes and split-second decision making with the resilience this work requires. Those people never quite earn their unicorn horns, so to speak. They tend not to last in this field.

Modeling Resilience for Program Participants

The afterschool professionals who earn their horns, the ones who can adapt to our field’s ever-changing circumstances, are the ones who model for program participants what it means to be resilient. As with any significant adult in their lives, children observe and absorb the ways their afterschool facilitators deal with adverse situations. Seeing how adults display resilience when facing difficult situations shows participants how to deal with the hardships they inevitably will face.

The afterschool professionals who earn their horns, the ones who can adapt to our field’s ever-changing circumstances, are the ones who model for program participants what it means to be resilient.

Young people often have unique relationships with adults in their afterschool programs. Those adults occupy a sweet spot: They are authority figures, but they can support each child’s individual needs and wants. Because they can customize what happens in their classrooms, they can connect with participants on a personal level. They often serve as role models and confidants. This trusting relationship is what enables afterschool facilitators to model resilience (and other SEL skills) simply by doing what they do every day in their ever-changing context. Often they are demonstrating resilience without either themselves or the young people being aware of it.

Perhaps we can take the time to become even more aware of the example we are setting as afterschool leaders and facilitators in order to make our modeling even more effective in helping participants learn resilience. If we point out to participants the resilience they exhibit daily in response to changes in their afterschool program, they can develop a self-awareness that gives them confidence to access a tool they now know they possess. Knowing that they know how to carry on with photography class after a last-minute location change can help them face larger adversities. Having demonstrated resilience, they now know that they are capable of resilience. We can help participants grow and give them confidence by showing them that they already use resilience and other SEL skills.

In the uncertainty of the world in which our young people are growing up—the world they will eventually lead—resilience is more important than ever. Well-rounded and successful human beings need the ability to work with people in all their differences; they need to be able to change plans, respond on the fly, and solve problems creatively. One of the ways we can support program participants to achieve success in school and in life is to do our daily unicorn magic. When we are told *no,* when circumstances change, when resources are taken away, we work harder than ever to continue to serve program participants. Simply by overcoming these obstacles, we model resilience. We move forward creatively, bravely, and strongly, showing our young people how to tap into the magic by becoming resilient unicorns themselves.

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The Intersection of Belonging and Equitable Outcomes

Priscilla Parchia

Out-of-school time (OST) professionals seek the best ways to supplement and enhance young people's experiences to achieve equitable outcomes for participants. Often this enhancement presents as academic support, arts or sports programming, job development, or project-based learning. OST professionals strive to create environments where participants feel they belong.

The goal of fostering belonging drives programs to create systems and develop relationships with youth and families. The intersection of creating equitable outcomes for youth and creating a sense of belonging is tangible in OST. The combination is directly woven into the work's core tenets, as evidenced in staff training and program evaluation systems. Consequently, OST programs can have an incredible impact on young people's sense of belonging.

What Is Belonging?

Baumeister and Leary (1995) hypothesize that "human beings have a pervasive drive to form and maintain at least a minimum quantity of lasting, positive, and significant interpersonal relationships" (p. 497). Goodenow (1993) defines belonging as "the extent to which students feel personally accepted, respected, included, and supported by others in the school social environment" (p. 80). A sense of belonging gives

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youth a sense of security and connectedness, lack of which can negatively affect their perceptions of themselves and ultimately their motivation to learn and study (OECD, 2018).

St-Amand and colleagues (2017) identify four defining attributes of belonging:

- Positive emotions, including feelings of intimacy, usefulness, pride, and support
- Positive relations with peers and adults
- Energy and a willingness to get involved in a meaningful way within a group
- Harmonization, "the ability for individuals to change personal aspects to align with any situations or people that would warrant such an adaptation" (St-Amand et al., 2017, p. 109)

These attributes suggest that OST program participants are already primed to realize their hope of belonging. For example, the fact that they participate indicates that they are willing to get involved. Belongingness depends on every young person actively participating as a responsible, contributing citizen of the community (OECD, 2018).

Who Feels They Belong?

International data collected by the OECD Equity in Education study in 2018 indicate that, though most students felt that they did belong, disadvantaged students were less likely to feel that way, by 7.7 percentage points. The study also found that students' sense of belonging had declined since 2003 (OECD, 2018). The Quaglia Institute for Student Aspirations *School Voice Report 2016* indicate that only 64 percent of students surveyed reported that school is a welcoming and friendly place. Feeling welcomed is essential to a sense of belonging.

Students who didn't express a sense of belonging were found in one study to score, on average, 22 points lower on science exams than those who did (OECD, 2017). Many studies have shown that lack of connectedness or belonging is the cause of anxiety, low self-esteem, depression, substance use, delinquency, and antisocial behavior (Korpershoek et al., 2019). A weak sense of belonging also holds students back from higher education. In the OECD study (2018), students who were in the bottom quarter on a scale of belonging were more likely than those at higher levels to end their education at the secondary level. Immigrant students may find it particularly difficult to find a sense of belonging in school. As Beck and Malley (1998) say, "Neglected children with damaged spirits and a diminished sense of self are at high risk for failure."

The implication of these studies is clear: Students at a disadvantage—a condition that in the U.S. is clearly demarcated by race and opportunity—are less likely than others to feel that they belong in school. Students who do not fit the Eurocentric pedagogy and industrial setup of American schools feel rejected. Socialization in schools functions differently for students of different races or classes. According to Beck and Malley (1998), children who are considered to be disadvantaged are "socialized for subordination"; the rest are "socialized for responsibility." Being socialized for subordination causes students to feel alienated and disengaged with learning so that their educational outcomes are affected (Beck & Malley, 1998).

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The Place of OST

OST offers young people opportunities to break from these molds to have more freedom to be connected. Afterschool has more space for creating a sense of belonging. Belonging is core to the values of the field. OST's intentional learning environments are youth-centered, take an assets-based approach, and prioritize mentorship and relationships (Vossoughi, 2017). All of these characteristics contribute to participants' sense of belonging. In this way, OST programs "stand as examples of what is possible when learning is conceptualized not only as a cognitive process but also as a social, emotional, cultural, and historical activity grounded in community-based values and visions for the future" (Vossoughi, 2017, p. 5).

The volume of research about belonging strongly supports its importance in youth development. Furthermore, strong evidence shows that OST can create spaces where young people can develop positive identities while receiving support for academic achievement. The research also suggests that youth who experience the effects of inequitable systems are at a disadvantage in feeling that they belong. Krys Burnett, writing about the corporate world rather than education, posits, "At the core of inclusion is diversity. Inclusion means that people with marginalized identities feel as if they genuinely belong, are valued and relied upon, empowered and ultimately matter" (Burnett, 2019). Correlating equitable outcomes and belonging in OST is essential, as OST spaces connect young people to their communities and a sense of belonging.

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Exploring STEM Engagement in Girls in Rural Communities

Results from GEMS Clubs

Kathryn A. Wheeler and Georgia Hall

Creating enriching and encouraging programs to engage girls in STEM is critical because girls and women bring unique experiences, perspectives, and ideas to scientific work. Besides benefiting the women themselves, having more women in STEM occupations will enable society to benefit from women's expertise by maximizing innovation, creativity, and competitiveness (National Academies of Sciences, Engineering, and Medicine, 2016).

More and more jobs involve STEM, yet women are still underrepresented in many STEM fields, particularly engineering and computer science (National Science Foundation, 2019). Rural students in particular have historically faced numerous obstacles to entering STEM fields, including low educational aspirations, lack of STEM role models, and lack of access to advanced STEM curriculum (Versypt & Ford Versypt, 2013).

GEMS (Girls Excelling in Math and Science), founded in 1994, strives to ensure that each participant sees herself "as a change agent or a problem-solver, a possible technology entrepreneur, engineer or a scientist, and a person who makes a difference" (GEMS, 2019). GEMS aims to reach girls who might otherwise not have broad exposure to formal STEM opportunities and role models, such as girls from rural areas and other underserved communities. Through

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its website, GEMS offers online support, including activity ideas, teaching tips, and other resources, to anyone interested in starting a GEMS club or in doing STEM activities at home. GEMS currently operates in more than 150 locations around the world.

As a research partner to GEMS, the National Institute on Out-of-School Time (NIOST) conducted an investigation of girls' experiences at GEMS clubs in rural Pennsylvania between September 2019 and February 2020, with funding from the McElhattan Foundation. Our observation data suggest that GEMS activities successfully fostered cognitive, behavioral, and emotional engagement with STEM in participating girls.

Learning Activation in STEM: A Theoretical Framework

To observe girls' engagement in STEM in GEM clubs, NIOST staff used the observation instrument designed by Activation Lab (2018), a national research project that aims to determine how best to spark children's interest and abilities in ways that lead to persistent engagement in STEM learning.

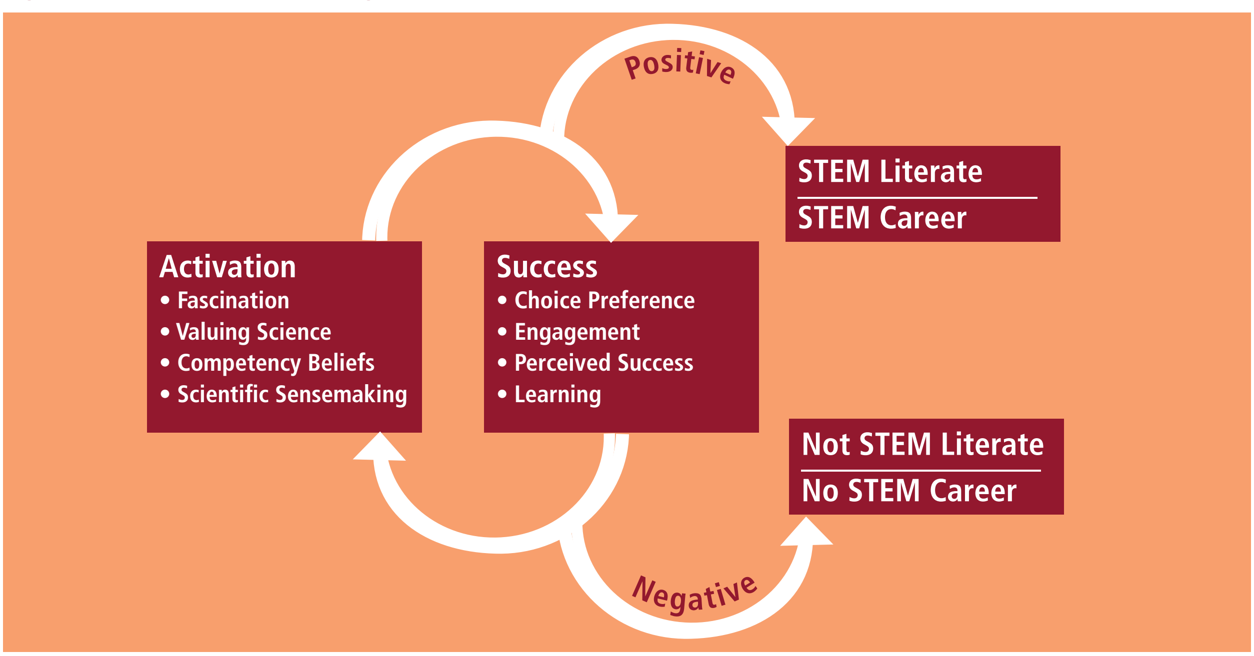
Learning activation in science is defined as "a set of dispositions, practices, and knowledge that commonly enable success in proximal science learning experiences and are in turn influenced by these successes" (Dorph et al., 2016, p. 1). *Proximal* experiences are those that occur next in time. According to Dorph, Schunn, and Crowley (2017), science learning activation is conceptualized as a "developmental feedback loop" (Figure 1) in which "activated science learners have the resources to be successful when they engage with science" (p. 19). Success leads to more activation, which leads to more engagement with science, which leads to more success, and so on. When young people experience success in STEM, they are more likely to engage in extracurricular STEM activities, study STEM subjects in school, and consider STEM careers. By contrast, negative science experiences, especially at a young age, can reduce activation and discourage young people from pursuing STEM literacy or career pathways (Dorph et al., 2017).

This theoretical framework identifies four dimensions of science activation for individual learners (Dorph et al., 2016):

1. Fascination with natural and physical phenomena
2. Valuing science for self and society
3. Competency beliefs in science
4. Scientific sensemaking

Under this framework, success in young people's STEM learning experiences is characterized by the

Figure 1. The Science Learning Activation Framework



Source: Dorph et al., 2017. Reprinted with permission.

following elements (Dorph et al., 2016; Dorph et al., 2017).

- Choice: Choosing to participate in a STEM activity when the opportunity is presented
- Engagement: Experiencing positive cognitive, behavioral, and emotional engagement during the learning experience
- Perceived success: Feeling positive about one's experience and ability to learn
- Learning: Meeting the content learning goals of the experience

Our research focused on the choice and engagement elements of success. Past research has demonstrated predictive associations in both directions between the dimensions of science activation and the elements of success in proximal learning experiences. In a study of children's experiences in school science lessons and in visits to a science museum, Dorph, Cannady, and Schunn (2016) found that that choice preferences were predicted by fascination, values, and sensemaking. Engagement levels were predicted by competency beliefs, fascination, and values. Moreover, successes predicted further growth in activation: growth in fascination, values, and competency beliefs themselves were predicted by choice preferences and engagement levels (Dorph et al., 2016).

Research Questions

Our investigation explored participants' engagement with STEM activities in their GEMS clubs as an indication of the success of the activities. The premise is that, because young people "vote with their feet," they need to feel successful as they engage with STEM activities, or they are likely to drop out. To feel truly successful, participants need to engage with the STEM activities on all three levels: cognitive, behavioral, and emotional. If they are more engaged, they experience more success; conversely, if they are less engaged, they experience less success.

Three research questions related to STEM engagement guided our GEMS club observations:

1. What types of science behaviors did girls engage in most frequently?
2. How actively involved were girls in the STEM activities?
3. What was the affect [emotional state] of girls while doing the STEM activities?

Program Context

GEMS is an informal network of clubs around the world whose leaders can choose from a wide variety of program activities and designs available for free online (GEMS, 2019). The accessibility and flexibility make GEMS a good fit for underserved neighborhoods, including rural areas like the one we studied. The two GEMS clubs we observed were situated in school buildings in two different small towns outside Pittsburgh; both served girls in grades 3–5. Each club was led by two women who were teachers in the host school. They differed in their STEM backgrounds and their expressed level of comfort with leading STEM activities.

Girls self-selected to participate: Flyers were posted in the school, and girls (or parents on their behalf) signed up if they were interested. Interviews with GEMS participants and alumnae conducted in fall 2019 (Hall & Wheeler, 2020) revealed that girls most often joined GEMS because the description of the club intrigued them, they had friends planning to join, they knew and liked the facilitators, or they had previous interest and/or experience in STEM.

Methods

Table 1 summarizes the observations NIOST researchers made at the two GEMS clubs in November 2019 and February 2020. Club 1 was on a semester system, while Club 2 offered a yearlong session. The second set of observations thus was conducted during different stages of the program at the two GEMS clubs. The T1 observation in November occurred near the beginning of the program in both clubs. However, the T2 observation in February was near the beginning of the new semester's program at Club 1 but in the middle of the yearlong program at Club 2.

We collected data using the Engagement Observation Protocol of the Activation Lab Evaluation Toolkit (Activation Lab, 2018), which includes open-ended field notes and ratings on Likert scales of various elements of engagement. Two NIOST staff members conducted observations, one at Club 1 and the other at Club 2. During each visit, a randomly selected girl was observed for 10 consecutive minutes; then a second girl was randomly selected, and then a third, and so on for as long as time allowed. The numbers of girls in each observation are listed in Table 1. In all, we conducted 18 observations totaling 180 minutes.

Data recorded during each 10-minute observation included:

Table 1. GEMS Club Observations

Club and Observation (T)	Month	Participants Observed	Activity
Club 1-T1	November 2019	3 girls in Grade 3	Lego project on windmills
Club 1-T2	February 2020	5 girls in Grades 3–5	Lego project on beehives
Club 2-T1	November 2019	4 girls in Grade 3	Movable models of hands
Club 2-T2	February 2020	6 girls in Grade 3	Kaleidoscopes

1. A description of what the participant was doing
2. Notes on whether the participant interacted with others and, if so, with whom and for how long
3. Science behaviors exhibited
4. The cognitive focus of the science engagement
5. Participation level
6. Apparent emotional state
7. An overall rating of the participant's engagement

Observing STEM Behaviors and Engagement

Based on the Activation Lab observation protocol, we report results in three categories: science behaviors, including cognitive focus; active behavioral engagement; and emotional engagement.

Science Behaviors and Cognitive Focus

The observation protocol tracks 16 types of scientific behaviors, from "ask" and "answer" to "experiment" and "problem-solve." For each observation, each behavior is recorded as present if it is observed at least once during the 10-minute observation, whether that behavior occurs once or multiple times and whether it lasts five seconds or five minutes. In all, observers recorded a total of 112 science behaviors during the 18 observations.

Results indicate that the girls engaged in a wide variety of scientific behaviors (Figure 2). The behaviors seen most often across all observations were listening, using, asking, experimenting, answering, discussing, and observing. The least common behaviors were describing and volunteering.

The types of science behaviors appeared to depend, at least in part, on the activities. At Club 1-T1, for example, when girls were involved in a windmill Lego project, the scientific behaviors seen most often were experimenting, exploring, reading, and using. At the same club at T2, also a Lego project, the most common scientific behavior was asking. At Club 2-T1, which involved following complicated instructions to create models of moving hands, the most commonly observed scientific behavior was listening. At T2 at this club, when girls were actively involved in building kaleidoscopes, the common behaviors were using and connecting.

Observational data also included records on the focus of cognitive engagement exhibited by the girls (Table 2). Results indicated that girls were most often engaged in thinking about procedures, ideas, artifacts, and facts; they were least often involved in metacognition or in thinking about phenomena or challenges and problems.

Active Behavioral Engagement

All but one of the 10-minute observations involved one or more instances of "active" behavioral engagement, defined by the protocol as involving initiative; examples are raising a hand or answering a question. In addition, 12 of the 18 observations (67 percent) involved one or more instances of "passive positive" behavior in which girls showed that they were ready to learn and participate, such as listening or being attentive or alert. Only three observations included one or more incidences of "passive negative" behavior, such as not taking initiative, giving up, being unprepared, or being distracted. No observations involved "disruptive" behavior.

Using those same four categories of engagement, we then analyzed which category was dominant, that is, it was observed more than 50 percent of the time in the focal child. Figure 3 shows the results. Active behavioral engagement was the most common dominant level of participation, seen in 12 of the 18 girls. Passive positive engagement was observed in four participants. In none of the 18 observations was passive negative or disruptive behavior dominant. Two observations were

Figure 2. Frequency of Science Behaviors

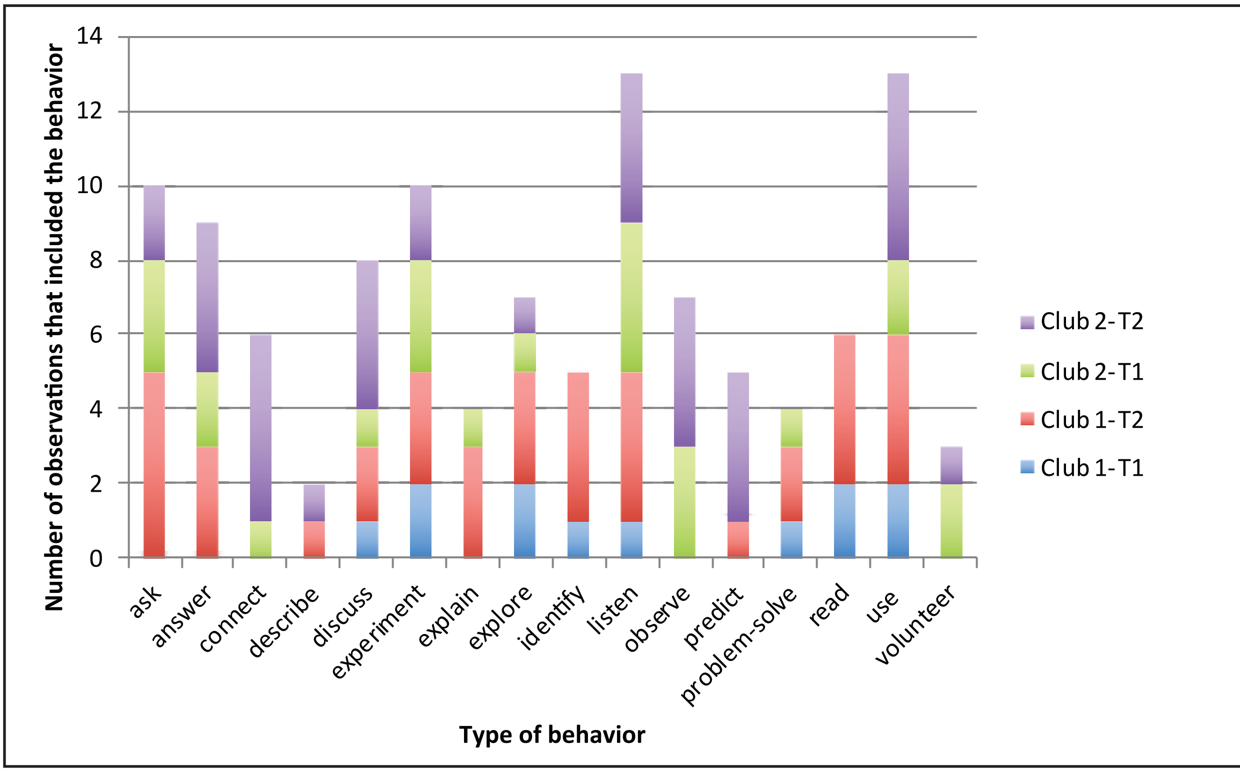


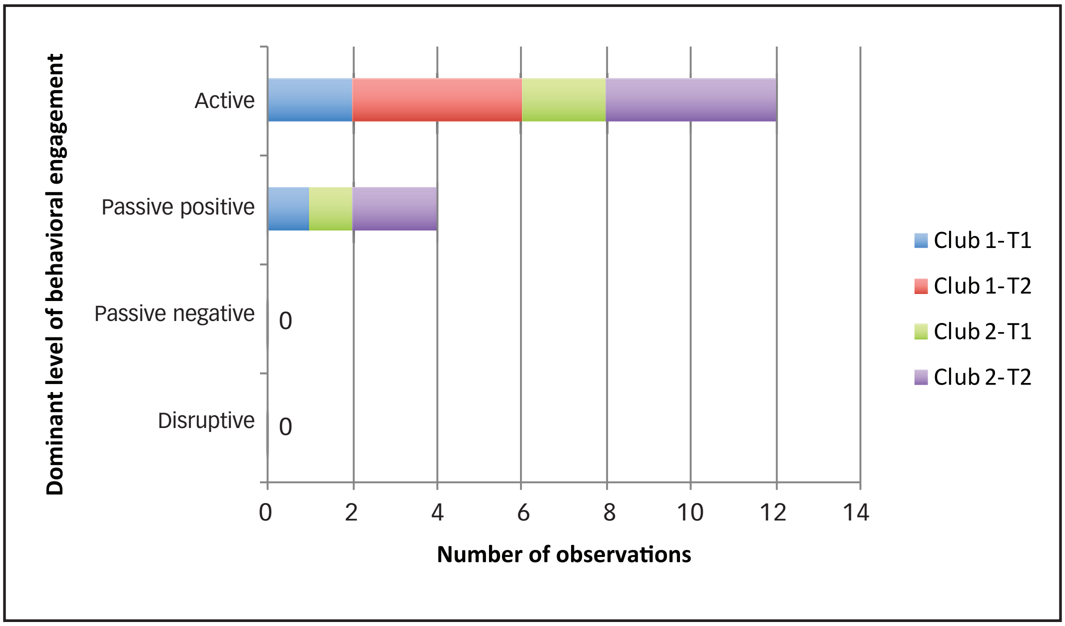
Table 2. Focus of Cognition

Type of Cognitive Engagement	Observations That Included This Type	
	Number	Percentage
Procedures	14	78%
Ideas	10	56%
Artifacts	9	50%
Facts	8	44%
Challenges/problems	6	33%
Phenomena	5	28%
Metacognition	1	6%

not dominated primarily by any one type of participation. Corroborating evidence of active involvement comes from the fact that 16 of the 18 girls (89 percent) were rated "high" or "very high" in overall engagement.

GEMS activities are designed to be interactive and collaborative. Activities were very social: 17 of the 18 observations involved at least one interaction with an adult facilitator, and 17 involved at least one interaction with a peer. "Extensive, ongoing interactions" with peers were found in 11 observations, whereas only three observations involved extensive, ongoing interactions with adults. It appears that adults gave instructions and were available to answer questions, but, in general, they interacted briefly with individual girls, letting the girls direct their learning. One facilitator ex-

Figure 3. Dominant Level of Behavioral Engagement



plicitly told her observer that she typically encouraged participants to consult with each other before asking her for help. Structuring the activities to encourage social interaction among peers seemed to promote participant engagement.

Emotional Engagement

The observation protocol has three data points for participants' affect or emotional state. The first requires the observer to record one of four potential emotional states for each activity recorded during the observation. The second is a rating of the dominant type of affect during the observation. The third is a single rating of the overall affect of the observed participant. Each scale used slightly different measures.

The four primary emotional states used to rate each activity for the first data point were:

1. Positive aroused affect: amazed, joyful, fun, happy, enthusiastic, eager, inspired, determined
2. Positive unaroused affect: alert, calm, relaxed, at ease
3. Negative unaroused affect: bored, drowsy, tired
4. Negative aroused affect: distressed, upset, angry, frustrated, worried

Of the 18 observations, 15 (83 percent) included at least one instance of positive aroused affect, and 12 (67 percent) included at least one instance of positive unaroused affect. Observers saw just one brief incidence of negative unaroused affect. They also recorded one instance of negative aroused affect: A girl got upset when another girl moved her project. The situation was quickly resolved when the girl got her project back right away.

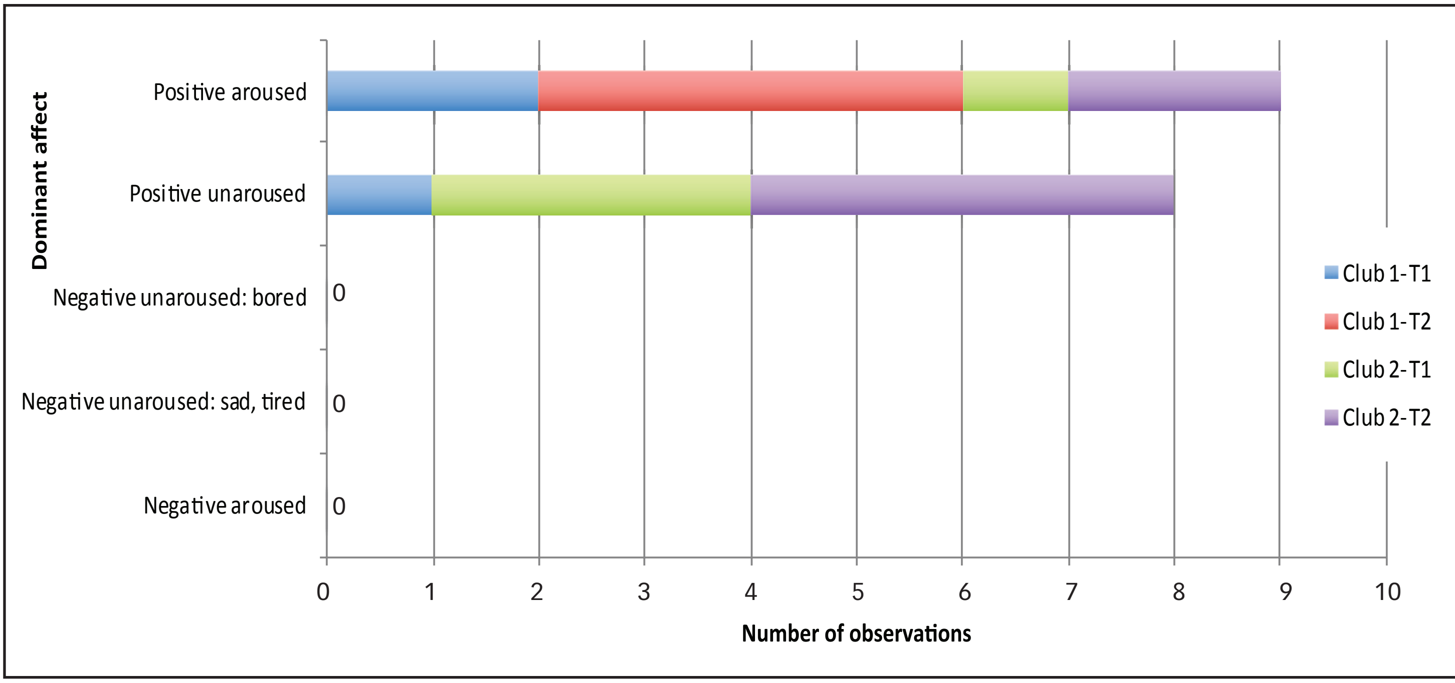
The next data point is the type of affect that dominated the observation, that is, it was observed at least 50 percent of the time. Figure 4 shows the results: Positive aroused affect was dominant in nine of the 18 observations, and positive unaroused affect dominated in eight. None of the negative states were dominant in any observation. One girl showed several emotional states during the observation and so did not have a single dominant affect.

On the third data point, overall rating of affect during the observation, all 18 girls were rated as being positively aroused or positively unaroused; none was rated as flat, mixed, negatively unaroused, or negatively aroused. All measures of affect thus suggest that, with the exception of one brief incident, the girls experienced positive emotions during their GEMS sessions.

Activating Science Learning

Our observation data suggest that, by the criteria of the science learning activation framework, the GEMS club model can effectively engage girls in STEM. In the observed club sessions, girls engaged in a variety of scientific behaviors, actively participated in STEM activities, and experienced positive emotional states. No negative behaviors were observed. The only instance of negative affect was related to participant interactions;

Figure 4. Dominant Emotional States



no girls were observed feeling frustrated, upset, or distressed by any aspect of the STEM activity itself. When they encountered challenges, the girls were activated to solve the problem on their own, connecting with each other when they needed help. They appeared to enjoy the process of engaging in science behaviors and learning STEM content.

These GEMS clubs were found to spark involvement in STEM behaviors and create positive associations with STEM activities. The cognitive, behavioral, and emotional engagement we observed are key components of success as described by the science learning activation framework (Dorph et al., 2016; Dorph et al., 2017). Our observations suggest that the GEMS clubs enabled participants to experience both increased success and increased activation.

The science learning activation feedback loop (Figure 1) suggests that participants who experience activation thereby experience success, which leads to more activation. These participants may, in the long term, be more likely to pursue STEM literacy and STEM careers. Thus, GEMS participants who choose to engage in STEM, have positive experiences, and feel successful at mastering STEM content can be expected to grow in fascination with science, the extent to which they value science, their beliefs in their own competency in STEM, and their ability to make sense of science. Experiencing this growth in the elementary years is likely to lead to more choices to participate in STEM; more cognitive, behavioral, and cognitive engagement; more perceived success; and more mastery of learning content. Thus, GEMS seems to be moving girls toward long-term pursuit of STEM literacy and possibly of STEM careers.

The ability to generalize from this study of two small GEMS clubs in a single rural area is limited. The fact that the two afterschool clubs had differences in activities, formats, and facilitator backgrounds but had similar observation findings suggests that other GEMS clubs might also show similar results. Additional research would be required to discover whether these findings would apply to GEMS programs with different activities and facilitators or that serve children of different ages, racial or cultural groups, and socioeconomic backgrounds. Further research would reveal whether findings are similar in other types of OST STEM programs: ones that are coeducational or boys only, that serve younger or older children, or that are located in urban or suburban communities. Furthermore, this study examined only two of the four components of success in the science learning activation framework: choice and engagement. We did not explore perceived success or learning, so our conclusions about what constitutes "success" may be limited. Future studies might explore young people's own perspectives on choice, engagement, perceived success, and learning.

With these caveats, our findings suggest that an OST STEM approach that combines active engagement with successful experiences may have a positive impact on young people's participation in STEM. However, the science learning activation framework suggests that engagement and success are not enough. To continue on a science trajectory, participants need to experience science activation. OST programs that pay attention not only to behavioral and cognitive engagement but also to emotional engagement in STEM experiences may motivate participants to have more STEM experiences, thereby fostering STEM interest and knowledge in the long run. Ultimately, the science learning activation framework is a youth-driven model. It requires adult STEM facilitators to pay attention to participants' fascinations and to find ways to further that engagement.

OST STEM programs like GEMS, whose content and resources are freely accessible online, are important in rural areas where other informal STEM opportunities may be limited. Such programs can build young people's concrete experiences of STEM success and motivate them to seek more STEM experiences. Inclusive and engaging STEM programs that stimulate the feedback loop between activation and success can not only enrich the lives of individual participants by planting the seeds of lifelong STEM learning, but also feed the STEM pipeline and inspire a new generation of scientists from diverse backgrounds.

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Data Is Delicious!

Book Review

Elizabeth J. Starr

Review of *Measure, Use, Improve! Data Use in Out-of-School Time*. C. A. Russell & C. Newhouse, Eds. Information Age, 2021.

The latest book in the series Current Issues in Out-of-School Time, edited by Helen Janc Malone, covers the history, current context, and nuts and bolts of data and evaluation. *Measure, Use, Improve! Data Use in Out-of-School Time* is filled with practical approaches providers have used to develop their capacity for measurement and data use.

The dramatic punctuation in the title is not there to trick you into thinking data is exciting, as a parent might exclaim "broccoli!" with a little too much enthusiasm. In the case of *Measure, Use, Improve!* the exclamation point is sincere. The power of data for OST program improvement is, in fact, exciting.

Readers will come to share this excitement—to believe that their programs and organizations can in fact collect meaningful data and use it to improve. The opening section, Setting the Stage, frames the "why" of data use, making the case for investing time and resources in evaluation. The chapters lay out fundamental principles: that data collection should begin with questions, that evaluation is a collaborative process, and that it must be part of a system of continuous quality improvement. Authors share lessons from their many years of experience at LA's BEST, After-School All-Stars, and the S. D. Bechtel, Jr., Foundation.

The second section, Building Blocks of Evaluation, helps readers see concretely how to build a culture of program improvement informed by meaningful data. The chapters break down the basics of data collection for readers who are not familiar with the process. In two chapters, authors from the YMCA share program-level experiences with data analysis and the national organization's blueprint for capacity building. Other authors address real-life data challenges and solutions. Every Hour Counts, a national OST intermediary organization, shares its measure-

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ment framework. Spoiler alert: The framework supports more than measurement! Another chapter shows how youth can participate in evaluation.

The next section, Developing Systems of Evaluative Thinking, gives concrete strategies and how-to's for readers who crave actionable ideas. Chapters cover how to develop evaluative thinking and show how two statewide systems, in Minnesota and Wyoming, have fostered a culture of evaluation. Another chapter covers how to solicit and use youth feedback. More system-level thinking focuses on how organizations can use data to change or expand their focus.

Building organizational capacity takes time. The authors in the last section, Using Data and Evaluation to Improve Staff Capacity, describe decades of work. One chapter shares experiences from statewide work in Michigan. Another describes how authentic partnerships between evaluators and youth development staff can strengthen an organization. The third concentrates on how to use data specifically to support staff.

This book is compelling because the authors consistently bring data and evaluation work to life, telling stories of struggles, missteps, and successes. They include enough detail that readers can find commonalities with their own situations and identify processes they can adapt. For example, though James Specter's description of how After-School All-Stars embraced evaluation is specific to this national organization, the process and thinking he describes are valuable for many types of organizations. Similarly, many chapters offer concrete strategies, such as action plans, measurement frameworks, and sample evaluative thinking questions, to move the book from theory to practice.

The voices represented range from statewide afterschool networks, national youth organizations, and local OST programs to funders, whose perspectives are often mysterious to grantees. Youth voice is featured in chapters by Joseph Luesse and Kim Sabo Flores, who write about youth participation in evaluation, and by Valerie Threlfall, who discusses ways to include youth feedback.

Similar themes keep coming up in different sections. Repetitive? Maybe, but the consistency is also reassuring, suggesting that the field is on the right track. The main issue OST practitioners have with data is surfaced right away and repeated throughout the book: Even though we all agree that we need data to improve programs, the reality of collecting and using data can feel overwhelming. Continuous quality improvement takes time, resources, and effort. Several chapters mention multi-day retreats devoted to data and evaluation. The authors in this book do not try to sugarcoat the very real challenges, but they do emphasize that the effort is worth the time and resources spent.

Resources are not the only necessary element. OST organizations also need to create cultures of evaluative thinking. Authors emphasize again and again that data are useful only when people reflect on them and respond. As Kim Firth Leonard of the Oregon Community Foundation put it, the OST field strives for "data-informed" rather than "data-driven" decision making (p. 124). Building a culture of evaluative thinking requires buy-in from all stakeholders. In Chapter 16, Miranda Yates, Stephanie Mui, and Jennifer Nix suggest that stakeholders need a "deep belief in the power of evaluation as a mission-driven activity and social justice tool" (p. 288). If everyone held this belief, imagine what we could do with data!

A central idea of the book is that data use improves not only programs but also the field. As programs improve, the field learns what works and what to leave behind. For example, in Chapter 16, Jamie Wu, Trevor Davies, Lorraine Thoreson, and Laurie Van Egeren describe how Michigan's data-informed improvement work with 21st Century Community Learning Centers has benefited local programs, state efforts, and the OST field nationwide.

Indeed, this book is itself is a field-building effort. It documents decades of data work in OST, offering a perspective on how far the field has come, how far we need to go, and how much time and effort it takes to use evaluation effectively for program improvement. Bringing together the stories of diverse organizations and youth practitioners makes each individual story more powerful.

This book would make good reading for practitioners just entering the field. (The whole series is a gift to anyone looking to create a strong syllabus for a youth development course!) More seasoned practitioners, researchers, evaluators, and funders will also benefit from the book's historical perspectives and lessons learned.

Providers who feel overwhelmed by the prospect of working with data will be heartened to read the ideas, strategies, and lessons in *Measure, Use, Improve!* The authors convey sincere and contagious optimism, even as they acknowledge the challenges. They are cheerleaders for the power of data to advance the impact of OST. It turns out that broccoli really is delicious.

Afterschool Matters

Call for Papers

Special Issue: Literacy-Rich Experiences in Out-of-School Time

Afterschool Matters is interested in manuscripts focused on creating, facilitating, and inspiring literacy-rich environments in OST settings for a special Winter 2022 issue. The deadline for submission is **June 30, 2021.**

Literacy remains out of reach for many children and youth in the United States, in spite of the common belief that access to a free public education guarantees that every American can realize this fundamental right. OST programs historically have fostered literacy skills in the process of providing safe, wholesome activities for young people, particularly in underserved communities. Today, the place of OST in the ecosystem that attempts to address disparities in access to literacy education is well established.

OST programs have traditionally taken a wide-ranging approach to literacy education: building reading and writing skills in the context of a sports or maker program, starting with literacy in a child's home language, engaging families, and many other strategies that often are not available to public schools.

Afterschool Matters seeks articles on the full range of efforts to engage young people in literacy. All articles should connect theory to practice and should be broadly applicable across the field. Articles must be relevant and accessible to both practitioners and academic researchers. We also invite personal essays and reflections for our department Voices from the Field, whose pieces are not peer-reviewed.

We invite you to discuss possible topics with us in advance. A broad variety of topics will be considered, including the following:

- Research or best-practice syntheses on literacy development in OST
- Innovative program approaches in literacy development
- Blending literacy with program emphasis areas, such as sports, STEM, outdoor learning, civics, and more
- Addressing literacy in OST with special needs youth, immigrant and refugee youth, or other vulnerable populations

Published by the National Institute on Out-of-School-Time (NIOST), *Afterschool Matters* is a peer-reviewed journal dedicated to promoting professionalism, scholarship, and consciousness in afterschool education.

SUBMISSION GUIDELINES

- Submit your article no later than June 30, 2021, to ASMsubmission@wellesley.edu.
- Submit your article electronically in Microsoft Word or rich text format. Submission should not exceed 5,000 words. Use 12-point Times New Roman font, double-spaced, with one-inch margins on all sides. Leave the right-hand margin ragged (unjustified), and number pages starting with the first page of text (not the title page, which should be a separate document).
- **Include a separate cover sheet** with the manuscript title, authors' names and affiliations, and the lead author's phone number and e-mail address.
- The names of the authors should not appear in the text, as submissions are reviewed anonymously by peers.
- Follow the Publication Manual of the American Psychological Association, 7th edition (2019), for reference style guidelines. Present important information in the text and do not use extensive footnotes.

We welcome inquiries about possible article topics. To discuss your ideas, please contact:
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Submit manuscripts electronically by June 30, 2021, to ASMsubmission@wellesley.edu

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