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Unveiling the Community Cultural Wealth of Black Out-of-School Time Staff

Ruth J. Kaggwa, Precious M. Hardy, Amy M. Leman, Kristine Callis-Duehl, & Kelly Gill

Black staff in out-of-school time (OST) programs are frequently positioned as disciplinarians, behavior managers, or "chaperones," while curriculum and instruction responsibilities are assigned to formally trained (and often White) educators. Imbalances in power and funding mean White leaders usually hold decision-making authority, while Black frontline staff, typically working part-time, bear most on-the-ground responsibilities (Baldridge et al., 2024). These staff may be positioned as cultural brokers and natural mentors to youth who share their racial identity, but their capacity otherwise remains underutilized (Cherfas et al., 2021).

In addition to the endemic issues in OST staffing such as low pay and lack of career advancement, Black OST staff face distinct challenges, including limited training, precarious employment, racial bias, exclusion from leadership roles, and stereotypes that question their instructional capabilities (Baldridge et al., 2024). Additionally, many OST programs lack policies and training that recognize staff members' cultural knowledge and lived experiences and can develop these assets as instructional resources.

Rather than being constrained by these barriers,

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Photo provided by the Donald Danforth Plant Science Center

some Black OST staff leverage their community cultural wealth (CCW, Yosso, 2005) to bridge skill gaps, adapt to resource limitations, and implement effective strategies that support youth development. Larson and Ngo (2017, p. 4) state, "Culture matters because each day youth and staff bring their cultural experiences to the program, and these experiences influence how they think, act, and learn." Black staff who come from the same minoritized background as the youth they serve have significant capacity to bridge educational opportunity gaps. Because they share cultural referents and experiences with youth, they can facilitate strong rapport and culturally responsive practices (Jones & Deutsch, 2011; Matloff-Nieves, 2007), leading to enhanced support and positive student outcomes (Gay, 2000).

Black OST staff often embody the very representation youth need to see to counteract negative stereotypes and develop academic confidence (Aronson & Laughter, 2016; Ladson-Billings, 1994). Observing role models who share their cultural experiences enhances young people's self-efficacy and helps them envision success in fields they might otherwise view as inaccessible. Consequently, Black OST staff serve as mentors and catalysts for equity, bridging resource and knowledge gaps that disproportionately impact minoritized communities (Lauer et al., 2006). Beyond fostering a sense of belonging, strong relationships with staff also play a pivotal role in youth engagement, influencing young people's attendance in OST programs (Akiva & Horner, 2016; Boat et al., 2024).

Moving from the chaperone stereotype to fully integrating Black OST staff as legitimate educators is a key step in addressing longstanding educational disparities (Gay, 2000; Woodland, 2008). When Black OST staff bring their cultural knowledge and community-based expertise to their work, they can foster self-discovery, empowerment, and critical thinking skills among racially minoritized youth (Ginwright, 2010; Larson & Ngo, 2017). Failing to recognize and sustain the culturally relevant contributions of Black OST staff marginalizes their insights and diminishes their potential to transform informal learning (Cherfas et al., 2021; Winfield et al. 2023).

Moving from the chaperone stereotype to fully integrating Black OST staff as legitimate educators is a key step in addressing longstanding educational disparities.

This study unveils how Black staff in one OST program in a racially minoritized community used CCW to position themselves as key educators rather than peripheral staff. Using Yosso's (2005) typology of six kinds of CCW, we examine how Black staff members described their use of CCW in their work with young people. Findings emphasize the need for OST programs to integrate CCW into staff training, mentorship, and leadership pathways, giving Black professionals the support, recognition, and resources they need to thrive. Their CCW makes Black staff integral to educational equity. Transforming how the field thinks about the professional development and integration of racially minoritized OST staff is necessary to broaden access, learning, and cultural responsiveness. This transformation can result in improved outcomes for racially minoritized part-time OST staff and the young people they serve.

Our central research question was, "How are the forms of community cultural wealth salient for Black OST staff working in a racially minoritized community?" By centering the experiences of Black OST professionals, we highlight the cultural, relational, and pedagogical assets they employ—assets that are largely neglected in discussions of informal education. Through this lens, we also reiterate why recognizing and sustaining Black OST staff is an equity imperative, especially for the communities that most need effective education outside of school.

Theoretical Framework: Community Cultural Wealth

Community cultural wealth (Yosso, 2005) provides a strengths-based framework for understanding how racially minoritized individuals accumulate and leverage various forms of capital to navigate social and educational inequities. Departing from Bourdieu's (1986) notion of cultural capital, which often uses a deficit lens when focusing on marginalized groups, Yosso (2005) underscores the rich assets that minoritized communities already possess. She outlines six interconnected forms of capital:

1. **Familial capital:** Cultural knowledge and lessons derived from extended family and community ties, fostering a sense of collective responsibility

2. **Linguistic capital:** Adeptness in multiple languages or communication styles, including vernacular forms
3. **Aspirational capital:** The capacity to maintain hopes and dreams despite systemic barriers
4. **Social capital:** The networks and relationships offering practical and emotional support
5. **Resistant capital:** The knowledge and motivation gained from challenging inequality and overcoming discriminatory practices
6. **Navigational capital:** The skills needed to maneuver through institutions and spaces not designed with marginalized communities in mind

Existing research on CCW has primarily focused on minoritized students in formal academic contexts (Martinez et al., 2020; McGowan & Pérez, 2020). In education research, multiple studies (e.g., McGowan & Pérez, 2020; Ortiz et al., 2019) underscore how racially minoritized learners leverage CCW to develop strong academic identities and persist despite systemic inequities.

However, the role and application of CCW in OST remain comparatively understudied (Habig et al., 2021; Rubinson, 2016). Our study addresses this gap by examining how Black OST staff draw on all six types of CCW to facilitate youth learning while navigating the constraints of limited resources and lack of formal training.

Community cultural wealth (Yosso, 2005) provides a strengths-based framework for understanding how racially minoritized individuals accumulate and leverage various forms of capital to navigate social and educational inequities.

Familial Capital

Yosso (2005) refers to familial capital as the knowledge gained from family and close friends related to the history and culture of the community. Black OST staff in our study described having learned from parents and elders life skills, such as social etiquette, resilience, and personal conduct, that they now modeled for youth. These ideas align with the findings of DeNicolo et al. (2015) and Luna and Martinez (2013), who documented how advice passed down through families can shape the ways minoritized individuals engage in educational spaces. In line with Tolbert Smith (2022), we found that parents' emphasis on resilience, persistence, and drive helped staff see themselves as potential leaders and mentors.

Staff also drew on memories of growing up in low-income, single-parent homes to empathize with youth facing similar circumstances and to offer them extra help. Similarly, Samuelson and Litzler (2016) observed that African-American and Latinx undergraduates felt compelled to "give back" to younger students as an extension of their familial capital. Rubinson (2016) noted that OST mentors can foster relationships akin to familial ties, reinforcing young people's social-emotional well-being.

Linguistic Capital

Yosso (2005) defines linguistic capital as the experiences of communication using more than one language, with the attendant knowledge and skills, along with varied linguistic forms and resources. Our data revealed how Black OST staff employed African American Vernacular English and colloquial phrases to build rapport and demonstrate genuine care. Some staff noted that they demonstrate differences between vernacular and formal or "standard" communication styles. DeNicolo et al. (2015) found a similar phenomenon among Mexican-American students who sought to learn English to expand educational and career opportunities.

Staff also used storytelling, poetry, and drama based in Black traditions in OST activities. Denton et al. (2020) highlight the need for more research on how "storytelling or artistic mediums" function as forms of linguistic capital in informal learning contexts. Culturally relevant storytelling can bolster young people's enthusiasm and sense of belonging (Denton et al., 2020).

Aspirational Capital

Aspirational capital includes "the ability to maintain hopes and dreams for the future, even in the face of real and perceived barriers" (Yosso, 2005, p. 77). Black OST staff in our study expressed ambitions for their future careers and life goals. These aspirations were often rooted in experiences of growing up

in challenging circumstances. Similarly, Luna and Martinez (2013) found that racially minoritized college students who experienced poverty maintained high goals and a commitment to self-improvement.

Study respondents also took on mentorship roles. By modeling success and reinforcing young people's dreams, staff exemplified the potential of aspirational capital to instigate positive changes (Luna & Martinez, 2013; Ortiz et al., 2019; Tolbert Smith, 2022).

Social Capital

Social capital is the collection of people and resources in a community, including peers and social contacts (Yosso, 2005). Social contacts support individuals both instrumentally and emotionally. In our findings, Black OST staff often invoked relationships with coaches, mentors, or fellow staff as crucial sources of knowledge and encouragement. These experiences reflect existing research on social capital in underrepresented communities (Chavez, 2018; Coronella, 2018), where empowering figures share essential knowledge and open doors for younger generations (Zamudio, 2015).

Resistant Capital

Resistant capital is the ability to hold on to one's community culture and persevere when faced with adversity and inequality (Yosso, 2005). It includes instructing children in the cultural structures of racism and how to oppose injustice. Black OST staff in our study cited experiences in which they were "living lives that intentionally countered society's negative deficit views" (Tolbert Smith, 2022, p. 758). Samuelson and Litzler (2016) found that Black male engineering students used resistant capital to challenge negative stereotypes, drawing on personal experiences as both a source of motivation and a tool for overcoming societal barriers. These authors also describe how Black women in academic settings pushed back against stereotypes by striving for high performance (Samuelson & Litzler, 2016).

Navigational Capital

Navigational capital refers to "the ability to maneuver through institutions not created with Communities of Color in mind" (Yosso, 2005, p. 80). Tolbert Smith (2022) describes how navigational skills can be imparted in educational contexts. By giving youth their "very best," in the words of one respondent, Black staff in our study modeled an ethic of excellence and determination to overcome societal barriers.

Methods

Research Context

Data collection occurred in an afterschool and summer STEM (science, technology, engineering, and math) program at an out-of-school time learning facility in East Saint Louis, Illinois. Of the approximately 20,000 residents in this community, 95 percent are Black, and nearly 30 percent live below the poverty line. Each year, the OST facility serves over 1,500 predominantly Black youth, ages 6–18, providing safe recreational spaces and supportive adults to assist participants in achieving their goals. The Donald Danforth Plant Science Center, the University of Illinois Urbana-Champaign, and the OST facility joined efforts to changing lives by collaboratively providing quality youth and community programs in STEM, agriculture, food production, nutrition, and physical activity.

At the time of our study (2022–2023), the OST facility had 18 staff members, ages 18–60. Most were Black women, many of whom came from the local community or from a similar background. Staff roles were typically part-time; high school diplomas were the most common educational attainment level.

Participants

We recruited five Black OST staff members (average age 41) to explore how racially minoritized and underresourced communities utilize CCW to support young people. The selection was based on informal and formal STEM education experience or recommendations from leaders at the OST facility. Table 1 (next page) summarizes respondents' demographic information. These participants were part of a more extensive study of mentoring and professional development in OST settings (Kaggwa et al., 2024). All participants gave informed consent through either online or paper forms.

Study Design

Following Yin's (2018) case study methodology, we investigated how these five staff members applied CCW in their work. This single-case longitudinal study was conducted over one year (May 2022–April 2023),

Table 1. Participant Demographic Information

Position	Sex	Age	Highest Educational Attainment
YDP*	Male	37	High school diploma
YDP*	Male	34	Some college
YDP*	Male	43	Unknown
STEAM educator	Female	48	Bachelor's degree
Curriculum program director	Female	42	Doctorate

* Youth development professional working directly with youth

capturing multiple time points. Data were gathered through monthly focus group sessions and semi-structured interviews conducted at the conclusion of the professional development program (see Kaggwa et al., 2024). During the monthly sessions, participants shared examples of how they utilized CCW in their work with youth, described common barriers, and discussed strategies for overcoming those challenges. To guide these sessions, we employed a focus group protocol featuring questions such as:

1. "Please share an example of how you use your social capital at the OST facility. What was the situation?" (social capital)
2. "What knowledge and skills do you have that fostered your ability to challenge inequalities and negative stereotypes?" (resistant capital)
3. "Please share an example of how you maneuver social institutions that were not created for communities of color." (navigational capital)

In addition, all respondents completed monthly written reflections. Two staff members participated in interviews at the end of the year to offer in-depth insights into their use of CCW in their OST work.

Data Analysis

To analyze the data, researchers independently coded focus group and interview transcripts, identifying themes that corresponded with Yosso's (2005) six CCW components. Coding was performed deductively (Fereday & Muir-Cochrane, 2006). The coders convened in multiple sessions, striving to achieve consensus before, during, and after the coding process. Two additional coders examined all data sets, offering diverse viewpoints to bolster the project's validity. Three researchers analyzed data in the Dedoose qualitative analysis platform.

Highlighting the Community Cultural Wealth of Black OST Staff

Our findings unveil how the Black OST staff in our study applied their CCW in their work with racially minoritized K–12 youth from an underresourced community. The examples we cite for the six kinds of CCW highlight the resources staff members applied from lived experiences but do not represent an exhaustive list.

Familial Capital

Black OST staff shared lessons on public appearance and personal conduct that they learned from family members and applied in interactions with program participants. One respondent cited a simple example about keeping one's shoes tied: "I can't let a kid walk past me, no matter how old they are. 'Hey, let's just stop for a second. Let's get those shoes tied.'"

Another area in which the example of family members influenced staff members' work with youth was leadership and resilience. One male staff member recalled that his mother repeatedly told him that he was "the man in the house" and therefore he had to "lead by example." A female staff member recounted how her mother continued to inspire her:

> My mom … she doesn't give up. [She taught me,] you can't give up, you can't quit. So [that motivation] absolutely comes from her upbringing…. Now, as an adult, it's, like, "Oh, man, she is so resilient. She's so powerful. She's so encouraging because she never gave up."

Respondents said they empathized with youth from households that faced challenges similar to those their own families faced, such as inadequate income and lack of male role models. As one male staff member put it, "Sometimes in a single-parent household, some kids don't have … that male figure that take the extra mile, spend his money, or do extra…." This respondent described how staff "chipped in" to help

program participants pay for a field trip as an example of how OST staff can fill a quasi-parental role.

Linguistic Capital

Black OST staff discussed using phrases from local community vocabulary to engage youth. One respondent said, "Like, one of the things I'll ask … when I see kids … is, 'You good?'" He went on to describe how, "depending on their inflection, it can totally mean different things"—from warning to acknowledgement to offer of help. Using the local vernacular enabled this staffer to connect with young participants on their level while offering adult support for positive behaviors. Staffers also described ways in which they encouraged young people to use polite formal language to show respect for adults.

Respondents also used their cultural congruence with OST participants to facilitate communication and STEM learning. One staff member explained, "We used skits to discuss food safety. The kids were excited to tell me what I was doing wrong." We also observed staff leveraging poetry and drama during instruction, engaging youth in STEM learning by tapping into a storytelling tradition that fosters active participation and creativity (Figure 1).

Aspirational Capital

The staff members we interviewed expressed how they tried to instill hope for greater possibilities in program participants, despite barriers and setbacks. As one respondent put it, "We tried to just reach them to get to their minds for them to just reach out…. [We don't want to] let them go to jail or experience the streets, because the streets, that's not what they want."

Another staffer's comments on young people's use of language highlights an overlap between linguistic and aspirational capital: "They use vulgar language, curse words a lot.… And I was, like, 'Have you ever heard [me] curse? ... You know why? Because you have to expand your vocabulary so that you're able to speak in every environment.'"

At least one respondent found that his OST position developed his own aspirations:

> [Working in this program] helps me set goals, helps me want more of the mentorship, made me want more out of life…. I have an overnight job that I got last week. And I'm just trying to save some money and just have better money management skills.

Figure 1. Staff member using poetry and culturally relevant teaching

Social Capital

The Black staff in our study described the importance of social connections in various ways. Staff who had been participants in the OST program where they now worked described how ongoing mentorship and social ties influenced their decision to stay involved. A mentor shared that a youth development professional who participated in sports programs at the OST facility when he was younger was deeply influenced by "Coach M," who was "not only just like a regular coach, but also kind of like a father figure." This respondent added that the relationship with Coach M influenced the staff member's "ability to relate to students today."

Staff also built social capital among themselves. A respondent who had recently been promoted to a managerial position, for example, named one staff member as the person to go to for event planning and a different staffer as the resource for "scientific projects." Knowing one another's strengths can help staffers serve young people more efficiently and effectively.

Social capital was also important in working with OST participants. Staff cultivated social capital among participants through regular gatherings, collaborative lesson planning, and group outings. One OST staff member described how he built his players' social capital by creating connections off the field: "How I reached my kids for my football team is just go out and hang with them,… like sometimes we take my team out to bowling. Just … spending time with them one-on-one."

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Resistant Capital

A reflection of one male staff member perfectly illustrates the need for and the exercise of resistant capital.

> People immediately write me off.… They think, "Oh, there is a black man. Okay. This black man, how's things about to be? Is he going to be aggressive?" Because they might … automatically think, "He might be aggressive or … territorial." No, as I begin to talk with people, I begin to create friendships, bonds, … to where it becomes beneficial for me and that individual.

One participant, who had been recently promoted from part-time staff to a leadership role, reflected on an interaction with a police officer in the parking lot of the OST facility:

> I was stereotyped. And I handled it very well. And it was amazing to kill his stereotype. No, I'm not a thug. I'm not trying to get away from you. I'm not running. I'm just going to work to serve my community.

This respondent reflected on how he assumes the role of a mentor and guide for the youth, warning them away from paths that could lead to incarceration:

> You want to lead them down the right path. Like … what kid is going down the wrong path, and you just … want to tell them, like, "Dead and in jail is what they expect you to be. So let's beat this stereotype." [We] want to just try to motivate [participants] to be better than what they expect you to be. Because risk-taking can either be good or bad. So you want to take good risks.

Black OST staff reflected on how their personal growth, responsibility, and accountability combined to influence their responses to racism. They actively taught youth to do the same, demonstrating that resistance can serve as a form of mentorship that empowers future generations to question systemic injustices.

Navigational Capital

One Black staff member described the barriers through which program participants had to navigate: "Many people think [the children] can't, and so they won't. [People] don't see [the children]. They are already defeated when they come. Most of the time they already have that crappiest education." Her response to the stereotyping and inadequate investment imposed on Black children was to affirm that it was "[my] job to give them the best of [me]." The reward for that effort, for this staffer, was when program alumni came back to tell her how much her teaching and example meant to them.

One respondent expressed gratitude for the fact that the OST program itself was a safe space that did not require navigational capital:

> The benefits of working at [the OST facility] is that it is a place that has communities of color in mind because it is a community of color, specifically Black. And so we have the privilege of not having to navigate this.

In addition to personal safety strategies, staff also described providing practical guidance to youth on how to handle encounters with authority. A respondent described how he modeled use of navigational capital in an encounter with an irate parent.

> She was just cursing me out. I was just, like, "Yes, ma'am. I'm sorry about the confusion. Have a great day." And at the time, one of the kids that was there watching this.… He's a difficult kid, he's a very difficult kid. When the lady left and I [noticed he] saw how I handled it, I was, like, "You see how I did that?" He was, like, "Oh, that would have never been me." I'm, like, "Right. That's my point. You have to learn how to do exactly what I just did. That lady was cursing me out. And I told

her, 'Yes, ma'am. Thank you. Have a great day.' Every action doesn't need a reaction."

Overlaps Among the Types of Community Cultural Wealth

Respondents' reflections on CCW revealed overlap and connections among the six types of capital, some of which have been noted above. Yosso (2005) recognizes the connection between social and navigational capital: "Navigational capital thus acknowledges individual agency within institutional constraints, but it also connects to social networks that facilitate community navigation through places and spaces" (p. 80). One OST staff member in our study made a similar connection in their role as mentor for program participants: "I just try to give them examples of things that they probably already know. You don't want to get shot. You don't want to end up dead. You don't want to go to jail."

"I just try to give them examples of things that they probably already know. You don't want to get shot. You don't want to end up dead. You don't want to go to jail."

Another staff member illustrated how he draws on familial and social capital to handle disciplinary challenges at the OST facility.

> I just tried to be like mentors that I had in the past. Not too cool, but not too mean. It's cool to be, … like, kids want to be around me.... I use trials from my past life to help me, motivate me.

Familial capital overlapped with linguistic capital as another respondent reflected on how he uses lessons instilled by his mother to teach participants how to talk to adults. This staffer says to participants:

> As you're interacting with an adult, make sure you use some verbiage that says, "Yes, sir. No, sir. Yes, ma'am. No, ma'am." [I'm] helping them, teach[ing] them to become responsible for themselves. Motivating them in ways as much as my mother did as well.

Conclusions and Implications

Our findings offer a nuanced look at how Black OST staff, who are often precariously employed and underrecognized, leverage their CCW to enrich OST experiences for students while countering longstanding narratives that marginalize Black staff as mere chaperones. CCW is a valuable source of expertise Black OST staff can use to support young people. The lived experiences, community ties, and cultural competencies of these staff members equip them with skills to foster meaningful relationships, mentor youth, and create engaging learning environments. Rather than viewing Black OST staff through a deficit lens that assumes a need for extensive formal training, OST programs should recognize and amplify these professionals' strengths.

For example, our study respondents used familial capital in their work, translating childhood lessons about resilience and leadership into strong mentoring practices. They used their linguistic capital to create inclusive, relevant learning environments by using culturally familiar language while encouraging use of more formal language when appropriate. They actively challenged stereotypes through resistant capital and bridged resource gaps via navigational capital, thereby demonstrating their capacity for transformative leadership that remains undervalued under current precarious staffing structures. Social capital was fostered by supporting youth and building relationships with them through social activities. Participating Black OST staff were also motivated to mentor youth and serve as role models, in part because of their own childhood experiences where they themselves lacked mentors.

The unique contribution of our research is its direct examination of how OST staff employ CCW, as CCW has been examined predominantly among students in formal education (e.g., McGowan & Pérez, 2020; Samuelson & Litzler, 2016). OST programs serve as critical sanctuaries, providing safe spaces for underserved youth. However, if staff are marginalized, program effectiveness can be impaired. By illuminating how Black staff in one program mobilized their CCW, our study illustrates the central role of Black OST professionals in creating robust, culturally attuned experiences for youth.

Our study is limited by reliance on self-reported data from Black OST staff, who may have leaned toward socially desirable responses. Observational data could have helped to overcome this bias. Furthermore,

the sample is small, and all respondents come from a single OST facility serving predominantly Black youth in a low-income community. The findings therefore may not be generalizable. However, they do incorporate the authentic voices of practitioners, whose experiences and opinions suggest implications for practice and policy.

Implications for OST Professionals and Programs

Our findings suggest the need for a transformation in how the field thinks about racially minoritized part-time OST staff. Rather than being mere caretakers, these staffers are central to efforts to broaden access, learning, and cultural responsiveness. Adopting this view could improve outcomes for racially minoritized OST staff, broadening their opportunities in informal education, while simultaneously enabling them to better serve program participants.

Our study findings suggest that OST programs could combat the underutilization of Black staff by fostering Yosso's (2005) six dimensions of CCW. One way to harness familial capital is by encouraging intergenerational involvement, in which families share cultural stories that can be integrated into programming. Culturally sustaining pedagogy that promotes the inclusion of home languages and dialects in programming would build on staff members' and participants' linguistic capital. Offering clear promotion pathways for staff would recognize and build on aspirational capital by facilitating opportunities for meaningful leadership and professional growth. Structured peer mentorship opportunities, in which more experienced staff guide less experienced practitioners, can build on existing social capital while creating new bonds. Such structures could support staff in their daily work while showing youth how to build strong, sustainable networks. Use of navigational and resistant capital can be fostered in professional communities of practice in which staff share strategies for handling challenges.

In order to tap into and foster all six types of CCW, OST programs must give staff time and opportunity to cultivate meaningful relationships with young people rather than prioritizing rigid content delivery. Strong staff-youth relationships enhance participants' outcomes and increase their engagement in OST programs (Akiva & Horner, 2016; Boat et al., 2024). For example, programs can set aside dedicated time for informal check-ins, establish mentorship pairings that foster long-term connections, and create unstructured spaces where staff and young people can engage in meaningful conversation. When staff have the space to engage authentically with youth, they become trusted mentors, role models, and key figures in students' social-emotional development.

> Our findings offer a nuanced look at how Black OST staff, who are often precariously employed and underrecognized, leverage their CCW to enrich OST experiences for students while countering longstanding narratives that marginalize Black staff as mere chaperones.

Implications for OST Leaders and Policymakers

OST leaders and policymakers could consider embedding CCW as a formal, sustained, and integrated component of OST policies, training, and professional development. This strategy would recognize that Black OST staff are not peripheral helpers but integral contributors to youth success. It would value these staff members' inherent strengths, cultural knowledge, and lived experiences and leverage these strengths as essential assets in youth development. Training efforts should be intentionally designed to build on these existing strengths.

State or city OST networks, or state legislation, could amplify these efforts by encouraging tailored approaches for serving racially minoritized youth. For example, professional development that trains OST leaders and staff to identify and build on their cultural assets can lead to more culturally sustaining programming. Approaches might include community-centered curricula, specialized workshops that equip staff to handle sensitive race-based conflicts, and targeted mentorship networks connecting Black OST staff with external professionals. Such larger-scale efforts can help programs better serve the unique needs of racially minoritized youth while enabling staff to feel valued for their cultural contributions.

Stable funding and career pathways enforced through policy changes would acknowledge the

fundamental role of Black staff in bridging opportunity gaps. Policies that foster and promote public-private partnerships with local organizations and families can further amplify familial and social capital, ensuring that programming remains culturally relevant and empowering for Black staff and youth.

Ways Forward

By examining the CCW of Black OST staff, this study adds to the growing literature on strengths-based epistemologies in informal learning contexts. As the staff in our study navigated precarious employment conditions, racial biases, and limited recognition, they simultaneously drew on familial ties, linguistic capabilities, aspirational visions, social connections, resistance strategies, and navigational skills to uplift and mentor students.

Future research could examine the long-term outcomes of staff-led initiatives or investigate how various community contexts influence the application of CCW. Comparative studies might explore the forms of cultural wealth mobilized across multiple OST facilities and different types of programs. Such studies would add depth to our understanding of how best to empower OST participants and staff. Ultimately, stakeholders can strengthen the broader equity mission of OST programming by recognizing, rewarding, and integrating the multifaceted cultural capital of Black OST staff.

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Enhancing Cultural Responsiveness in Afterschool STEM Programs

Andrés Forero Cuervo, Daniel Morrison, & Alessandra Pantano

Out-of-school time (OST) science, technology, engineering, and math (STEM) programs have gained recognition for their potential to enhance youth engagement, motivation, and skills by addressing young people's needs for autonomy, competence, and connection (Faust & Kuperminc, 2020; Hoffman et al., 2021; Mulvey et al., 2023; Yu et al., 2022; Yu et al., 2020). These programs, particularly when they combine academic and social focuses, can significantly impact student interest in STEM, with middle school being an optimal stage for intervention (Young, Ortiz, & Young, 2017).

OST STEM learning has been linked to improved attitudes toward STEM fields, increased knowledge and skills, and a higher likelihood of pursuing STEM education and careers (Afterschool Alliance, 2011). Consequently, OST activities have the potential to address the opportunity gap faced by underserved communities in STEM. However, creating truly inclusive environments requires the adoption of culturally responsive practices (Simpkins et al., 2017).

Culturally responsive teaching (CRT) leverages students' diverse cultural backgrounds and perspectives to enhance learning experiences, making educa-

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tion more meaningful and engaging for students, thus ultimately leading to improved academic performance (Gay, 2002). CRT has been implemented primarily in traditional classrooms; its potential in OST STEM programs remains largely unexplored (Dodo Seriki, 2018).

Researchers argue that integrating culturally responsive practices in OST STEM programs can enhance both social and academic outcomes for youth (Simpkins et al., 2017; Soto-Lara et al., 2021; Yu et al., 2021). Key practices include centering youth experiences, challenging traditional STEM representations, fostering critical STEM agency, and valuing diverse identities (Archer et al., 2020). Additional strategies have been identified as crucial to foster and maintain positive STEM dispositions among girls of color in OST programs, including integrating "productive struggle" activities, contextualizing STEM in everyday experiences, and emphasizing community and social impact (Young, Young, & Pauffler, 2017).

Designing culturally responsive OST activities requires a holistic approach, integrating cultural responsiveness into all program components (Shivers et al., 2011). This approach involves defining culturally responsive practices for program structure and for staff training (Simpkins et al., 2017), as well as developing contextualized curricula that connect participants' learning experiences to their "funds of knowledge" and "funds of identity" (Llopart & Esteban-Guitart, 2016).

This article presents a case study on enhancing cultural responsiveness in an afterschool STEM program serving marginalized youth from groups that are underrepresented in STEM. The program fosters both academic and social growth through a framework called the Math CEO CRT framework, which consists of six key dimensions (see Figure 1). Each dimension is detailed with pedagogical practices, implementation examples, and potential impacts on students. By examining the integration of these dimensions into the program's curriculum, staff-youth interactions, and program structure, this study offers valuable insights to inform future STEM program design and practical implementation strategies.

Math CEO Program Overview

Math Community Educational Outreach (Math CEO; Pantano, 2024) is a partnership between the University of California (UC) Irvine and low-income families in Southern California. Founded by university math faculty in 2014, it provides weekly 90-minute afterschool math enrichment for middle schoolers (grades 6–8) from Title I schools in Santa Ana, California, along with STEM-focused field trips to UC Irvine. Teacher liaisons promote the program, and participation is voluntary. Each quarter, about 27 UC Irvine undergraduate mentors and 130 youth participate, with an average of 20 mentors and 80 youth per meeting. Mentors receive four hours of training before the program begins, along with two hours of coaching before each session, learning to blend innovative math content with culturally responsive pedagogy. As leadership team members, we organize STEM meetings; develop curriculum activities; and train mentors in content, pedagogy, and cultural aspects.

At Math CEO's core is a strong sense of community. Mentors act as friends and role models, nurturing an inclusive environment where young people feel appreciated and connected. Throughout 23 annual sessions, middle schoolers work with the same mentors each quarter, collaborating in small groups on mathematical explorations designed to enhance understanding and appreciation of mathematics, as well as social interaction.

Math CEO provides an intergenerational learning experience. Through informal investigations, mentors and students engage in mutual learning, sharing ideas in a joyful, exploratory environment. Mentors strive to enhance reasoning and critical thinking, exemplifying persistence and a growth mindset.

Figure 1. The Six Dimensions of the Math CEO CRT Framework

The Six Dimensions	
1.	Students at the center
2.	Interpersonal relationships and well-being
3.	Deep critical and logical thinking
4.	Relevance, friendly language, and representations
5.	Promoting social justice
6.	Equity through embracing cultural diversity

The program is hosted primarily at UC Irvine, with a new branch at California State University, Dominguez Hills. Students therefore gain firsthand exposure to university life. The program is academically challenging and aims to empower students with the confidence to choose a college path if they so desire.

Math CEO creates a culturally responsive curriculum that uses math to explore themes including geographical equity, global warming, urban planning, health choices, social justice, and cultural expression. These resources are available online to foster equitable informal learning environments. The program serves a diverse population, reflecting Southern California's rich cultural tapestry: Participants are approximately 92 percent Chicanx/Latinx, 4 percent White, and 3 percent Asian. Mentors are about 56 percent Chicanx/Latinx, 30 percent Asian, and 5 percent White. This diversity promotes cross-cultural understanding and collaboration, enriching the learning experience for both mentors and participants.

Pre- and post-implementation surveys of Math CEO mentors and young people have demonstrated statistically significant impacts on students' mathematical dispositions, college knowledge, and social-emotional skills, as well as mentors' relational and teaching self-efficacy, interest in STEM and teaching careers, and sense of community contribution. In-depth interviews have linked these impacts to culturally responsive practices at Math CEO (Pantano, 2024; Soto-Lara et al., 2021; Yu et al., 2020; Yu et al., 2021; Yu et al., 2022). As a result, enhancing cultural responsiveness has become a priority for our team.

A Framework for Cultural Responsiveness

Researchers advocate for intentional and thoughtful approaches to designing afterschool programs that respect, reflect, and leverage participants' cultural diversity (Simpkins et al., 2017). This practice-based article outlines a framework created by an exemplary high-quality afterschool STEM program to guide its efforts in becoming more culturally responsive.

We developed the CRT framework shown in Figure 2 to structure our efforts to make Math CEO more culturally responsive while ensuring accountability. Enhancing cultural responsiveness in an afterschool program is a complex endeavor. However, this framework identifies dimensions and spheres of action that can be addressed individually while acknowledging their interconnectedness within a larger system.

The CRT framework evolved from an earlier model our team used to train mentors (Pantano et al., 2024). Each coaching session typically focused on one component of the framework, corresponding to a specific skill set deemed crucial for mentor development. The previous framework focused on enhancing mentors' skills in student-centered pedagogy and relationship building, but it was limited to pedagogical practices without addressing program structure or curriculum. It also lacked substantial connections to culture or social justice. This new CRT framework expands upon and enhances these elements, providing a more comprehensive approach to culturally responsive mentoring.

Our CRT framework was developed through a four-step process:

1. We identified key aspects of our program's structure, curriculum, and pedagogical practices that led to a successful implementation of CRT.
2. We examined various CRT rubrics to identify additional components previously outside our scope, using them to build a working version of the framework.
3. Through observations in both coaching and mentoring sessions, we analyzed expected outcomes and intended mentor actions for each component, generalized effective strategies, and refined categories for greater clarity.
4. We revised our language to enhance accessibility and integrated the dimensions into a coherent, easily understandable structure for mentors.

Teaching mathematics is a key goal of Math CEO. However, its ultimate aim is to foster personal growth and development, symbolized by the core of the diagram shown in Figure 2 (next page). The six hexagons around the core represent the dimensions of CRT that guide students' positive development; they are essential for meeting students' diverse needs. Three concentric rings—program structure, curriculum, and pedagogical practices—surround the core, representing the domains in which the CRT dimensions are applied. An effective program integrates all six dimensions across all three domains, ensuring a comprehensive approach to culturally responsive informal STEM education.

Three Domains of Cultural Responsiveness

Here we outline the three domains of cultural responsiveness illustrated by the concentric rings in Figure 2.

Figure 2. The Math CEO CRT Framework

Program Structure

The program structure domain covers the program's organization and design, including meeting location, frequency, and participant and staff decisions. Math CEO, for example, serves Chicanx/Latinx middle schoolers from a local low-income community. Hosting the sessions at UC Irvine allows undergraduates to mentor young people while exposing them to a college environment, subtly but strongly promoting higher education. Program structure also includes nuanced elements that shape student experience. For example, mentors stand and circulate during meetings, rather than sitting behind a desk, in order to engage with multiple students and foster a sense of community; they also encourage participants to speak in more than one language. These intentional choices enhance both program effectiveness and cultural responsiveness.

Curriculum

A core element of an afterschool program, the curriculum domain includes content, learning objectives, pedagogical guidance, and other specifics of activity implementation. Enhancing cultural responsiveness in the curriculum requires reviewing mathematical and social-emotional outcomes, along with activity relevance, complexity, and engagement. Well-designed activities set the foundation for each session. The curriculum must be adaptable, with ongoing adjustments based on past successes and challenges, to keep activities dynamic, student-centered, and aligned with CRT practices.

Pedagogical Practices

Although program structure and curriculum form the foundation of an afterschool program, mentors bring cultural responsiveness to life through their teaching practices. As the key link between design and implementation, mentors work directly with students; they therefore must be trained in culturally responsive strategies, such as building positive relationships and teaching mathematical content in ways that honor and reflect students' diverse backgrounds. These practices are key to achieving the program's goals of positive youth development in the context of culturally responsive informal STEM education.

Aligning the Three Domains

A truly effective culturally responsive afterschool program seamlessly integrates all six CRT dimensions across program structure, pedagogical practices, and curriculum. For example, an activity aimed at strengthening cultural connections may fail without proper mentor training. Since these domains are interdependent, a successful implementation of CRT practices requires careful and ongoing alignment across all three.

Six Dimensions of Cultural Responsiveness

This section outlines the six dimensions of the culturally responsive framework and the corresponding benefits for students. Included for each dimension is a box

Dimension 1: Students at the Center

Encouraged Mentor Practices
Encourage students to collaborate on problem-solving tasks and explain concepts mutually.
Foster an environment where students are central to discussions and encouraged to answer questions.
Motivate students to ask questions and share their ideas.
Provide students with ample time to think and reflect.
Allow students to steer activities based on their interests.
Design activities with themes that are relatable to students.
Intended Student Outcomes
I actively participate in the activities and can share my ideas and ask questions.
I both help and receive assistance from my fellow students.
I have some control over what I learn.
The activities are engaging and align with my interests.

detailing encouraged mentor practices—specific actions to activate each dimension—and intended student outcomes—how students ideally will experience each dimension and their expected responses during meetings.

Dimension 1: Students at the Center

This dimension prioritizes youth-driven learning by tailoring activities, teaching methods, and pacing to students' needs while promoting active participation. Mentors empower students to guide their learning, balancing independence with collaboration. Peer-to-peer knowledge sharing strengthens teamwork, as students benefit by explaining concepts to each other, often finding peer explanations more relatable and engaging than those of adult mentors. Encouraging peer support before mentor intervention helps students engage deeply, fostering both mathematical and social skills in an interactive learning environment.

Dimension 2: Interpersonal Relationships and Well-Being

This dimension emphasizes building strong connections between mentors and students, as well as among peers. Mentors foster a safe environment for building relationships, embracing a "more than a tutor" philosophy and actively engaging with students on a deeper level. Afterschool programs uniquely allow mentors to see young people beyond academics. Mentors offer both instruction and affective support while modeling social-emotional skills. Strong relationships help students embrace academic challenges and feel comfortable sharing personal concerns, enabling mentors to provide well-rounded support.

We prioritize this dimension at the beginning of each year, as trust and rapport lay the foundation for the rest of the dimensions.

Dimension 3: Deep Critical and Logical Thinking

This dimension sets high expectations for curriculum and mentors, challenging students to develop deep content knowledge, logical reasoning, and critical thinking through thought-provoking questions. To address negative self-perceptions, mentors must express genuine belief in students' abilities. High expectations encourage confident engagement,

Dimension 2: Interpersonal Relationships and Well-Being

Encouraged Mentor Practices
Listen to and value students' ideas.
Respond to students with care, respect, and compassion.
Be mindful of students' situations outside of the program.
Be curious about students' life experiences, and demonstrate that you care about them.
Check in with students about their progress.
Model appropriate behavior and responses to challenges.
Share your college experience with students.
Intended Student Outcomes
I feel safe and respected, and I have people to turn to when I have problems.
I can share my interests and experiences.
I feel that my mentors care about me.
I feel that my ideas and suggestions are valued by everyone.

Dimension 3: Deep Critical and Logical Thinking

Encouraged Mentor Practices
Apply mathematical concepts to real-world situations to develop modeling skills.
Encourage students to justify their answers and explore abstraction and generalization.
Promote multiple reasoning paths to justify solutions.
Pose questions that challenge students' understanding.
Demonstrate belief in students' ability to expand their understanding.
Encourage students to persist through challenging problems.
Intended Student Outcomes
I feel challenged by the activities.
I can solve problems and explain my answers.
I feel capable of completing activities with support.
My mentor asks me for my reasoning.
I believe my math skills are improving.
I persist after encountering difficulties.

pushing learning beyond traditional boundaries. This attitude among mentors builds students' confidence, resilience, ability to persist through challenges, and capacity to learn from mistakes.

Dimension 4: Relevance, Friendly Language, and Representations

This dimension makes math meaningful by connecting activities to real-life experiences and using diverse mathematical representations such as manipulatives, diagrams, tables, pictures, and abstract expressions and formulas. Mentors build on students' prior knowledge, tailoring explanations to their backgrounds and interests. Individual differentiation may not always be feasible, but mentors can enhance relevance for small groups by incorporating student interests, surveying or polling students, allowing students to modify an activity in reasonable ways, having students explain to each other, and presenting multiple problem-solving approaches.

Mentors use both formal and informal language, along with various mathematical representations, to enhance understanding and engagement. Although precision matters, introducing concepts in relatable language can aid comprehension, with students gradually adopting formal terms. Encouraging familiar language, including slang or non-English languages, makes math more accessible and affirms students' cultural identities.

This dimension makes activities accessible and relevant to students with varied experiences, meeting them where they are and building skills from there. Showing multiple problem-solving methods cultivates critical thinking and caters to different learning styles, enhancing overall understanding.

Dimension 5: Promoting Social Justice

This dimension fosters awareness of social justice issues through mathematical activities that include analyzing problems and exploring solutions. It begins with personal stories from students and mentors, expanding to families, communities, and global contexts. Activities highlight connections between

Dimension 4: Relevance, Friendly Language, and Representations

Encouraged Mentor Practices
Relate concepts to students' real-life experiences.
Provide multiple ways for students to understand and solve problems.
Help students connect different mathematical representations (like manipulatives, diagrams, tables, graphs, expressions, and equations) to advance understanding.
Allow students to use informal language in discussions, and use it yourself.
Use simple language to explain complex topics.
Provide differentiated support and scaffolds for all students to succeed.
Intended Student Outcomes
I can solve problems in my preferred way.
I relate to the activities we do.
I use comfortable language when discussing problems.
I feel supported in solving problems my own way.
My mentors use language I am comfortable with.

Dimension 5: Promoting Social Justice

Encouraged Mentor Practices
Educate students about fairness and social justice.
Help students empathize with others' struggles.
Demonstrate how math can address social justice issues.
Encourage students to consider how they can improve the world around them.
Intended Student Outcomes
I know more about global issues.
I understand how social justice issues impact individuals.
I feel capable of making the world a better place.
I can apply my math knowledge to understand social justice.

math and social justice, incorporating students' interests and cultural backgrounds. Although this approach is not feasible for every activity, it deepens students' understanding of the world and of the relevance of math. It also reinforces high expectations, empowering students to believe in their ability to create positive change.

Dimension 6: Equity Through Embracing Cultural Diversity

This dimension honors culture by integrating students' and mentors' cultural knowledge to create an equitable community. The curriculum fosters cultural exchanges; celebrates diversity; and addresses biases, inequities, privilege, representation, and cultural appropriation. It focuses on affirming the cultural identities of students—especially marginalized youth—and exposing them to diverse cultures. In contrast to traditional math activities, which often reflect mostly dominant groups, Math CEO activities intentionally validate students' identities and incorporate a variety of ways to approach concepts. Cultural exposure promotes appreciation; however, mentors must learn deeply about cultures to avoid appropriation and to promote a relevant, inclusive, and culturally sensitive learning environment.

A Case Study

It is challenging to successfully activate all six dimensions of our framework in a single curriculum activity. We therefore provide an example of how our program works toward this goal. The Four Friends activity exemplifies how our curriculum aligns with CRT practices.

Four Friends is a logic puzzle that teaches combinations and counting techniques using multiple mathematical representations. Students discover there are 24 (that is, $4! = 4 \times 3 \times 2 \times 1$) different ways to assign four hobbies to four friends, assigning each hobby only once. Each assignment is called a "world" because it reflects a possible real-life scenario for the four friends. Students learn to create and read counting trees and tackle new counting challenges. The activity also seeks to facilitate open discussions about potential biases and stereotypes related to how hobbies are associated with people of various genders and ethnicities.

Dimension 6: Equity Through Embracing Cultural Diversity

Encouraged Mentor Practices
Encourage students to explore and discover cultures that are unfamiliar to them.
Learn about and celebrate each student's unique cultural identity.
Share aspects of your own culture, including personal stories.
Create a safe space for all students to learn and share, validating multiple cultures.
Teach students to discuss differences of opinion respectfully.
Ensure that students are valued and represented in activities.
Provide positive cultural role models for students.
Intended Student Outcomes
I have learned about cultures other than my own.
I feel proud of my cultural identity.
I feel comfortable sharing about myself and my opinions.
I see people like myself represented in the activities.
I know about people like me making a difference in the world.

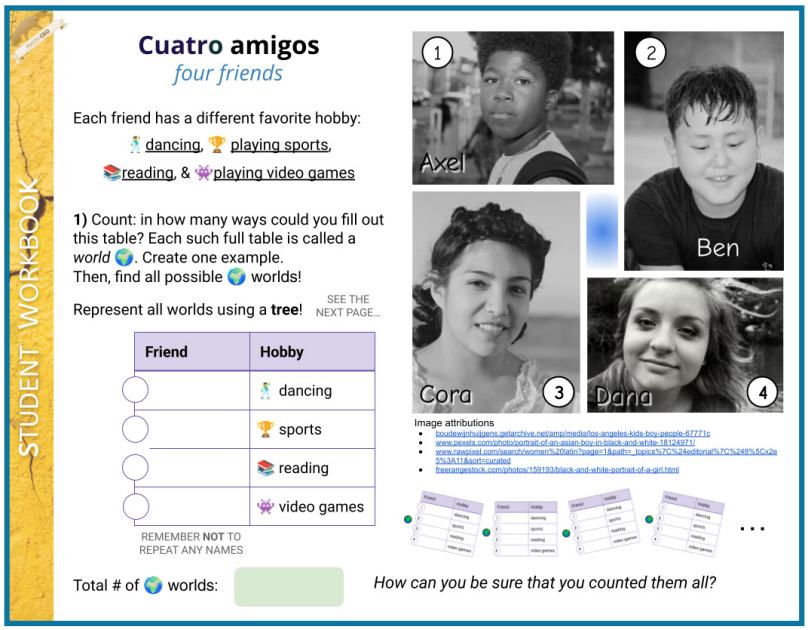
The activity opens with students imagining a world for four friends and imagining their story by investigating questions such as:

- How do they know each other?
- How did they meet?
- What do they like to do together?
- What else do you want to add to their story?

Using fictional friends reduces pressure while allowing students to share indirectly their own interests and experiences. This process helps establish interpersonal relations (Dimension 2). Mentors encourage detailed storytelling and share their own perspectives, strengthening mentor-student bonds and creating a safe space for personal sharing.

Students then have just 15 seconds to match the four friends with four hobbies: dancing, sports, reading, and video games (Figure 3). A class tally is performed to reveal collective unconscious biases about gender and ethnicity. Typically a large proportion of students see Ben as a gamer, Cora as a dancer, Axel as an athlete, and Dana as a reader. Seeing this congruence leads to a student-centered (Dimension 1) social justice discussion (Dimension 5). Rather than lecturing about stereotypes, we let students observe biases firsthand. Through group reflection on their own assumptions, students naturally explore social justice issues without formal terminology. Math plays a key role: By analyzing all possible worlds, students come to recognize how stereotypes limit options. Mentors are prepared to guide this sensitive conversation, helping students identify and address implicit biases.

Figure 3. Matching Friends to Hobbies



Matching Friends to Hobbies

This activity employs a learn-by-doing approach, centering young people in their learning experience (Dimension 1). Instead of listening to a lecture on the factorial formula, students explore hobby assignments for the friends to count combinations, creating various combinatorial worlds as tables (Figure 4, next page). We then introduce counting trees to check whether all possibilities were considered. Using "take turns" routines, students match their tables to tree branches, naturally driving their own learning process.

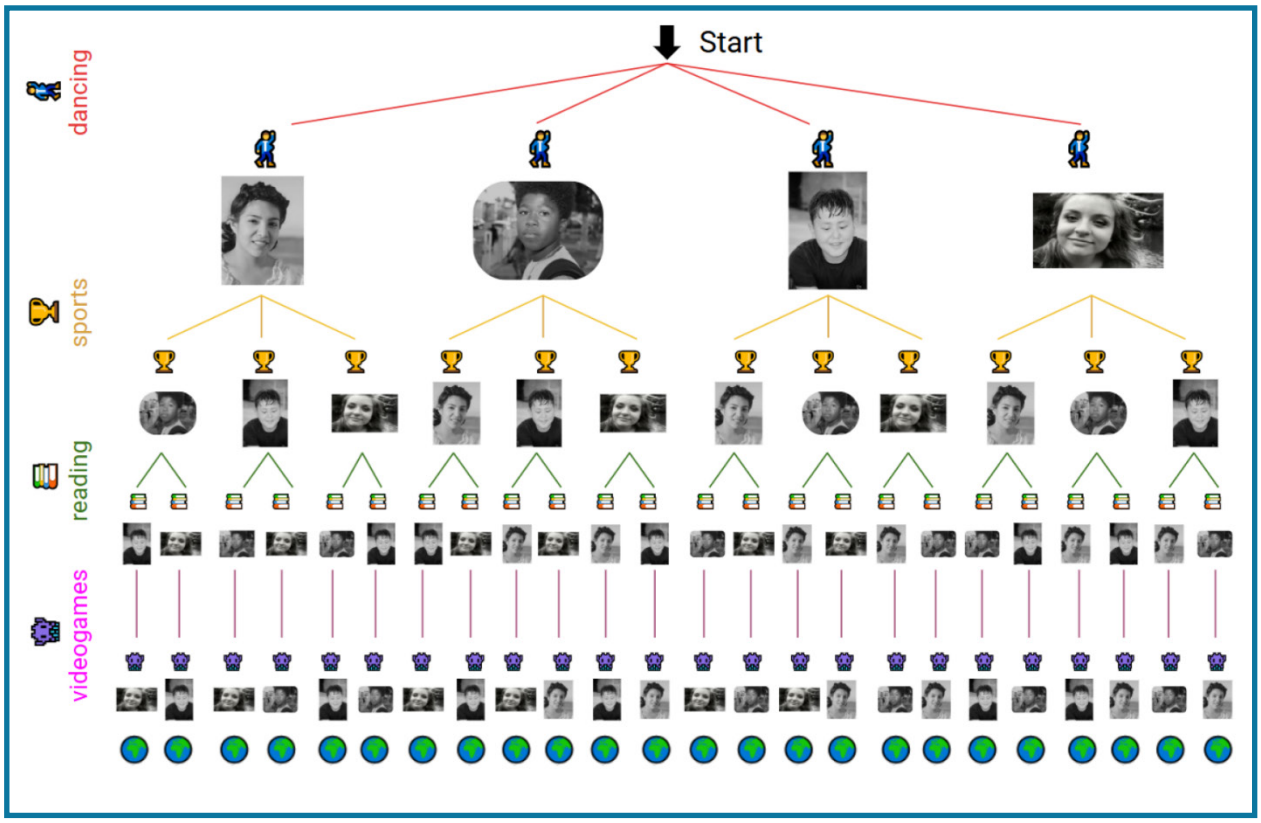
Four Friends Counting Tree

This method fosters deep critical and logical thinking (Dimension 3), enabling students to understand the reasoning behind the 24 combinations, rather than simply counting them. A series of increasingly challenging questions helps students discover the factorial formula and analyze tree structures:

- Look at each level in the counting tree. What do you notice?
- How else can we organize the tree? Is it equivalent to the original?
- Are there more worlds in which Ben dances or worlds in which Ben reads? Why?
- In how many worlds does Ben *not* play sports?
- There is a new hobby. How many worlds are there now?
- What if people *can* repeat hobbies? How many worlds are there now? How many times is that compared to the original problem?

The activity focuses on friendship to make it relevant to young people (Dimension 4). Students select hobbies for fictitious friends whose stories they've created, increasing engagement and investment in the mathematical task. Technical terms (*permutation*, *transposition*, *combinatorial object*, *equivalence*, *decision tree*, *factorial*) are minimized, leaving room for more friendly language (*counting all possible worlds*). This strategy engages middle schoolers in mathematical discourse without intimidating them. Multiple mathematical representations are provided to

Figure 4. Four Friends Counting Tree



enhance understanding and problem-solving skills, including friends and hobbies cards for students to match, table templates to complete, counting trees, diagrams, and expressions (Dimension 4). Counting trees are particularly crucial, as they connect trial-and-error methods with systematic approaches. We present two tree-building methods, starting with either friends or hobbies, and challenge students to explain why these approaches yield equivalent results (Dimension 3).

In this activity, we take a nuanced approach to incorporating cultural contexts into mathematical activities. Instead of explicitly linking culture and math, we center the activity on a universal topic—friendships among young people from diverse backgrounds and ethnicities. This approach allows cultural exchanges to emerge naturally while students discuss the friends' hobbies and personal stories, aligning with Dimension 6 of our CRT framework.

In summary, this mathematical activity is thoughtfully designed to be relevant and accessible to students while fostering deep mathematical reasoning and critical thinking. Its student-centered approach encourages active participation and exploration, allowing students to build stories that gradually unpack various aspects of culture. Mentors contribute their own cultural perspectives, strengthening bonds with students and creating a supportive learning environment. The activity effectively exposes biases and raises awareness of equity issues, demonstrating how mathematics can be used to address social justice concerns. Through friendly language, multiple representations, challenging activities, and exploratory tasks, the activity gives students voice and ownership in their learning.

Ongoing Challenges in Implementing the CRT Framework

Based on our experiences, we pinpoint in Table 1 (next page) several ongoing challenges in implementing this CRT framework in an afterschool STEM program and share solutions we have attempted. Each challenge relates to one or several dimensions in the framework.

To address ongoing challenges faced by college mentors, we implemented a weekly coaching program with five key components:

1. **Teacher guide:** Online resource packet, distributed before each session, offering activities, solutions, strategies, illustrative videos, and suggestions for incorporating CRT practices

Table 1. Ongoing Challenges and Potential Solutions

Ongoing Challenge	Potential Solution
Supportive Environment & Relationships	
Mentors unprepared for students' diverse needs and life circumstances	Provide training in cultural awareness and trauma-informed pedagogy.
Risk of triggering trauma when discussing social justice issues	Train mentors to be sensitive to students' backgrounds; model safe learning environments.
Trouble navigating the political climate of associated organizations	Make efforts to align program goals with broader institutional values.
High student-to-mentor ratio with college volunteers	Focus on the quality (versus quantity) of mentoring relationships; coach mentors on cultural humility and relationship building.
Curriculum Design	
Imbalance between accessibility and challenge in activities	Coach mentors on appropriate scaffolding while maintaining high expectations.
Risk of unintentionally appropriating cultural elements	Ensure genuine, respectful inclusion of cultural elements in the curriculum.
Difficulties in creating deep cultural connections	Celebrate diversity meaningfully and respectfully; consult with cultural community members.
Student-Centered Pedagogy	
Difficulty in using open-ended questions or allowing student choices	Coach mentors to ask deeper questions; provide sample prompts in materials.
Premature intervention that limits productive struggle	Let mentors experience struggle during coaching to model best practices.
Reverting to lecture-style teaching	Run exploration-based activities during coaching for mentors to experience.
Content Knowledge	
Fear of exposing mentors' own misunderstandings	Destigmatize mistakes during coaching; create a supportive environment for intellectual risks.
Limited content knowledge, hindering differentiation	Provide additional online teaching resources for mentor support.
Imbalance between technical and informal language	Recommend starting with informal language, then transitioning to technical terms.

2. **Weekly homework:** Online assignments to familiarize mentors with math content and pedagogy, emphasizing the importance of productive struggle and centering youth in the learning process
3. **In-person coaching sessions:** Weekly workshops focusing on key mathematical concepts and CRT practices, including activity practice and engagement strategies
4. **Reflection assignments:** Weekly prompts encouraging mentors to connect coaching insights with their mentoring experiences
5. **Follow-up meetings:** As-needed sessions providing individualized feedback based on observations

Additionally, we involve mentors in co-developing curriculum activities that integrate culture or social justice into mathematical tasks.

Culturally Responsive Teaching for Youth Development

This article outlines a framework to enhance cultural responsiveness in high-quality afterschool STEM programs. Anecdotal evidence suggests that implementing this framework leads to positive outcomes for mentors and youth alike. To quote one mentor:

> I loved and cherished this program, and I hope to be back in Spring! This program exudes with passion for educational equity, culturally responsive learning, and care. The students are always first, and always valued in every aspect of the lessons. This really resonated with me, as an aspiring teacher with similar values!! The staff are absolutely wonderful, encouraging, extremely helpful, and always looking to improve to be the best they can be. I am so so grateful I participated in this program, for the connections I made with the students and staff, and for my own growth as a future educator :) THANK YOU!

Math CEO was developed as a university-community partnership focused on mathematics. However, the CRT framework can be applied broadly to increase social-emotional learning support in informal STEM education. We are currently working to assess its effectiveness more rigorously.

We conclude with recommendations for successfully implementing the CRT framework across its three domains:

- **Program structure.** Make efforts to support CRT unequivocally through organizational principles and actions. The organization should clearly communicate expectations and provide comprehensive support through coaching materials, training, and informal interactions.
- **Curriculum design.** Incorporate and clearly describe CRT practices within the curriculum. This approach ensures that culturally responsive experiences are built into activities from the outset, rather than relying solely on mentors to activate them.
- **Pedagogical practices.** Regularly observe mentors' interactions with young people to identify emerging CRT practices. Integrate exemplary practices into future curriculum and program structure modifications.

Successfully implemented, this CRT framework has the potential to make afterschool STEM programs more relevant, meaningful, and respectful of historically marginalized young people, fostering positive youth development.

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It Takes a Network

How to Scale Up an Afterschool STEM Program

Pendred Noyce, Laura Martin, Jacob Sagrans, & Jan Mokros

Quickly disseminating an innovative, timely afterschool program raises challenges, from recruitment and professional development to assessment, program fidelity, and quality. In this paper, we describe our experience as project developers, trainers, and researchers working with an afterschool network, Imagine Science, to disseminate a middle school club program about epidemic diseases and data. What we learned from working with this network may be useful to others who have created an afterschool science, technology, engineering, and mathematics (STEM) program they hope to spread widely.

At its simplest, scaling up simply means finding ways for a quality educational program to affect significantly more students—increasing both reach and impact (Education Northwest, 2020). Beyond mere counting, a successful scale-up demonstrates fidelity to the program's core principles and leads to improved outcomes for a broad range of students. In out-of-school STEM, scaling typically involves increasing use of a pedagogical approach or a particular curriculum.

Professional development for the frontline staff who work directly with children is crucial to any

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scale-up effort. One common strategy is a train-the-trainers model, in which lead trainers prepare a cadre of teacher–leaders or professional developers to present an innovative approach to large numbers of practitioners. While this strategy is cost-effective, it may lead to dilution if fewer practitioners than expected implement the new approach. For example, one study notes that, after a train-the-trainer intervention, one-third of the trained Girl Scout troop leaders reported no changes in their practice (Lingwood & Sorenson, 2014). The authors did not discuss what support local supervisors gave to troop leaders.

Ongoing support may be crucial to realize changes in practice. One approach is to create supportive peer groups. The ACRES program (Afterschool Coaching for Reflective Educators in STEM) offered an intensive, in-place approach to changing pedagogical practice in which small groups gathered in person or online for instruction in strategies, along with discussion, mutual observation, and mentoring (Peterman et al., 2021). Each learning module included six hours of coaching as participants applied the module's principles to their own afterschool setting (Peterman et al., 2021). This cost-effective approach supported pedagogical change in instructors across distances too great to allow repeated in-person training.

A third approach can be found in the Planets project (Clark et al., 2021). This project designed professional development resources as tiered support, addressing afterschool educators' immediate needs, STEM content and practices, pedagogy, and activity extensions. Project leaders found that helping educators understand the basic science of the project facilitated fidelity of implementation of the activities (Clark et al., 2021).

Whatever the approach to professional development, a perennial challenge for scaling is that the impact of staff development may be lost when staff turns over. When new staff members need to learn a new program, the rate at which the program reaches additional young people slows down. Afterschool and summer sites tend to experience a high rate of turnover due to low pay and the fact that many positions are temporary (Education Northwest, 2020). The result is pressure for staff development to be quick and simple. Sites are rarely in a position to invest much money or time in professional development for staff who may be available to work for only one season. Click2Science addressed this problem by offering short, just-in-time online modules to teach specific skills in afterschool science education, such as setting up the room and asking open-ended questions (Fenton et al., 2019). Although there is evidence that use of Click2Science increased program quality, the modules address generic afterschool science skills, not specific curricula (Fenton et al., 2019).

A challenge (as well as an opportunity) in scaling up change is the fact that, in *adopting* a program, sites need to *adapt* the program's educational experiences to their particular environments, including their staffing, schedules, and facilities. A project called Philadelphia Playful Learning Landscapes (Perlman Robinson, 2019) sought to transform varied spaces into learning opportunities for children outside of school. The project identified "scaling building blocks" that contributed to the success of the project. These scaling strategies, which brought in community players from many levels, included cultivating leadership, forging alliances among institutions and nonprofits, sharing data, and encouraging flexibility at sites (Perlman Robinson, 2019).

In examining the role of afterschool programs in STEM education, the Afterschool Alliance (2015) offered a recommendation to "strengthen partnerships between the larger STEM education community and afterschool programs to advance practice and policy" (p. 18). Similarly, the Wallace Foundation (Kauh, 2011) found that strong networks across communities, led by a coordinating body, were key to success. In afterschool STEM, *networks* often refers to the state networks coordinated by TIES (Teaching Institute for Excellence in STEM). In this paper, however, we use *networks* more broadly to refer to any bodies or organizational structures that encourage communication, a sense of membership, commitment to similar goals, coordination, and common learning among service providers. Perlman Robinson (2019) uses the term "landscapes" and Kauh (2011) uses the term "systems" to refer to similar community-based support structures. Relationships between networks and researchers have also been found to support effective programming (Ferinde, 2022). Such approaches support the adoption of new practices in multiple settings with adaptations to existing strategies and plans.

In sum, components of innovative projects that successfully reach scale within the constraints of afterschool settings include a strategy for staff training

that takes turnover into account with short, basic training modules; materials and activities that can be adapted to different settings through STEM content, practice, and pedagogy; the availability of support for individual program facilitators; and coordinated support networks across communities that are working toward the same outcomes. Data Detectives Clubs, the program we created and evaluated, addressed these components of successful scaling.

The Program: Data Detectives Clubs

During 2020, we created a program of engaged learning called COVID-Inspired Data Science Education through Epidemiology (CIDSEE) to help middle school youth understand data and learn from COVID-19 and other pandemics. Focusing on the epidemiology of infectious disease and centering on real data, the program included an adventure novel, technology tools, and hands-on activities brought together in a club format called Data Detectives. Because neither data science nor epidemiology is usually taught in schools, we elected to offer the 15-hour curriculum through afterschool programs.

The goals of the CIDSEE project (locally called the Data Detectives program) were to:

1. Increase participants' confidence, interest, knowledge, and skills in using datasets and data tools to address understand pandemics like COVID-19
2. Spark youth interest in the data-driven work of epidemiology and affiliated STEM occupations, including research, modeling, data analysis, and science communication
3. Serve at least 400 underserved youth over three years

Funded by a grant from the National Science Foundation, the Data Detectives Clubs intervention comprised:

- An 11-chapter adventure book that takes youth to different times in history and places in the world where outbreaks and pandemics have occurred
- A 15–20 hour curriculum including reading time, hands-on activities, and discussion
- An 80-page facilitator's guide to understanding the content and conducting the program
- Four to six hours of facilitator training
- Use of special free software including Concord Consortium's CODAP, which allows users to graph the relationships among variables, and NetLogo, which shows contagion patterns in populations with different vaccination rates, population density, and other inputs that users can manipulate
- Access to a Padlet (an app that collects in one place all the links needed for the program), slide decks, and two-minute animations on selected topics and activities
- Hands-on activities ranging from testing samples of liquid for contamination to playing kazoos to follow the up-and-down curves of time-series graphs
- [a] Virtual visits by a person working with data in health or another field
- [a] Participation by youth and facilitators in surveys and interviews

Scaling issues included how to manage limited staff time and knowledge, how to adapt activities for different sites, and how to encourage contact among peers and community organizations. We sought to address these issues by training facilitators to implement the program. Training sessions, conducted remotely, consisted of review of the facilitator's guide, which outlined lessons and activities; small-group practice with the project software; and discussion of the project's science concepts and of social-emotional topics as they applied to program participants. STEM content and practices, pedagogy, and activity extensions were all part of the training plan. Thanks to periodic check-ins and follow-up training when requested, the trainees, who came from different partner cities, formed a community of practice with the project staff.

The greatest adjustments we made in response to trainee feedback over the course of the project revolved around the use of the CODAP graphing tool. We added hands-on exercises for facilitators to complete before training, spent more time to emphasize CODAP during the training, and created short step-by-step videos highlighting specific CODAP features. Club facilitators could refer to these videos to refresh their knowledge at any point during the program.

As an incentive for afterschool programs to weave together all these elements and persist through data collection, we offered each club a stipend of $1,500, paid at the conclusion of the curriculum unit. Despite this incentive, we found that organizing calendars and communicating expectations and data collection needs club by club, with the goal of reaching at least

400 youth, was a daunting prospect. To make the scaling task manageable, we decided to work with Imagine Science.

The Network: Imagine Science

Launched in 2015 after 18 months of planning, Imagine Science is a collaborative initiative undertaken by four major youth-serving organizations: Boys & Girls Clubs, 4-H, YMCA-USA, and Girls, Inc. Its mission is to build excitement and confidence in young people from low-income communities in pursuing STEM careers. It brings innovative, hands-on STEM programming to the hardest-to-reach youth in cities where all four organizations have a presence. As the network launched, the four Imagine Science partners carefully selected cities or regions for their initial programming. In each candidate location, across six states, Imagine Science's small staff reached out with questions about the community and built ownership among the various youth clubs and afterschool programs. The process of becoming an Imagine Science community partner generally required a year of planning, after which the partner received three years of modest start-up funding. Selection criteria for all Imagine Science partner cities (currently 19) are:

- Each city must have clubs affiliated with at least one of the four major youth-serving organizations.
- The city and each member club need to have at least some STEM work in development.
- Local leaders need to be strong, committed to STEM, and committed to sharing funding and impact data.
- Each partner city must embrace the call for substantial professional development and continual assessment for improvement.
- Each city's sites serve a high proportion of youth challenged by poverty, minority status, or limited English proficiency.
- Programs offered are not drop-in programs; youth are expected to attend continuously over each season.

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Imagine Science did a remarkable job of holding partner communities to these principles. From inception through summer 2021, when it began to implement Data Detectives Clubs, partner cities met the target population criterion: Of the young people served, 58 percent were girls, 89 percent youth of color, and 83 percent youth from low-income households. At the end of each season, clubs surveyed their participating students and many of their instructors using the Common Instrument Suite (Noam et al., 2020). Results were shared at an annual "Harvest Session" attended by one individual from each club in each partner city. Attendees examined data from their own city and from Imagine Science as a whole; then, together, they discussed how to strengthen their offerings. In this way, Imagine Science became a network with shared goals, strategies, and commitments, such as the commitment to continuous program improvement.

For the Data Detectives Clubs, Imagine Science provided primarily logistical support, helping to recruit, screen, troubleshoot, and monitor the partner cities that implemented the program. Problems affecting Imagine Science community sites at baseline, before they implemented Data Detectives Clubs, were similar to those of all afterschool programs. Staffing was a challenge before, during, and after the pandemic. For many curricula and activities, club facilitators had little access to training. Despite close monitoring by Imagine Science staff, in some cities not all institutional partners displayed equal commitment. Plans for sustainability after three years of start-up funding from Imagine Science ran out were sometimes difficult to implement.

Nevertheless, being part of a network meant receiving support and advice from other community sites. The Imagine Science manager was so available to partner city leaders as to sometimes seem ubiquitous. Optional one-hour quarterly whole-network calls allowed partner cities to discuss common issues such as scheduling, staff changes, or attendance. Cross-organization and cross-state friendships originating from the annual Harvest Sessions offered

another channel of friendly support; for example, leaders shared strategies for supporting youth in the reading expected in Data Detectives Club. Follow-up discussion groups with club facilitators showed that sharing information among clubs and cities was viewed as a valuable aspect of the project.

How Imagine Science Scaled Up Data Detectives

There is no mandatory curriculum for Imagine Science, but sharing curricula has been one of the most common ways Imagine Science partner cities collaborate. In 2021, partner cities expressed a desire for more training on specific high-quality curricula. The Data Detectives program offered a detailed curriculum accompanied by four to six hours of specific professional development for club facilitators. The project also offered recorded online tutorials on use of the technology tools.

Communication and Coordination

Communication between the partner cities and the Data Detectives program developers came about both through the Imagine Science coordinator and through the group evaluating our training and support for clubs, Strategic Learning Partners for Innovation. Feedback led us to increase professional development time for the technology tools and to create an audiobook version of the book for struggling readers. It also convinced us that partner city leaders did not have the time or clout to schedule their own career visitors, so the development team took on that role.

A strength of local clubs was their ability to adapt the program to children's needs; club facilitators often lived in the communities where they taught. Partner sites varied in their implementation of scheduling, hands-on activities, and discussion topics. For example, in communities that had lost members to the pandemic, facilitators spent extra time discussing the social and emotional effects of COVID. Facilitators also exercised caution—and asked for advice—when discussing and modeling the effect of vaccination on disease spread. Some parents expressed concerns over the vaccine chapter, but none removed their children from the clubs. The enthusiasm and dedication of the program facilitators more than made up for any gaps in their science preparation.

Partner sites varied in their implementation of scheduling, hands-on activities, and discussion topics. For example, in communities that had lost members to the pandemic, facilitators spent extra time discussing the social and emotional effects of COVID.

Not every Imagine Science city took on Data Detectives. Based on her familiarity with the organizations and their leaders, the Imagine Science program coordinator helped identify cities that had the capacity to undertake a complex program. The coordinator publicized the program, selected cities, coordinated with us to schedule professional development, and monitored the cities' progress through frequent phone calls. These regular contacts served as a way of monitoring adherence to the curriculum. The curriculum, however, was flexible: Activities related to the book chapter topics could be offered in different order or skipped if clubs were facing limited time. Time with the computer modules and their extensions was also flexible. The coordinator gathered demographic and attendance data from the partner cities, helped to coordinate the career visits, and made certain that partner cities administered and turned in the end-of-program surveys. As a result of her diligence and the enthusiasm of the partner cities, Data Detectives reached approximately 1,000 youth, more than twice our goal, in the project's first three years.

As we reached out to new cities, those that decided not to participate cited a lack of background among staff, a younger youth population than was optimal, or lack of an administrator to oversee the program.

Training

Our training workshops connected us with facilitators over the life of the project and informed our ability to grow the number of partner cities involved. We consistently took comments and critiques into consideration as we revised the workshop for delivery to new partners.

Feedback on the training began with a survey of all participants and continued with focus groups and interviews with selected facilitators. In the survey on the first year's workshops, 12 of 17 respondents rated the training experience as "very effective." Similarly, most participants reported the work-

shop made them feel excited about running the Data Detectives Club. Areas that received lower effectiveness ratings were preparing youth to make career connections, additional technology skills needed for implementation, and preparing the program for implementation with youth. These considerations were incorporated into subsequent training sessions.

A year later, a focus group of four facilitators who were also school STEM teachers discussed the potential for using the curriculum in schools. The teachers liked the program very much and discussed how it might be integrated into formal middle school instruction. They noted that finding space in the school curriculum for new units is difficult. However, they agreed that, where teachers had flexibility to, for instance, implement interdisciplinary studies, project-based learning, integrated STEM classes, or structured units, Data Detectives would be an asset. They felt the club approach would be appropriate for beginning teachers working in interdisciplinary school programs, such as those that combine science, mathematics, and reading.

Finally, in 2023, we interviewed seven new facilitators. All said that they loved the training. They found the facilitator's guide particularly useful; one said that it was "awesomely organized." The interviewees reported that they felt supported by the materials and the training. Over time, the training became an important factor in extending the reach of the project because it responded to facilitators' needs, allowing more partner cities to successfully deliver the program.

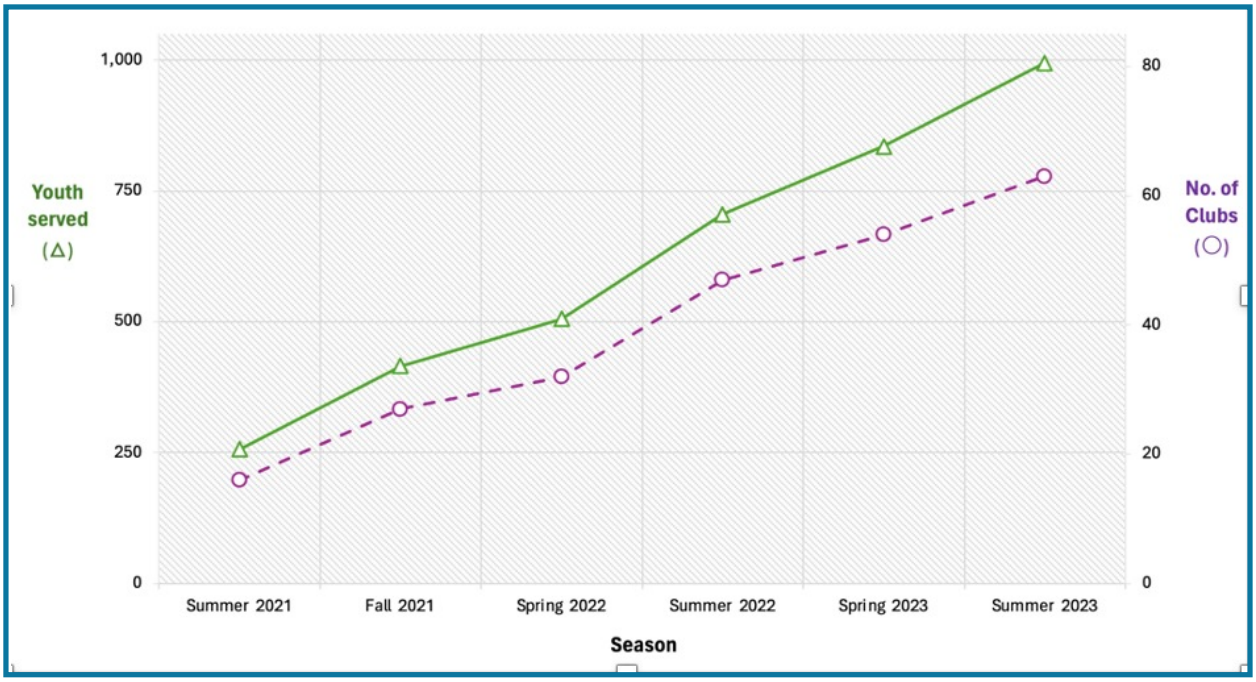
Figure 1 shows the growth of Data Detectives in terms both of young people served and of participating clubs. The number of Imagine Science partner cities implementing the program increased from six in summer 2021 to 19 in summer 2023.

Results of the Collaboration

The emphasis Imagine Science placed on evidence-based practice, data collection, and sharing through annual Harvest Sessions created a culture of openness and curiosity about data. More concretely, Imagine Science staff played an invaluable role in facilitating data collection, with repeated reminders to partner cities about scheduling surveys and reporting demographic and attendance data. This persistence allowed our assessment partner, Partnerships in Education and Resilience (PEAR), to derive robust findings from the intervention.

PEAR administered the Common Instrument Suite (Noam et al., 2020), a validated self-rating tool for youth in afterschool programs. The survey invites participants to rate how their attitudes have changed from the beginning of the program to the end with respect to STEM engagement, identity, and

Figure 1. Data Detective Scale-up: Clubs and Youth



career interest. To these validated scales, we added 14 customized questions to study engagement, identity, and career interest and general interest in data science and epidemiology topics, as well as attitudes toward reading and understanding of the community impact of data science. The surveys were administered to 647 youth participating in the program between summer 2021 and summer 2023.

Results showed that youth demonstrated statistically significant positive changes on all three scales of the PEAR-validated survey. PEAR compared the Data Detectives data to its national convenience sample of all 7,377 elementary and middle school youth who took the retrospective pre-post Common Instrument Suite (Little et al., 2020) through summer 2020. Data Detectives participants had higher growth rates than the comparison group on all three scales, as shown in Figure 2. There were no significant differences among participants of different ages, grades, genders, races, or ethnicities; length of participation also did not correlate with growth rates. Data Detectives participants also showed positive changes on the 14 custom survey items, including questions about data science identity, epidemiology career interest, perceptions of community impact of science, science story engagement, and the extent to which reading science stories prompted curiosity about science. We detailed research on students' learning specifically about time-series data in a separate recently submitted paper (Mokros et al., 2024).

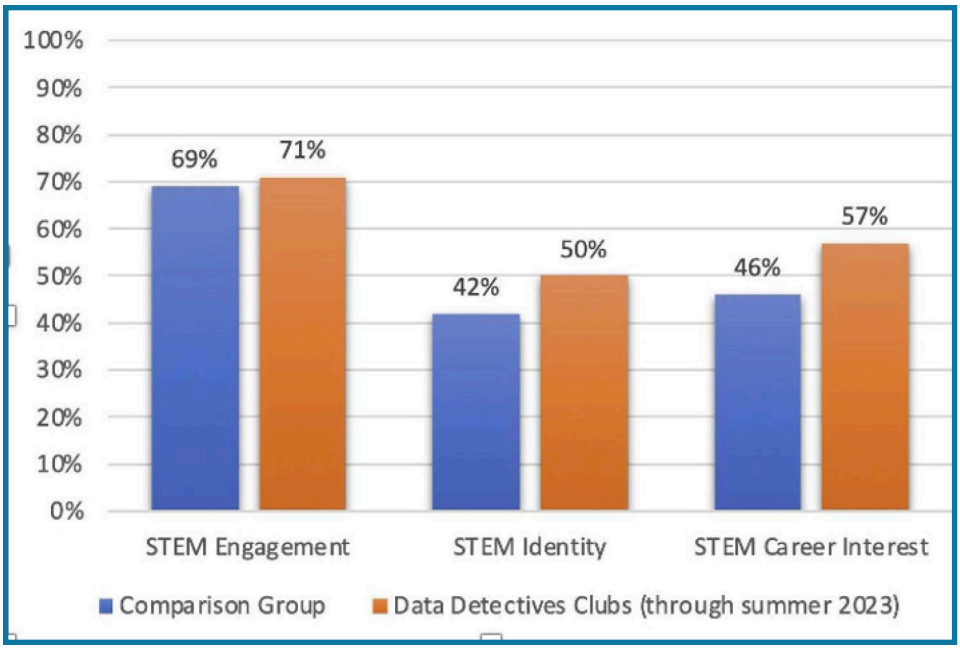
During the scale-up, we occasionally fielded expressions of interest from afterschool clubs and programs that were not part of the Imagine Science network. We tried to be responsive to requests, providing both materials and training. However, we found that unaffiliated sites, even when they had science specialists on staff, had trouble achieving consistent youth attendance, completing the program in the face of competing priorities, and providing data. Through spring 2024, 12 unaffiliated clubs completed the curriculum, and three were cancelled. In contrast, Imagine Science clubs had 56 completions with only one cancellation. Without the support of a network of peers and the Imagine Science program coordinator, program staff tended to revert to their usual afterschool programming.

For more information on Data Detectives Clubs, visit https://tumblehome.org/.

The Importance of Afterschool Networks to Curriculum Scale-up

In 2020 and 2021, with schools closed and out-of-school time programs scrambling to meet children's needs, we felt a special urgency to pilot, improve, and disseminate our Data Detectives curriculum. Our technological and scientific partners helped us continually update program content. However, it was our work with Imagine Science that allowed us to meet and exceed our scale-up goals. Perhaps the most important factor was that, even before implementing this new curriculum, members of the network had already committed to the idea of high-quality science programming and to common principles of professional

Figure 2. Participant Growth in STEM Engagement, Identity, and Career Interest



development, assessment, data gathering, and continuous improvement.

The process of applying to implement Data Detectives required partner cities to commit to a set of expectations for staff attendance at training, for completion of the program, and for data collection. The enthusiasm of administrators and their support for front-line facilitators helped overcome issues such as managing schedule conflicts, supporting students for whom reading was a challenge, or handling the diversity of students' skills. None of the progress outlined in this article could have happened without the organizational structure of the Imagine Science network and the close two-way communication between the network coordinator and individual partner cities. Working through a network that shared common goals and commitments allowed the program developers to focus on improving the offering while the network attended to encouraging partner cities to implement the curriculum with fidelity even as they made necessary adaptations.

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Key Features of a Successful Girls' Afterschool STEM Program

Participant Insights 30 Years Later

Lili Zhou

Out-of-school learning contexts provide rich opportunities for authentic and experiential learning, connecting learners with real-world experiences and allowing them to explore socialization into their collective identities, such as gender, race, and the intersection of the two (e.g., Cooper, 2011). However, one challenge lies in the variability of informal educators' expertise and vision. The qualifications and experience of informal educators can vary widely, and limited research exists on their professional competencies, the pedagogical approaches they use, or the long-term vision they bring to programs (Allen & Crowley, 2014; Jeffs & Smith, 2021).

Afterschool science, technology, engineering, and mathematics (STEM) programs often include interventions such as exposure to role models, hands-on activities, and single-sex learning environments to foster learners' interest in STEM (e.g., Ennes et al., 2020; Holmes et al., 2012; King & Pringle, 2019). Research has shown that participation in these programs can effectively boost students' interest and confidence in STEM subjects (e.g., Chen et al., 2011; Chittum et al., 2017; Zhou et al., 2025).

Despite the success of informal STEM programs, one ongoing challenge is sustaining learners' interest beyond the programs' initial impact (Morris et al., 2019). Although some longitudinal studies suggest

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that such programs can have a lasting impact on girls in STEM (e.g., McCreedy & Dierking, 2013), further research is needed to identify the distinctive features of successful programs that create meaningful and enduring change.

The present study seeks to address this gap with a retrospective exploration of the experiences of the first cohort of participants in a longstanding girls' STEM program, Girls Excelling in Math and Science (GEMS). In interviews and focus groups, women now in their 40s described their experiences in the program 30 years ago. The study is guided by the research question: *What distinctive features of GEMS as an informal learning environment emerge from the retrospective narratives of the original participants?* Guided by sociocultural theory, I used thematic analysis to unpack participants' narratives to reveal three key features of the program. The study provides actionable insights for designing effective afterschool programs and informal learning opportunities to engage girls and learners from historically underrepresented communities in STEM fields.

Sociocultural Theoretical Perspective

The study is framed by Vygotsky's sociocultural theory, which emphasizes the social environment as a facilitator of development and learning. Vygotsky (1978) recognized the importance of instruction and assistance in learning and viewed instruction as a social practice to guide learning. Sociocultural learning theory emphasizes social participation, collective learning, and culturally relevant activities.

Building on Vygotsky's work, Rogoff (1990) expanded the understanding of teacher-student communication by incorporating emotional and nonverbal forms of interaction, exchanging daily life experiences, and engaging students in personally relevant activities. Rogoff introduced the concept of "guided participation," where adults or peers challenge, constrain, and support children in posing and solving problems. This process involves both interpersonal communication and material arrangements of activities and responsibilities. In addition to interpersonal interactions, Leont'ev (1974) emphasized the importance of interactions with activities themselves. Participation in activities mediates students' cognitive development, shapes their learning processes, and determines their outcomes.

The sociocultural theory underscores the critical role of both interpersonal and activity-based interactions in fostering meaningful learning experiences. Guided by sociocultural theory, this study seeks to explore the features of GEMS as a learning environment that fostered social interactions and engaged students through various activities. By analyzing participants' reflections and past experiences, the study explores how these features contributed to the program's long-term impacts. Retrospective accounts offer a unique lens for understanding how social and cultural factors shape learning over time, providing insights that may not be immediately visible in real-time observations. This approach aligns with sociocultural theory by capturing how learners interpret and make meaning of past interactions.

The sociocultural theory underscores the critical role of both interpersonal and activity-based interactions in fostering meaningful learning experiences.

Context

Girls Excelling in Math and Science (GEMS) is an informal STEM program initiated in 1994 by a mother, Laura Jones, and her daughter's teacher, Ms. Cooper (a pseudonym), with the goal of fostering girls' confidence in mathematics and science. In GEMS's inaugural year (1994–1995), more than 40 fifth- and sixth-grade girls joined the program through teacher recommendations, parental requests, or voluntary enrollment. As the program's leaders, Laura and Ms. Cooper attended educational workshops, sought out professional development opportunities, and explored resources from the internet and library. Besides using existing activities like Möbius strips and chromatography, they also developed their own activities, such as coding, designing mazes, dyeing shirts, and more (Jones, 2002a, 2002b). Over time, they added more science, engineering, and technology activities.

Laura completed two reports, in 1997 and 2002, to examine the impact of the GEMS on the original GEMS girls (OGGs) who attended during the inaugural year. The findings from both reports were

documented in her unpublished thesis (Jones, 2002a). The first report, in 1997, focused on feedback from girls, parents, and classroom teachers. The results were positive and encouraging; teachers noted increased interest in math and science among the girls. The second report, in 2002, investigated the OGGs' high school course selections and career interests. A survey of 41 OGGs showed that the OGGs were more likely than their peers to enroll in advanced technology, mathematics, and science courses.

Laura's unpublished reports serve as a foundational reference for this study. My study shifts focus from evaluating outcomes to understanding the OGGs' experiences with GEMS as a learning environment. It delves into the OGGs' retrospective narratives, exploring what they remember about their participation and how they interpret those experiences as adults.

Methods

In 2018, Laura partnered with my doctoral institution to expand GEMS's reach. As a research assistant, I collaborated with Laura to establish new GEMS clubs, design activities, and conduct program-related research (Zhou, 2024). This article is part of a larger project aimed at examining the long-term impacts of GEMS on its participants.

Participants and Data Sources

With assistance from Laura and her daughter Janet, who is an OGG, 25 OGGs were invited to participate in our survey. The survey asked about respondents' educational backgrounds, careers, and memories related to GEMS, among other aspects. Seventeen OGGs responded to the survey, but three surveys were left incomplete. Of the 14 OGGs who completed the survey, 12 identified as White, one as White and Black or African American, and another as White and Hispanic or Latinx. All participants in this study are identified by pseudonyms.

All 14 OGGs had completed a college degree; six held master's degrees, and one held a doctoral degree. Four of the 14 OGGs had pursued STEM majors at some point, while 10 had not. Two of the 14 participants were currently working in STEM fields; the remaining 12 individuals did not mention any STEM-related experience. Additionally, 10 of the 14 OGGs reported that they were mothers.

Nine OGGs, all of whom identified as White, participated in subsequent interviews. I grouped participants by common experiences from survey responses: working in the same field or being a mom. The result was three focus groups consisting of four, three, and two OGGs. The focus group interviews had three goals: introduce the study purpose, establish rapport and trust, and provide an opportunity for the OGGs to recall collective GEMS memories. Following the focus groups, semi-structured individual interviews were conducted with the nine OGGs. We used insights from the focus groups to tailor questions to individual participants in order to prompt their memories. The questions adapted and grew through dynamic exchanges during the interviews.

Data Analysis

This study employed thematic analysis to explore participants' retrospective narratives (Braun & Clarke, 2006; Clandinin & Connelly, 2000). Using sociocultural theory as the guiding framework emphasizes the critical role of interpersonal interactions, activities, and cultural contexts in shaping learning experiences. This framework informed the coding process and interpretation of themes, enabling a deep understanding of GEMS as a learning environment.

The analysis process consisted of three stages. First, I carefully reviewed both the survey and interview data to identify information relevant to participants' experiences in GEMS. In the second stage, I conducted an iterative coding process, categorizing the data into meaningful units and identifying patterns that emerged organically from the data. This inductive, data-driven approach ensured that themes reflected OGGs' authentic experiences. In the third stage, guided by a sociocultural theoretical perspective, I synthesized the identified patterns into overarching themes, offering a comprehensive understanding of participants' experiences of GEMS.

Outstanding Features of GEMS

The analysis of participants' retrospective narratives, guided by sociocultural theory, revealed three key features of GEMS: social engagement as a foundation for learning, activities as a catalyst for learning, and the enduring influence of GEMS. These features, which remain as relevant now as they were 30 years ago, provide valuable insights for today's afterschool initiatives.

Social Engagement as a Foundation for Learning

Social engagement was a foundation of the GEMS program, fostering a supportive and inspiring environment that empowered participants and enhanced their learning experiences. Through meaningful interactions with leaders and peers, participants built confidence, curiosity, and a sense of belonging.

Inspiring Leaders

Laura took the initiative to establish GEMS with the primary goal of supporting her daughter, Janet, and other girls in learning mathematics and science. Laura's dedication to GEMS spanned an impressive 30-plus years. Janet recalled how her mother played a pivotal role in creating GEMS, providing a comfortable and nurturing environment:

> I think it started when [Laura] took me to a magnet school, and I told her that math was hard. I don't remember all the details, but suddenly she was creating this math and science club for girls. For me, it just felt natural—I went along with it, and it gave me more time to spend with my mom and my friends.

Janet's teacher, Ms. Cooper, collaborated with Laura as a co-leader of GEMS. Many OGGs shared that they chose to participate in GEMS specifically because of Ms. Cooper. May said:

> Ms. Cooper was my favorite teacher—her enthusiasm for every lesson or activity made learning exciting. She had such a love for the subject that it made you feel excited too. I still remember how she always brought pie on Pi Day!

Cassy added, "Ms. Cooper helped us to learn. She taught in ways that helped almost every student understand." Stella expressed appreciation for Ms. Cooper's teaching style: "Ms. Cooper was a visual storyteller. When she taught math and science, she used visuals a lot."

Creating an engaging learning environment like GEMS requires strong leadership. Effective leaders must have a clear vision to set specific goals, ensuring that activities and initiatives align with the program's objectives. Moreover, the GEMS leaders' expertise in pedagogy and understanding of student dynamics not only guided the content but also inspired a passion for learning among participants.

Through meaningful interactions with leaders and peers, participants built confidence, curiosity, and a sense of belonging.

Supportive Peer Community

GEMS created a safe and inclusive environment that fostered collaboration, friendship, and personal growth among its participants. The girls-only setting allowed OGGs to freely express their thoughts, ask questions, and share their perspectives without fear of judgment. Many OGGs cherished the experience. In interviews, they emphasized the importance of the girls-only environment, which provided a supportive and understanding space in their pre-teen years:

- "I remember being with my friends and having so much fun."
- "I do remember laughing with my friends every week."
- "I especially loved GEMS because my best friend … went too."

For some, GEMS served as a much-needed refuge. Cindy reflected, "I just remember it being such a positive environment…. Sixth grade was my year of a bully, and this was a safe space for me to interact with positive girls." The absence of boys contributed to a relaxed and pressure-free environment. Elli explained:

> There were no boys, which made a big difference. In sixth grade, that's often when you start worrying about what others think and don't want to answer questions for fear of looking stupid. GEMS felt like a much more relaxed environment, where girls didn't have to deal with that kind of pressure.

In interviews, they emphasized the importance of the girls-only environment, which provided a supportive and understanding space in their pre-teen years.

May contrasted GEMS with traditional classrooms, sharing:

> I felt more comfortable and participated more in GEMS than in a classroom setting. The hands-on, no-grades environment made it fun and relaxed, unlike in class,

where I often kept answers to myself out of fear of being wrong. As a child, those fears are a big deal.

By offering a judgment-free and supportive peer community, GEMS provided the girls with a safe space to build social skills, form meaningful friendships, and gain confidence in learning.

Activities as a Catalyst for Learning

According to Jones (2002a, 2002b) and the OGGs' descriptions, GEMS offered experiments, projects, and activities. OGGs recalled many memorable activities, such as constructing bridges with gumdrops and toothpicks, creating volcanoes with baking soda and vinegar, designing shirts with alcohol and markers, dissecting owl pellets, estimating candy quantities in containers, engaging in simulated stock market activities, and launching rockets fueled by a combination of vinegar and a common heartburn remedy. The activities worked as a catalyst for learning; OGGs described learning through activities as experiential and enjoyable. In addition, hands-on activities provided the OGGs with the opportunity to collaborate. The assessment of these activities differed from traditional classroom assessments, relying primarily on participants' reflections and group discussions.

Experiential Activities

As OGGs recalled their experience in GEMS, they frequently used the words *excited, fun, interesting,* and *engaging* to describe activities, for example:

- "I enjoyed the freedom of kind of playing around—to see what would happen."
- "These activities were fun and entertaining."
- "I remember the feeling of being excited about the activities."
- "I remember enjoying the activities very much and being excited about learning because the activities made it fun!"

May vividly described her complex feelings about GEMS activities:

> I was always excited to dive into a science experiment or math activity. Although I was a bit shy in large groups, I was eager to get started. The leaders would give instructions, and I'd rush over with a mix of anticipation, nervousness, and excitement all swirling together.

Paige elaborated on how the experiential learning in GEMS drew on knowledge gained in school to make connections with real life:

> My math and science experiences in GEMS were more experiential and applied compared to school, where math was mostly about solving problems. GEMS connected those skills to real-world activities, showing their importance and the kinds of problems they could help solve.

OGGs said that the activities in GEMS provided enjoyable learning experiences. These activities empowered the OGGs to become more confident in learning and cultivated their interests in STEM subjects.

Learning without Pressure

The OGGs particularly cherished the noncompetitive and judgment-free environment of GEMS, where there were no grades, no right or wrong answers, and no judgment from other students or teachers. Learning was not driven by the pursuit of grades or competition; rather, it was about the experience, fostering a sense of enjoyment rather than fear of failure. OGGs said:

- "It just felt like a space where we didn't have to worry if our answer was wrong, or something didn't quite work."
- "You can ask questions. There was definitely no stupid question."
- "There's no grade [in GEMS]. You don't fail, you're not yelled at. We're going to just learn this thing for fun."
- "I feel the pressure went away because there wasn't a right or wrong answer—no one was grading."

As OGGs recalled their experience in GEMS, they frequently used the words *excited*, *fun*, *interesting*, and *engaging* to describe activities.

Jess described learning without pressure: "It seemed like play, but you were learning at the same time. It was a lot more comfortable and relaxed because you didn't realize you were learning." Lynda commented, "When you allow kids to learn for the sake of learning, it becomes a completely different

experience." Elli shared, "The hands-on aspect helped me understand concepts better than in a traditional setting of books and tests. You could see how things worked for yourself and understand concepts while enjoying yourself." Lynda added, "It's not just about reading from a textbook—it's more like, 'Set off the volcano and explain why baking soda reacts this way.'" GEMS incorporated hands-on and experiential learning, providing the OGGs with the opportunity to participate actively in their learning.

Enduring Influence of GEMS

Reflecting on their experiences in GEMS over 30 years ago, the OGGs shared how the program left a lasting impression on their lives. They identified several long-term impacts, including significant contributions to their personal growth, career choices, and ongoing perspectives on gender equity in STEM.

Building Confidence

The OGGs noted that GEMS changed them as individuals. One OGG stated, "I do believe it gave me more generalized confidence in my math abilities." Another added, "GEMS helped me realize my potential." Elli expressed, "Although I didn't go into a math or science field, I believe that was an opportunity as a young girl to do something outside of my comfort zone."

Several OGGs shared how GEMS reshaped their perceptions of their abilities, particularly in mathematics. Stella, for instance, struggled with mathematics before GEMS. "I had always been awful at math," she said. "GEMS made me think that math wasn't as scary. I learned that I understood applied math in a way that I didn't get from memorizing times tables." Stella attributed her career choice, which allows her to merge her passion for sciences with her natural communication abilities, to the encouragement she received at GEMS:

> I think GEMS had a huge impact on encouraging people because, prior to GEMS, I had assumed, based on my past performance, that I would be a writer or something like that. I ended up in the technical world, where I could merge both my love of the sciences and my natural communication abilities.

These reflections underscore the long-term impact of GEMS, demonstrating how the program nurtured participants' confidence, broadened their perspectives, and influenced their personal and professional lives.

Inspiring the Next Generation of Girls in STEM

The impact of GEMS extends far beyond the original participants, as many OGGs have carried the program's commitment to empowering girls and women into their present lives and attitudes. Although only a small number of OGGs entered STEM fields, their experiences in GEMS have had a profound influence on many OGGs' attitudes toward gender equity and STEM education. For instance, Kate shared that the confidence she built in GEMS enabled her to feel comfortable even in male-dominated college courses. Another OGG reflected, "I am very mindful of gender stereotypes and how they impact females' beliefs about themselves and their abilities in math and science." This awareness demonstrates how GEMS inspired participants to challenge societal norms and support gender equity in STEM.

Janet's involvement with GEMS went beyond her years as a participant. She later assumed a leadership role, sharing, "I left GEMS when was in middle school. In high school, I would come back to help with activities as well as lead a session or two at the yearly conferences."

Stella actively contributes to supporting girls in science through professional mentoring and volunteering. She shared:

> I give back a lot to girls in the sciences. I also spend a lot of time professionally mentoring girls in science. I volunteer with Girls Who Code to teach girls how to code. We have an organization at our company called Built by Girls that does a lot of outreach work for women in STEM.

. "I had always been awful at math," she said. "GEMS made me think that math wasn't as scary. I learned that I understood applied math in a way that I didn't get from memorizing times tables."

Stella's dedication exemplifies how the values instilled in GEMS continue to inspire outreach and advocacy for women in STEM fields.

Additionally, many OGGs, now mothers, expressed a desire to provide their children, especially daughters, with opportunities similar to those they experienced in GEMS. Paige shared how the program inspired her to actively engage her daughter in STEM-related subjects: "I role-play a broad range of jobs with my daughter as well—astronauts, doctors, architects, in addition to family, princess, et cetera. I will be actively seeking out opportunities to engage her in these subjects as she grows older."

Practical Implications

This study highlights the enduring impact of GEMS on its participants, particularly in fostering confidence, nurturing interest in STEM, and promoting gender equity. The findings not only emphasize the unique features of GEMS but also offer practical suggestions for designing effective afterschool programs and informal learning opportunities to engage students in STEM fields. By drawing on sociocultural theory, this study underscores the role of relationships and hands-on activities in shaping participants' STEM engagement and learning experiences.

Creating Supportive and Inclusive Environments

One of the key features of GEMS was its ability to create a supportive and inclusive environment through social engagement, where participants felt safe to express themselves and collaborate without fear of judgment. The girls-only setting played a pivotal role in fostering this sense of belonging, enabling participants to build confidence while inspiring meaningful learning. These insights align with previous literature suggesting that afterschool programs can benefit from establishing environments that are free from competition and promote collaboration (Cooper, 2011). Afterschool and informal learning initiatives that design spaces to prioritize emotional safety and inclusivity reduce stresses that can hinder participation, particularly for underrepresented groups. Moreover, single-gender or small-group settings like GEMS, especially in STEM fields, encourage active participation and mitigate societal stereotypes.

Passionate and supportive leaders are central to the success of informal STEM programs (Allen & Crowley, 2014; Jeffs & Smith, 2021). In GEMS, Ms. Cooper and Laura played a crucial role in designing the program, connecting with participants and tailoring teaching approaches to meet diverse learning needs. Other informal learning contexts can replicate this success by training informal educators and mentors to adopt culturally responsive teaching practices and foster sustained engagement for STEM learners.

Emphasizing Experiential and Hands-On Learning

Research consistently highlights the importance of experiential, hands-on activities in making learning enjoyable and relevant (Morris et al., 2019). Activities such as building models, conducting experiments, and simulating real-world scenarios help participants connect classroom learning to tangible applications (Chittum et al., 2017). GEMS's experiential approach not only deepened understanding but also cultivated curiosity and enjoyment, making the subjects accessible and exciting.

Consistent with previous studies (Ennes et al., 2020; Holmes et al., 2012; King & Pringle, 2019), the OGGs' retrospective reflections on their GEMS experiences highlight the importance of prioritizing hands-on, project-based activities in afterschool and informal programs to connect STEM concepts with real-world problems and applications. Collaborative tasks can enhance teamwork skills and foster meaningful social connections among participants. Additionally, moving beyond traditional assessments by using reflections, self-reporting, or group discussions can enable evaluation of learning in a low-pressure and supportive environment.

Fostering Long-Term Impact and Advocacy

The long-term influence of GEMS is evident in participants' personal and professional lives and their dedication to advancing gender equity in STEM. Examples like Janet and Stella demonstrate how mentorship can create a cycle of empowerment, enabling participants to

The long-term influence of GEMS is evident in participants' personal and professional lives and their dedication to advancing gender equity in STEM.

become advocates and role models for others. Many participants carried the values instilled by GEMS into their careers, parenting, and advocacy efforts, highlighting the potential for informal learning programs to spark enduring change. This study highlights the importance of creating opportunities for participants to see themselves as doers and active contributors to STEM fields.

To maximize the long-term impact of informal learning, programs must encourage participants to take leadership roles, fostering a sense of ownership and responsibility. Programs should also provide opportunities for participants to connect their in-school and out-of-school mathematics experiences, fostering a more integrated understanding of the subject and reinforcing its relevance to their lives (Zhou et al., 2025). Furthermore, incorporating elements that challenge societal norms and stereotypes can promote confidence and resilience, especially among underrepresented groups in STEM (Chittum et al., 2017).

Advancing Equity in STEM

GEMS demonstrates that informal learning environments can serve as critical spaces for engaging underrepresented populations in STEM. Drawing from participants' retrospective experiences over 30 years, this study's findings show that GEMS fostered confidence, curiosity, and a sense of belonging. This work illustrates the potential of supportive and inclusive programs to address systemic barriers that often hinder participation in STEM for students from historically underserved communities.

The study provides practical guidance to help educators and program leaders design equitable and impactful informal learning experiences. By reflecting on the long-term influence of GEMS on participants' personal growth, professional paths, and advocacy efforts, this study underscores the importance of creating programs that empower learners and contribute to a more diverse and equitable STEM community.

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Building Growth Mindset Using Lessons From Sports in Out-of-School Settings

Sanlyn Buxner, Erin Turner, Ricardo Valerdi, Seneca B. Miller, & Christina Baze

In sports, youth are coached to see persistence and hard work as important paths to personal improvement and success. They come to understand through practice that mistakes are tools to help them improve and that collaboration and teamwork are keys to success in team sports (Kovács & Szakál, 2024; Rottensteiner et al., 2015). These ideas about the importance of effort, persistence, mistakes, and collaboration are important components of a growth mindset, the belief that ability is not fixed but can be improved through effort (Dweck & Yeager, 2020). People with a growth mindset view challenges and mistakes as opportunities to learn; they believe that success depends on effort and practice. Further, research shows that a growth mindset is associated with learner persistence and has positive effects on learning in school and beyond, including in sports (Biddle et al., 1996; Blackwell et al., 2007; Dweck 2006).

However, young people who have a growth mindset in sports may not extend it to subjects such as mathematics and science (Chan et al., 2022; Kyler &

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Photo provided by the Growing Mathletes program of the University of Arizona

Moscicki, 2024). In this paper, we describe a strategy of combining growth mindset principles, mathematics concepts, and sports examples to support students in shifting their mindsets about their own abilities. We share outcomes from implementing these activities at five out-of-school settings.

A Strategy to Extend Growth Mindset in Sports to Mathematics

Through the Growing Mathletes program developed at the University of Arizona, we built on knowledge about young people's growth mindset in sports and the relevance of mathematics in sports to build a set of 19 lessons and two performance-based tasks that integrate growth mindset principles, mathematics concepts, and sports examples. Each lesson centers on sports-related topics and includes activities that integrate at least one core growth mindset principle and several key mathematics concepts. Based on literature about growth mindset and its connections to success in team sports, these principles are:

1. The value of collaboration (Cohen et al., 1999)
2. The power of effort and persistence (Diehl, 2017)
3. The value of mistakes in supporting learning (Ricci, 2021)
4. The malleability of the brain and the role of struggle in learning (Doidge, 2007)

The guides for implementing activities build on an additional educator-focused mindset principle of praising the process, not the person (Mueller & Dweck, 1998).

Growth mindset principles are introduced in multiple ways throughout the program, including inspirational quotes that open each lesson, videos that provide real-life examples, and activities that ask participants to reflect on how the principles apply in aspects of their lives. Activities integrate mathematics concepts related to specific features of sports, such as field layout, scoring practices, and game statistics, or how players and coaches make decisions, such as composing team rosters and comparing player statistics. Other general mathematics concepts include fractions, decimals, and percentages, as well as data representation and analysis.

In this article, we first describe the program context. Next, we offer lesson examples to highlight the five growth mindset principles. After a discussion of results from participant surveys and interviews, we close with implications for practice.

Program Context

We implemented activities at five out-of-school sites that serve children ages 8 to 13 from diverse backgrounds. All sites implemented at least eight hours of activities. Afterschool programs implemented activities for about an hour each day, with either one or four sessions per week, for eight sessions total. Summer programs implemented activities for several hours a day as part of weeklong camps. Afterschool sites had one facilitator, while summer programs had two. Table 1 on the next page shows a summary of participants at each site, with data about the racial and ethnic background of the communities served. In all cases, youth participants mirrored the demographics of the surrounding community.

Growth Mindset Principle 1: The Value of Collaboration

Teamwork is central to success in team sports. Growing Mathletes activities highlight core values of collaboration: that each person has unique strengths to contribute to a team and that many tasks require a variety of skills and abilities. Participants learn that no one person has every needed skill and ability but that, together, a team can draw on the strengths of each member to succeed.

Figure 1. Opening Quote and Reflection Questions for Baseball Positions Lesson

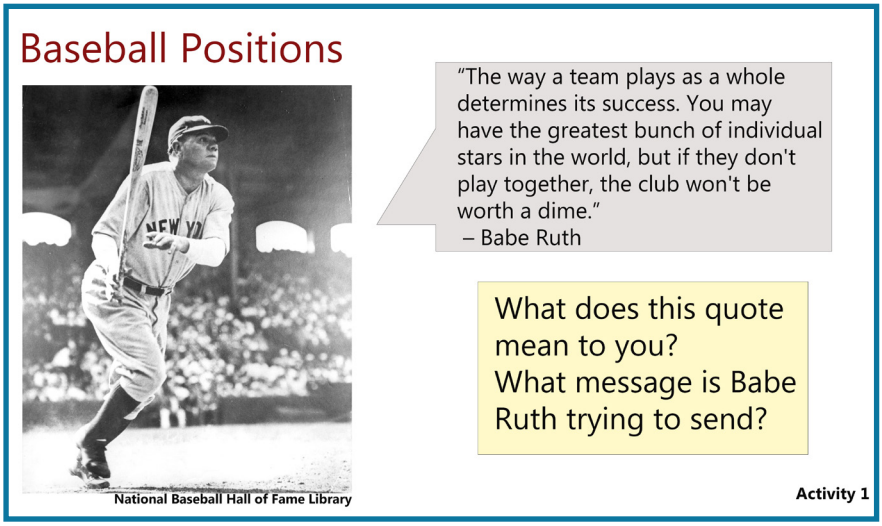


Table 1. Summary of Participants by Site

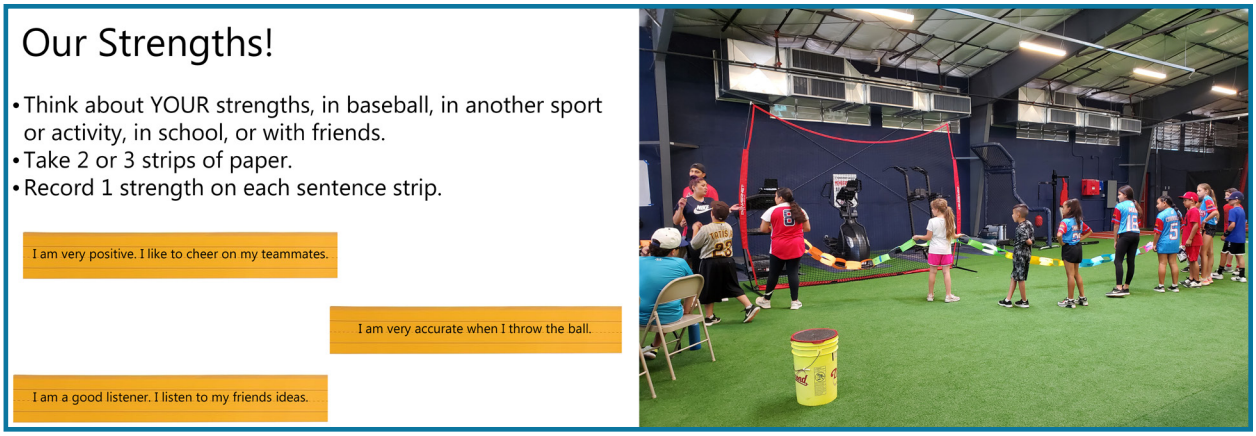
Site Type	Location	Racial Makeup of Community	Number of Participants, Ages, Gender
Afterschool	Southwestern U.S.	Black/African American 17% Latinx 45% White 24% Native American 3% Two or more races 7%	23 youth ages 8–13 10 girls, 10 boys, 3 did not report
Afterschool	Southwestern U.S.	Black/African American 21% Latinx 57% White 14% Native American 4% Two or more races 3%	22 youth ages 9–11 15 girls, 4 boys, 3 did not report
Summer	Southwestern U.S.	Black/African American 3% Latinx 31% White 55% Native American <1% Two or more races 6%	47 youth ages 8–13 18 girls, 27 boys, 2 did not report
Summer	Central U.S.	Black/African American 48% Latinx 43% White 5% Native American <1% Two or more races 2%	16 youth ages 8–13 3 girls, 12 boys, 1 did not report
Summer	Central U.S.	Black/African American 76% Latinx 7% White 11% Native American <1% Two or more races 6%	48 youth ages 8–13 14 girls, 33 boys, 1 did not report

For example, in the Baseball Positions lesson, participants reflect on the quote shown in Figure 1 and discuss how team collaboration applies in their lives at home, with friends, in afterschool activities, and in school. In the first activity, participants collaborate in small groups to calculate and compare the areas of a baseball field that each of nine players is responsible for covering. They reflect on the different skills players need to fulfill their roles and cover their areas of the field. They also consider how similar principles apply in other sports such as soccer.

In the next activity, participants watch videos that explain the roles that different baseball players have on the field and the strengths that each player brings to the team. They then reflect on their own strengths in sports, in school, or with friends and write these strengths on rectangular strips of paper. As a group, they form links with their rectangular strips and then connect the strips to form a "strengths chain." This chain helps participants visualize the importance of each member's strengths and contribution to the success of the entire group (see Figure 2, next page). Youth discuss how this principle applies in various settings. For example, when a group works together on mathematics tasks like calculating and comparing areas, each person's strengths support the group's success.

Facilitators noted that this activity supported participants' understanding of the value of building on one another's strengths. For example, a facilitator at an afterschool club noted that "the strengths chain helped to visualize why it is important to work together with each of our strengths." A facilitator at a summer camp explained that the activity helped campers

Figure 2. Youth Making a Strength Chain in Baseball Positions Lesson



understand "different players' responsibilities and … why it's important for every player to bring their strength."

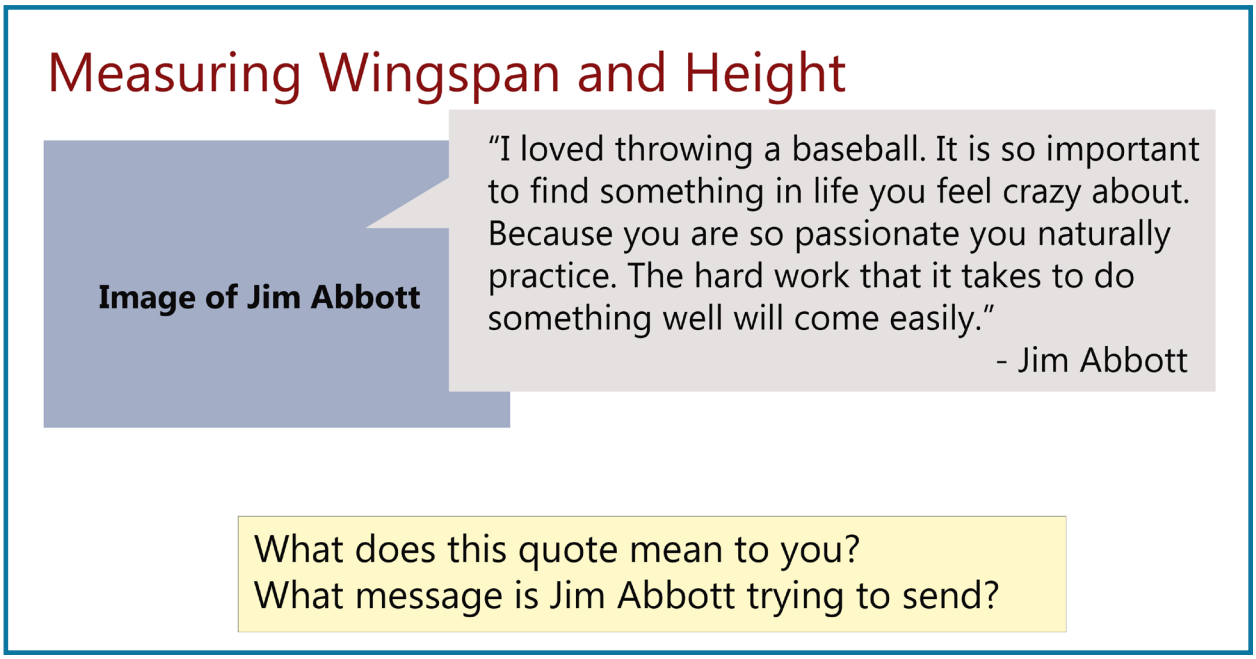
Growth Mindset Principle 2: The Power of Effort and Persistence

Effort and persistence are essential to improvement in sports. Growing Mathletes activities highlight that young people can improve and reach their goals through goal setting, effort, and progress tracking. Participants see tangible examples of the impact of effort as they persevere and work toward goals.

For example, the Wingspan and Height lesson introduces baseball player Jim Abbott, who was a successful pitcher despite having been born with only one hand. Prompted by the opening quote (see Figure 3) and a video about Abbott's life, participants discuss specific examples of overcoming challenges and persisting when meeting their goals in sports and in school subjects like mathematics. They next measure both their height and their wingspan (fingertip to fingertip with arms outstretched) and plot each person's data on a scatterplot. They discuss patterns and trends, including how wingspans change as individuals get taller, and reflect on how different wingspans might be useful in various sports. Facilitators share additional examples of how players with different physical attributes reached success through effort, practice, and persistence.

In the second activity, youth generate inspirational phrases that can help them persist in the face of challenges in sports, with friends, or in school. They

Figure 3. Opening Quote and Reflection Questions for Wingspan and Height Lesson



Note: We have not reproduced the photos of sports figures in figures 3, 4, and 6 in respect of the photographers' copyrights.

create a group inspiration wall, using phrases and images to serve as an ongoing reminder not to give up.

As another example, the Broad Jump lesson begins with a quote from basketball superstar Stephen Curry: "Success is not an accident; success is a choice." Participants discuss the quote and reflect on how effort and persistence can support improvements in various aspects of their lives.

In the first activity, participants review how to do a broad jump by bending their knees and jumping forward. Each one then jumps four times, applying different techniques in each round to improve the distance jumped. They measure the length of each jump and plot the data on a group histogram. They then discuss patterns they notice, including how the length of their jumps changed across multiple trials. Most participants discover that they jumped farther in later rounds, due to both practice and opportunities to apply new jumping techniques. They reflect on how this experience connects to effort and persistence in other activities, specifically, learning mathematics. For example, they may share experiences learning new strategies or models to solve problems and describe how their understanding and performance improved over time.

In the second activity, participants watch a video about how baseball legend Jackie Robinson was successful playing football and track in college but initially struggled in baseball. After discussing the skills Robinson needed to practice to improve in each sport, participants make connections to their own efforts to improve in specific areas of their lives, including sports and school subjects like mathematics.

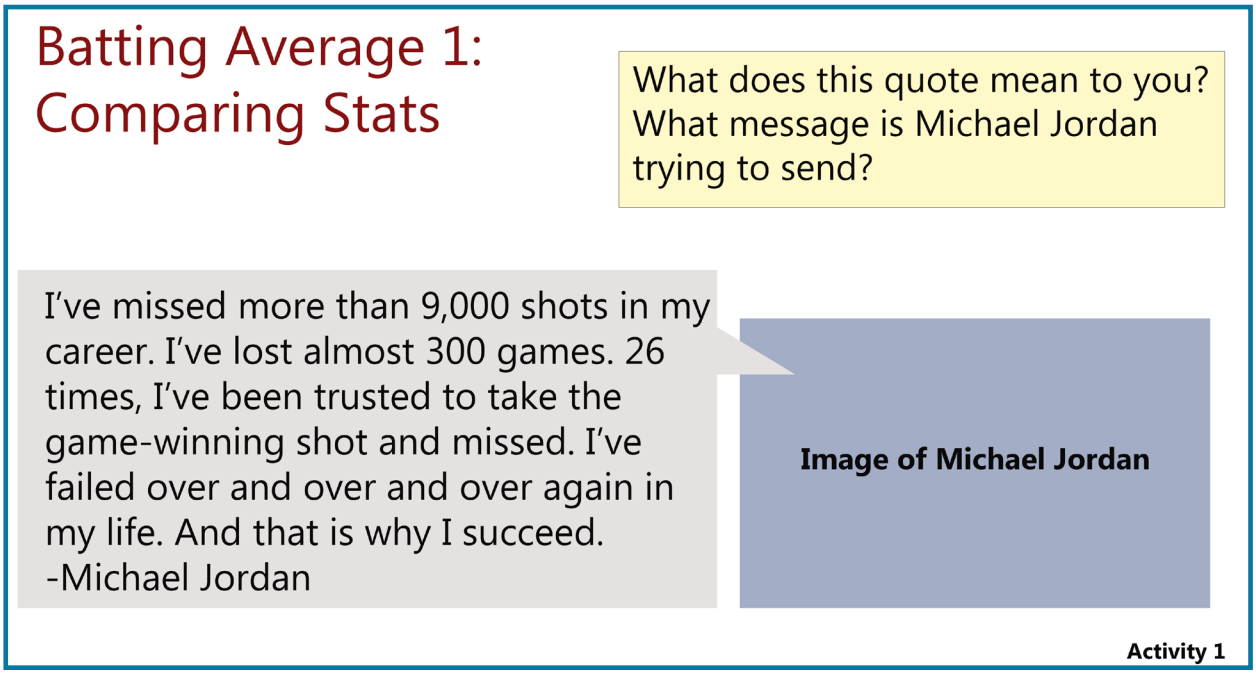
Facilitators frequently commented on the power of these activities to support participants' understanding of the value of effort and persistence. One facilitator at a summer camp noted that "the broad jump trials taught the kids not to think of the activity as a competition, but more so how they can individually improve and what techniques benefit them."

Growth Mindset Principle 3: The Value of Mistakes in Supporting Learning

Making mistakes and reflecting on them is critical to learning in sports, where mistakes are seen as an essential part of skill improvement. As players miss shots and catches, they reflect on how they can both improve their technique through practice and implement new insights for the next game. Growing Mathletes activities highlight that mistakes are an essential part of the learning process across various domains, including in school subjects like mathematics. Participants explore specific examples of learning from mistakes by reflecting on errors and making adjustments.

The Batting Average lesson presents basketball Hall of Fame player Michael Jordan's perspective on the importance of making and reflecting on mistakes to support success (Figure 4). As Jordan shares, failure

Figure 4. Opening Quote and Reflection Questions for Batting Average Lesson



is not to be avoided but rather is an essential part of success and learning.

In the first activity, participants work in small groups to calculate the batting average of several baseball players, representing each value as a fraction and as a decimal. As a group, they compare player batting averages, observing that even highly successful professional players often fail to get hits during games.

In the second activity, participants reflect on mistakes that batters make in baseball, such as swinging too early or too late or swinging at balls that are not on target. They discuss how players learn from those mistakes to improve their performance. Then they generate similar examples of learning from mistakes in their own lives, including in sports, in school subjects like mathematics, and in other activities like playing a musical instrument.

Next, they stand in a circle and listen to scenarios about making mistakes in school or in sports. They discuss each scenario and generate advice and specific suggestions about what the person could do, say, or think to learn from the mistake. As they share ideas, they pass a ball of yarn from one speaker to the next to create a web of connections (see Figure 5). This web provides a visual model of how the process of reflecting on mistakes forms new connections in the brain (Doidge, 2007). Facilitators commented on how well the activity helped young people connect making mistakes with learning. A summer camp facilitator noted that, after campers made the web:

> We explained to them, like, "Oh, this is what your brain looks like when you make a mistake. It learns from it, like sets a spark and that way, you don't make that mistake again or you can try a different route."

Growth Mindset Principle 4: Malleability of the Brain and the Role of Struggle in Learning

The idea that our brains continually grow and adapt in response to new situations and challenges is an essential component of improving in sports. Through Growing Mathletes activities, youth learn that new connections between neurons in the brain change all the time as a result of trying new activities and making new connections between ideas.

For example, in the Elasticity lesson, participants reflect on a quote from football player Ronnie Lott that helps them think about how they can intentionally help their brains grow (Figure 6, next page). Through this discussion, they reflect on how their brains can grow and adapt as they learn new skills and work toward goals.

During the first activity, participants measure how high different kinds of balls (tennis balls, foam balls, baseballs) bounce off a surface, measuring each ball three times. Groups then calculate the average bounce height for each type of ball and discuss its elasticity, that is, how well it bounces back to its original shape after being compressed. Groups collaborate to represent their data on a line plot and discuss patterns in the data.

In the second activity, participants apply the concept of elasticity to understanding the malleability of their brains. They watch a short animated video that explains the brain's neuroplasticity, or its ability to change and adapt in response to challenges and new experiences. The video compares the brain to a muscle that grows as it encounters new ideas and creates new neural pathways. Next, participants brainstorm specific instances when their own brains grew in response to new challenges, experiences, and learning,

Figure 5. Making a Web of Connections in Batting Average Lesson

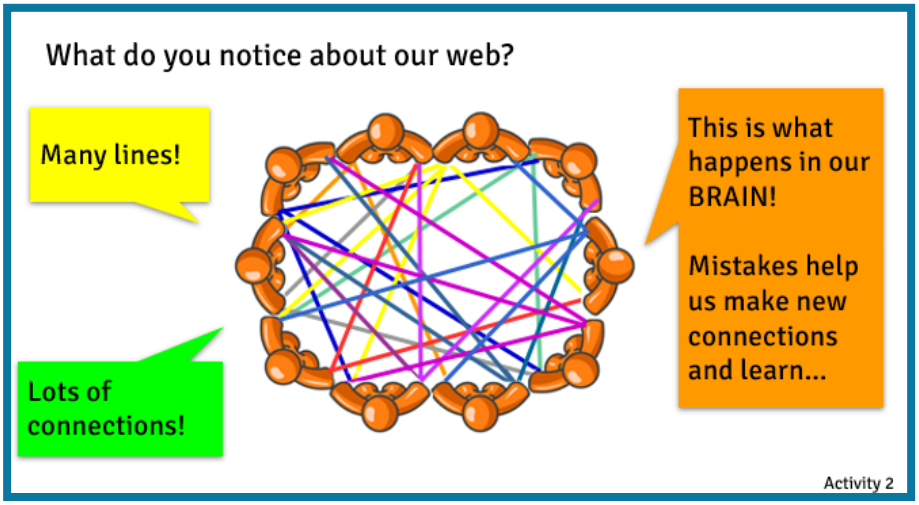
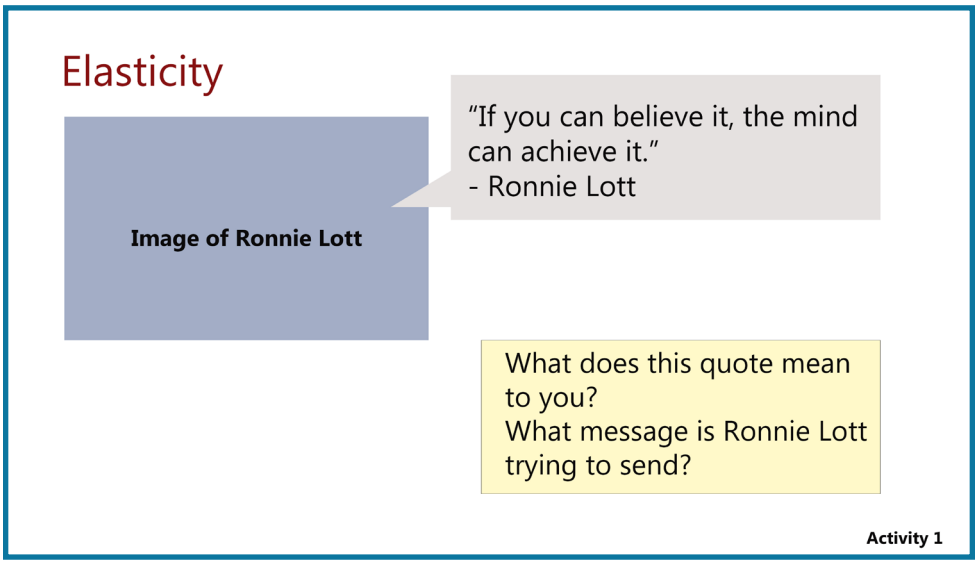


Figure 6. Opening Quote and Reflection Questions for Elasticity Lesson



such as how they learned to bat left-handed or get better at multiplication.

As another example, participants in the Base Running lesson reflect on a quote from the greatest baseball player of all time, Babe Ruth: "Don't be afraid to take advice. There is always something new to learn." This quote emphasizes the importance of taking advantage of opportunities to learn new things.

In the first activity in this lesson, participants use two different techniques to run the bases on a baseball field, a straight-line path and a circular "banana" path, and compare their times. They plot their data on a line plot and discuss which path is more familiar—usually the straight path—and which is faster—the circular path. They watch a video about neuroplasticity and reflect on their experiences developing new skills or habits, including how new learning can feel uncomfortable as their brains make new connections. They conclude by creating pictures that show what helps them to learn new skills in school, sports, and other settings. Facilitators at multiple sites shared the value of teaching youth about this growth mindset principle.

Growth Mindset Principle 5: Praise the Process, not the Person

The language facilitators use as they interact with youth in out-of-school spaces is important. It can reinforce growth mindset principles, specifically the idea that ability is not innate, fixed, and static but can be developed over time with effort and persistence. Facilitators must shift away from language that praises participants' ability or the outcomes of their activity toward language that praises their processes. Drawing on materials adapted from mindsetkit.org (Table 2), facilitators provided multiple examples of how they shifted their language toward praise that emphasizes effort and process. For example, a summer camp facilitator shared, "I can tell them that everybody can

Table 2. Examples of Language to Praise the Process, Not the Person

Instead of This (Person-Praise)	Try This (Process-Praise)
Great job! You must be good at this.	Great job! You must have worked really hard.
See, you are good at math. You got an A on your last test.	You really studied for your math test and your improvement shows it.
You got it! I told you that you were smart.	I like the way you tried all kinds of strategies on that math problem until you finally got it.
You are such a good student!	I love the way you stayed on task, you kept your concentration, and you kept on working. That's great!

Source: Mindset Toolkit (n.d.)

reach them up here if they try. You just can't do it right now. You can't do it yet."

Evidence of Success

From 2021 to 2024, Growing Mathletes activities were implemented in various out-of-school settings including afterschool and summer programs for young people in three U.S. states. Data were collected through pre- and post-implementation surveys with all participants, interviews with selected participants after implementation, and interviews with facilitators.

Youth Surveys

Youth surveys adapted Likert-scale questions from established surveys (Chen et al., 2017; Sarrazin et al., 1996; West et al., 2018) that assessed participants' overall growth mindset (e.g., I can change how smart I am with hard work), their growth mindset toward mathematics (e.g., I am capable of learning anything in math), and their growth mindset toward sports (e.g., I can increase my sports ability by challenging myself). Additionally, youth answered questions about their perceived competence in mathematics (e.g., I am good at math) and more broadly in STEM (e.g., I think that I am very good at coming up with my own investigations). Each survey domain included at least three items and had an internal reliability over 0.7, showing that the items worked well together to assess the domain.

Table 3 shows average pre- and post-participation scores and standard deviations for these five domains on a scale from 1 (strongly disagree) to 5 (strongly agree) for all participants who answered questions on both surveys. The table also includes the results of statistical tests conducted with paired *t*-tests comparing pre- and post-participation scores. Effect sizes for each survey were also calculated using Cohen's *d*, represented in standard deviation units. As can be seen in Table 3, participants both started with relatively high scores on all three growth mindset domains and increased in all three. We found statistically significant increases in both overall growth mindset and mathematics growth mindset, both with a small effect size. Perceived math competency and STEM competency also increased, with STEM competency evidencing a statistically significant increase with a small effect size. Taken together, these results suggest that participating in Growing Mathletes activities enhanced young people's growth mindset and their beliefs about their mathematics and STEM abilities.

Table 3. Pre- and Post-Implementation Youth Survey Responses

Domain	Pretest Mean (standard deviation)	Posttest Mean (standard deviation)
Overall growth mindset (n = 116)	4.26 (.72)	**4.55 (.63)***
Math growth mindset (n = 78)	4.34 (.71)	**4.48 (.64)***
Sports growth mindset (n = 116)	4.42 (.80)	4.47 (.70)
Math competency (n = 116)	3.85 (.76)	3.92 (.78)
STEM competency (n = 115)	3.13 (.52)	**3.28 (.48)***

* Statistically significant change ($p < .05$)

Youth Interviews

Interview data were transcribed and thematically analyzed by members of the research team with a focus on participants' understanding of how key growth mindset principles apply in sports, mathematics, and other activities. Themes included youth learning about the first four growth mindset principles.

The Value of Collaboration

Participants discussed the positive aspects of teamwork and collaboration used during the activities and in their own lives. A 13-year-old at an afterschool program shared positive aspects of working with others:

> Interviewer: What were some of the more exciting parts of building your poster board and your presentation?
>
> Youth: Teamwork was very exciting….
>
> Interviewer: So teamwork, something that you … really liked about it and that they give you a

chance to work on it. How do you think you work when you're in a team, whether in this or just in school?

Youth: I wanted to add that it is kind of a way to bond with each other.… If you really don't like the person, you have to work with them. Maybe the working together, maybe that'll make you friends.

A 12-year-old at an afterschool program shared how working with a group led to success:

Interviewer: What are some things that helped you with those tricky things? Did it help working with a group in a team to make decisions?

Youth: Yeah, because if I were by myself doing it, I probably wouldn't have finished the thing because I'd probably still be thinking about the unique features and all. And if I didn't have my team to help me, like with other things for the features, then I'd still be stuck on my features.

Effort and Persistence

Participants described how practicing and putting in effort would lead to improvements in their skills. A nine-year-old at a summer program shared how practice would help meet a goal of improving in math:

Interviewer: Did you set any goals today?

Youth: So one of them was to figure out how to get better at math, because I'm not the greatest at math.

Interviewer: And what's going to help you get better at math?

Youth: Practice.

Similarly, a 12-year-old at an afterschool program reiterated the importance of effort and practice in improving at running:

Interviewer: What goal did you set for yourself?

Youth: To get faster.… Right now, I don't really run that fast.… I want to get faster.

Interviewer: What are some of the things that you are going to do to meet that goal of getting faster?

Youth: Practice every day. Play more sports.

Learning from Mistakes

Participants articulated the prevalence and importance of failure in sports and how they use failures to get better. A 12-year-old at a summer program showed understanding of how to learn from one's mistakes:

Interviewer: So [today] you were successful three out of 10 times, unsuccessful seven. So what does that tell you about, like, learning from mistakes?

Youth: That it's okay to fail sometimes because even MLB players don't even get three out of 10 sometimes, right? They go maybe one, four, 10 over 10. Right. They're not always perfect, and you're never going to be perfect.

Interviewer: So how do you think MLB players learn from their mistakes?

Youth: They practice, and they have to know what they did wrong and fix it.

Malleability of the Brain

Participants described how the brain is similar to a muscle and can grow with challenges, making connections to learning math. An 11-year-old at a summer program shared his understanding of malleability and the role of struggle:

I kind of think of the brain as a muscle. When you flex and work different parts of your brain, they get stronger, and they get better and more adept at doing those specific tasks. So when it comes to math, when you're stressing it or when you're working your brain on a specific problem on a calculation, something like that on your brain gets stronger.

This idea was also shared by a 13-year-old at an afterschool program:

Interviewer: Is there anything new or exciting or interesting that you learned from today's session?

Youth: Neurons. I learned about neurons.… I didn't even know they existed. I didn't know it was a word, anything.… It's pretty much how your brain grows. They connect with each other after exercising it. The video said to be able to lift more—or, not necessarily lift, to be more intelligent, think faster. At the beginning, say there's three neurons, and they're all separate, doing whatever. And you would think slower, but if you

exercise your brain, if you did math problems, simple ones at first, three times two or two times four, it would grow.

Facilitator Feedback

Our evaluation activities focused on participant outcomes. However, conversations with facilitators indicated that they also saw the value of integrating sports, mathematics, and growth mindset for the young people they served. One facilitator shared:

> Over time, [students] kind of adjusted and started to be more into it…[even] kids that really aren't sports people.… If you're a sports person, the baseball part helped you like the math more.… If you aren't a sports person and you're just here, the school part helped you learn about the growth mindset.

Implications for Practice

Our experiences in the Growing Mathletes program combined with participant responses suggest that integrating growth mindset principles and mathematics concepts in the context of sports is an effective way to engage young people and to expand their perspectives on learning mathematics and the relevance of mathematics in their lives. By starting with lessons from sports—a context that emphasizes the power of effort, persistence, and teamwork and the value of embracing challenges and learning from mistakes—Growing Mathletes activities have the potential to help young people apply growth mindset ideas to other situations in their lives, including at home and at school.

We close with several recommendations for other out-of-school-time programs. First, we found that concrete examples of how and why growth mindset principles support success, including examples from successful individuals who apply the principles to their own stories, was an important part of helping young people change their beliefs about abilities (Yeager et al., 2016; Yeager & Dweck, 2020). Whenever possible, facilitators should consider sharing their own stories, or stories of individuals in participant communities, that highlight the relevance of growth mindset ideas.

… concrete examples of how and why growth mindset principles support success, including examples from successful individuals who apply the principles to their own stories, was an important part of helping young people change their beliefs about abilities.

Second, out-of-school time programs should attend closely to the language used to communicate with youth about ability and effort. Rather than using language that focuses on outcomes, facilitators should use language that emphasizes process and effort. Such language supports young people to recognize their own competence and reinforces the belief that anyone, with effort, can improve their skills. In practice, for example, the popular saying "no pain, no gain" can be updated to "no struggle, no gain," reminding young people that struggle in learning should be celebrated, as their brains are getting stronger.

Third, programs should emphasize that teamwork can be used in multiple domains, not just sports, to support collective success. Collaboration in academic learning as well as in sports allows young people to use the skills they have developed and emphasizes that they all have a role to play in success. Examples may include peer tutoring or peer mentorship.

Fourth, young people should have a safe space to make mistakes. They often have a growth mindset in sports because the expectation there is that they will fail many times while they learn to succeed. Out-of-school spaces should implement similar norms across youth activities. When young people make mistakes, the focus should be on *why* the mistake was made and reframing it as an opportunity to learn. When they are encouraged to fail when learning new things, young people can develop a growth mindset about failure that will support them in other aspects of their lives, including in school.

Future research could include looking at the impact of young people's increased growth mindset on their attitudes and performance in school, especially in mathematics. We invite others to build on what we have learned about integrating growth mindset principles and mathematics in the context of sports with youth in out-of-school settings.

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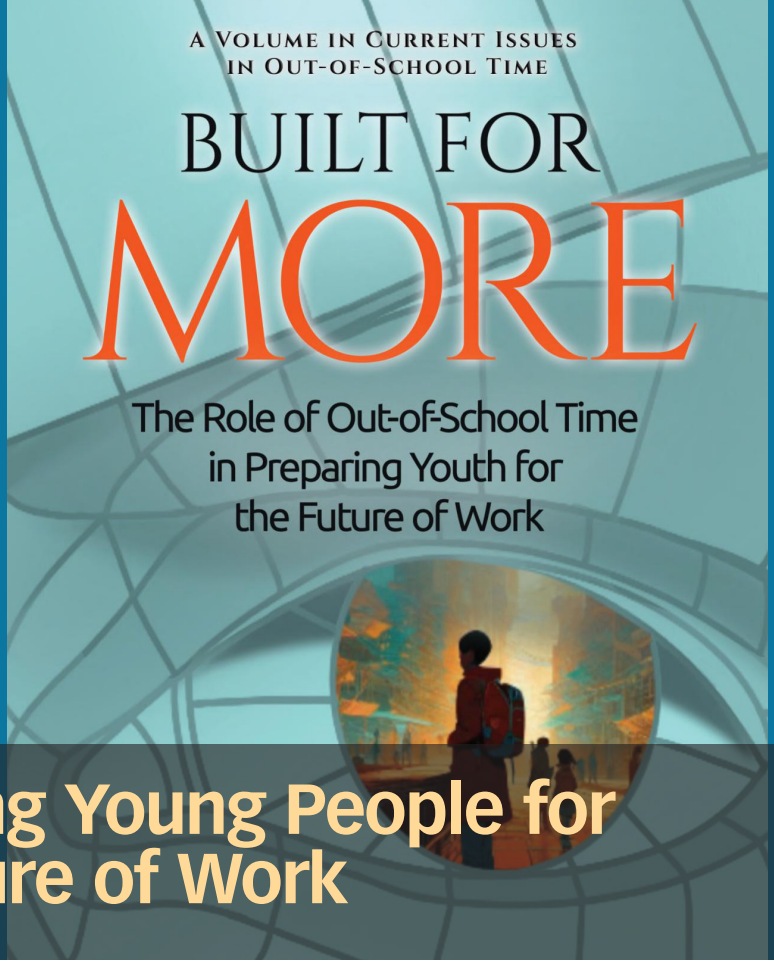
BOOK REVIEW



Preparing Young People for the Future of Work

Shannon Macalingay

Review of *Built for More: The Role of Out-of-School Time in Preparing Youth for the Future of Work*, edited by Byron Sanders & Shannon Epner. Information Age, 2024.

This latest book in the series Current Issues in Out-of-School Time, edited by Helen Janc Malone, brings to light the multiple ways in which the OST field provides pathways for young people to a place in the workforce. The importance of holistic development and of a firm foundation to prepare youth for the workforce is a recurring theme. By the conclusion, the authors provide a broad understanding of the importance of youth-adult collaboration in workforce preparation and how that dynamic partnership must include an awareness of cultural and environmental context.

Built for More is divided into three sections. Section I is "The Future of Work." The first chapter covers "learner-centered ecosystems." In Chapter 2, considering the impact of artificial intelligence (AI) technology on the future workforce, co-editor Shannon Epner (working with ChatGPT-4) suggests that OST providers "can co-create holistic learning experiences" to develop the skills young people need "to thrive in the AI era" (p. 30). Chapter 3 points to the benefits of high-quality STEM programs that foster an engineering mindset with real-life applications.

Section II is "Importance of Youth Workers in Preparing Youth for the Future of Work." Chapter 4 by Carlos Santini recalls the vital role OST workers can play in young people's growth. In the next chapter, Melea Mayer describes the importance of trauma awareness among youth workers. The chapter on higher education by Deutsch and Levy concludes that attention to "macro forces," such as social and political systems and cultural contexts, is necessary to enable youth workers to both support

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the development of individual young people and lead participants to be agents of change. Chapter 7 presents findings from the Power of Us youth worker survey, which was also featured in the Fall 2023 issue of *Afterschool Matters.*

Section III, "Role of OST in Sparking Career Pathways," focuses on ways in which OST programs embody holistic approaches for preparing young people for the workforce. For example, in "Leveraging the Community as a Civic Classroom," Raine and Wegner elaborate on how communities and community-based organizations can serve as platforms for transformative learning experiences that cultivate civic competencies such as critical thinking, communication, and empathy. Case studies in this section provide concrete examples of OST programs that focus on career development.

Built for More could benefit current youth workers and program leaders in many ways. In a community, youth workers and program leaders can work together by learning how to maintain consistent communication while preparing young people for future work. As a former youth worker, I felt reassured, as I read this book, about my role as a practitioner and my strategies for working with youth. *Built for More* can also help future youth workers when used as a textbook in a college youth development program because it features authentic input.

Built for More documents how the OST field can create a holistic circle of support to equip young people to face the workforce challenges of tomorrow. It serves as a call to action to inspire all who are committed to positive outcomes for youth not only to prepare young people for the workforce but also to empower them to lead meaningful change in society.