International Society of the Learning Sciences

Multi-Layered Brokering for Family Engagement in Out-of-School STEM: A Case Study of a Statewide Learning Network

Maggie Dahn, Kylie Peppler, Mizuko Ito
Irvine, dahnm@uci.edu, kpeppler@uci.edu, mizukoi@uci.edu
University of California

Kari Denissen, Keem Anderson
kari@igniteafterschool.org, keem@igniteafterschool.org
Ignite Afterschool

Abstract: Out-of-school time (OST) programs play a critical role in broadening participation in STEM by offering young people opportunities to explore interests and develop skills beyond formal schooling. Yet, the potential of these programs is constrained by limited and uneven strategies for engaging families—key partners in sustaining youth interest and identity in STEM. This study applies a multi-layered brokering framework to examine how Ignite Afterschool, Minnesota's statewide OST intermediary, advanced family engagement in STEM programming. Using a qualitative case study approach, we analyze how Ignite brokered resources, knowledge, and opportunities that positioned families as active participants rather than peripheral supporters in their children's OST STEM learning. Findings show how coordinated brokering across interpersonal and organizational levels can foster more inclusive, culturally responsive, and sustainable forms of family engagement. This work contributes a theoretically grounded model for understanding how network-level intermediaries can strengthen family learning and build connected, equitable OST ecosystems.

Introduction

Out-of-school time (OST) programs are increasingly recognized as vital spaces for broadening participation in STEM and other fields that have historically excluded minoritized youth (Afterschool Alliance, 2021, 2025). These programs offer young people opportunities to explore interests, build skills, and form mentoring relationships that extend learning beyond the school day (Ito et al., 2020; Young et al., 2017). By connecting youth to hands-on inquiry, collaborative design, and community partnerships, OST environments have the potential to strengthen pathways into STEM learning and careers. In the wake of pandemic-era disruptions, out-of-school time (OST) learning ecosystems have become increasingly fragmented, making it more difficult to sustain equitable pathways into STEM for minoritized youth. OST programs often lack coordinated, scalable approaches to engaging families as partners across settings. This gap limits the field's ability to build coherent, equity-oriented learning systems—a pressing challenge for the learning sciences as the field seeks to understand how participation is supported across contexts. While families play a critical role in nurturing children's curiosity and supporting long-term participation (Pattinson et al., 2024), many OST programs lack structured approaches for involving parents and caregivers as co-learners and contributors. Family engagement efforts, when present, tend to be fragmented and inconsistently implemented across programs and sites, resulting in missed opportunities for collective learning and support (Afterschool Alliance, 2022).

To address these gaps, researchers have increasingly turned to *brokering* as a useful lens for understanding how connections across learning settings are built and sustained. Brokering refers to the interpersonal and institutional work of linking young people to resources, relationships, and opportunities that support their development (Barron et al., 2009; Stanton-Salazar, 2011). Yet most studies of brokering in OST contexts have focused on individual actors such as teachers, mentors, or parents, while paying less attention to how organizations and networks coordinate brokering efforts at scale. This leaves a key question underexplored: How can network-level coordination align resources and relationships across OST programs to amplify the impact of families on youths' navigation of STEM opportunities?

This study addresses this systems-level question through a qualitative case study of Ignite Afterschool, Minnesota's statewide OST intermediary. We use a *multi-layered brokering framework* (Dahn et al., under review) to examine how Ignite strengthened family engagement in STEM across their network. Specifically, we describe how Ignite coordinated both interpersonal relationships and interorganizational partnerships to design a Family Engagement Framework and facilitate Family Listening Sessions that centered family voice. These efforts brokered resources, knowledge, and opportunities that positioned families not as peripheral supporters but as active participants in their children's OST STEM experiences. Through this case, we demonstrate how

 © ISLS

coordinated brokering across interpersonal and organizational levels can create more inclusive, culturally responsive, and sustainable approaches to family engagement in OST. In doing so, this work uses a theoretically grounded model to show how state and network intermediaries create more equitable learning ecosystems, linking families, programs, and institutions to sustain children's learning across contexts.

Background

Families in out-of-school time STEM

Parents, caregivers, siblings, and other extended family members play a central role in the learning trajectories of young people. Children grow up seeing how people in their family relate to formal and less formal educational settings, as well as the pathways they pursue. Research demonstrates that families and caregivers are important to the development of children's STEM identities, regardless of whether they consider themselves having STEM expertise or not (Dou & Cian, 2024; Ennes et al., 2023; Pattison et al., 2023).

Although involving families in learning is important to learning across settings, family expertise is often overlooked, especially in historically marginalized communities. Researchers counter this by offering asset-based frameworks that position families as partners and co-designers in their children's STEM learning. Dou & Cian (2024) for example, offer a Family-Centric STEM Identity Development (FSID) model as guidance for creating culturally sustaining out-of-school STEM environments. This model centers families' and caregivers' values, culture, and goals, all of which are critical to supporting children's STEM learning and identities. In the development of this model, the authors found that families and caregivers shaped understanding of STEM in key ways. These included having conversations with their children about STEM, evaluating and assessing identity expressions, and facilitating their children's engagement or disengagement with STEM-related activities.

Similarly positioning families as valuable assets in their children's learning, Roque (2016) introduced the Family Creative Learning model, a community-based program that supports families, particularly those from underrepresented communities, to engage together in creative computing and design-based learning. The model supports the notion that families are not just supporters, but co-designers, co-learners, and powerful contributors in the learning pathways of their children, especially in STEM (Roque, 2016; Roque et al., 2021). Family Creative Learning emphasizes intergenerational learning, equity-centered design, asset-based framing, community building, and scaffolded participation. Overall goals of Family Creative Learning include democratizing access to STEM, building family confidence and agency as co-learners and co-designers in their children's learning, and disrupting traditional power dynamics in educational systems.

These models and others like them also see family members as brokers for their children's STEM learning who help to identify, access, and advocate for additional learning opportunities in STEM. Models like Family Creative Learning can therefore help support connected learning by making connections across different settings where young people learn, namely between out-of-school environments and at home. However, while it is valuable to position families as critical to supporting children's learning, we need more systematic ways of thinking about how to set up families for these roles.

Brokering and making connections across settings

Brokering refers to the interpersonal and interorganizational work of connecting young people to people, resources, and opportunities that support learning and development across diverse settings, including homes, schools, and community programs (Peppler et al., 2019). Individuals such as peers, parents, mentors, and educators act as brokers by facilitating access to educational experiences, social networks, and institutional knowledge (Ching et al., 2016; Stanton-Salazar, 1997, 2011). Cultural and peer-based brokering has been shown to be especially impactful for youth from historically marginalized communities, particularly in fields like STEM where institutional gatekeeping has excluded many based on race, gender, or socioeconomic status (Kekelis et al., 2017; Koch et al., 2012; Kricorian et al., 2020; Kirshner et al., 2019; Rivera et al., 2019). Despite this, there remains a critical gap in the literature around how families—especially those from underrepresented backgrounds—are themselves brokered *into* STEM ecosystems, rather than solely being positioned as brokers for their children (Cooper, 2014; Civil & Bernier, 2006; Ishimaru et al., 2016; Su, 2008).

While individual brokers play a crucial role in connecting youth to resources, these efforts often depend on the broader institutional systems in which they are embedded. At the interorganizational level, brokering requires coordination across programs and institutions to ensure aligned and coherent pathways for youth learning. This includes practices such as shared purpose, collaborative planning, communication between stakeholders, and formal support structures (Bodilly et al., 2010; Kania & Kramer, 2011; National Summer Learning Association, 2016). However, such coordination remains rare, especially in STEM, due to fragmented systems, limited

incentives, and competitive dynamics among OST programs (Allen et al., 2020; Anthony & Morra, 2016; Bevan et al., 2010). These challenges are compounded by the structural inequities that persist in STEM education (Gasiewski et al., 2012; Janssen et al., 2022). While some organizations are beginning to prioritize brokering work aligned with youth interests (Dahn et al., 2023a, 2023b), there is still a lack of research on how brokering operates at the interpersonal and interorganizational levels.

Connected learning provides a useful grounding framework for addressing these needs because it emphasizes the value of interest-driven learning supported by caring relationships and connection to opportunity (Ito et al., 2020). Connected learning attends to learning that happens across settings, including schools, out-of-school time spaces, at home, and in communities. A key design principle of connected learning is concerned with how learning is connected across these different contexts—for example, how young people and their families are connected to the learning experiences that are happening in an out-of-school space. This focus on cross-context learning reinforces the need for multi-level brokering strategies that not only link youth to STEM opportunities but also support families and institutions in building the connective tissue (Chew et al., 2023; Pinkard, 2019) across learning environments.

Theoretical framework

Multi-layered brokering as a strategy for connected learning

In this paper we address the need to better describe the complex brokering with which state network intermediaries engage as they do work across both interpersonal and interorganizational layers of a system. Our theoretical framework brings together a connected learning framework and literature on brokering to introduce and illustrate through examples a framework for *multi-layered brokering* (Dahn et al., under review). Multi-layered brokering refers to processes of connecting and coordinating across interpersonal layers, which includes individuals, and interorganizational, which focuses on institutions and programs. Here we use multi-layered brokering to describe how state network intermediaries make connections across both of these interpersonal (i.e., between individuals) and interorganizational layers (i.e., between organizations). The interpersonal layer includes relationships between OST facilitators, families, and participating youth. The interorganizational layer focuses on the level of partnerships, networks, and institutional coordination. Both layers, which we illustrate through a case of family engagement in our findings, support connections to resources, knowledge, and opportunities for people and organizations. Table 1 offers an overview of the multi-layered brokering framework, including possible types of resources, knowledge, and opportunities that are exchanged in each facet of this connecting and coordinating work. We treat each layer as distinct in this paper to illustrate the framework, however, we acknowledge that the layers are intersecting and have dependencies since interorganizational coordination often requires trust-based interpersonal relationships between individuals affiliated with different organizations.

Table 1
A multi-layered brokering framework

	Resources	*Knowledge*	*Opportunities*
Interpersonal layer: Building trust-based relationships	Mentors Scholarships Transportation	Insights Cultural understandings Programmatic strategies	Leadership roles Mentorship roles Career placements
Interorganizational layer: Strategic coordination and institutional alignment	Grants Institutional assets Facilities Staff	Organizational priorities Shared goals Programmatic models	Strategic partnerships Program spread and scale

Multi-layered brokering is aimed at expanding access to resources, knowledge sharing, and opportunities for sustained STEM engagement. Multi-layered brokering attends to both the relational infrastructure of connections between organizations, or how connections are enabled, as well as the substantive exchanges in terms of what is brokered. Connecting includes actions such as making introductions, offering recommendations, or convening stakeholders around shared STEM goals, as well as coordinating work such as aligning on shared purpose and strategies, ensuring a cultural fit between partners, formalizing relationships, and sustaining partnerships over time. We use this framework to explain how state network intermediaries made connections and coordinated across out-of-school time efforts to support a strategic family engagement strategy in out-of-school

time STEM programming. Our research question is: How can a multi-layered brokering framework help to explain the complex work of state intermediaries as they navigate relational and organizational boundaries?

Methodology and methods

Participants and data sources

We use a case study method with a focus on Ignite Afterschool, Minnesota's statewide OST network intermediary. This organization was selected because they had a strong family engagement strategy that they were coordinating across multiple organizations within their network. Ignite Afterschool is part of the Charles Stewart Mott Foundation-supported 50 State Afterschool Network, a national initiative that connects state-level intermediaries to strengthen afterschool and summer learning programs across the U.S. Each state network acts as a broker for OST organizations by facilitating collaboration, expanding access, and improving quality within programs. The 50 State Afterschool Network also connects stakeholders, secures resources, and influences policy (50 State Afterschool Network, 2025). In partnership with STEM Next Opportunity Fund, they also support efforts to broaden participation in STEM-focused OST programming nationwide. By fostering a coordinated infrastructure of public and private partners, the network helps ensure that children and youth have access to high-quality, equitable learning opportunities beyond the school day (Afterschool Alliance, 2021).

Two key leaders from Ignite Minnesota who are also authors on this paper were participants in this research: Kari Denissen, Executive Director, and Keem Anderson, Associate Director. Data sources included a series of 10 conversations/semi-structured interviews with Kari and Keem over the 2024-2025 school year. These conversations were video recorded and transcribed. We engaged in similar conversations with 5 additional state network partners, and though they informed our understanding of OST intermediaries, those are not part of the analysis in this paper. Kari and Keem also shared artifacts with us to guide our understanding of their approach, including a Family Engagement Framework and Family Listening Session guide they created to guide their professional development approach. During our conversations, we documented the frequency with which and ways they built relationships with key organizational partners. We asked about the level at which they contacted individual partners (e.g., no contact, light contact, more contact) and additionally collected descriptions of the type of contact with which they engaged. This helped us better understand the level of contact they maintained with partners and how they engaged in connecting and coordinating work that was part of their everyday professional practice. Researchers were engaged as research-practice partners and the research was driven by the state partners' practice. Researchers have been engaged in partnership with out-of-school time intermediaries and programs part of the STEM Next Opportunity Network since 2021.

Analysis plan

We initially developed the multi-layered brokering framework from a qualitative case study with a separate state network intermediary organization, Nebraska's Beyond School Bells, and its program partners (Dahn et al., under review). The framework was developed around their implementation of a near-peer mentorship model at multiple OST program sites across the state. In this paper, we apply this multi-layered brokering framework to the work and actions of a separate state network intermediary in Minnesota to illustrate how they use multi-layered brokering to implement a different strategy in a different context. We framed the work of the state intermediary through a case study approach (Stake, 1995; Yin, 2009). In this case, we took the multi-layered brokering framework as a starting point for our analysis of how they successfully implemented a strategic family engagement program. We triangulated across interview transcripts and the shared artifacts to categorize the work of the OST intermediaries into the interpersonal and interorganizational layers with attention to the flow of brokering resources, knowledge, and opportunities across the layers. The research team discussed the categorizations and came to agreement on how the case demonstrated each component of the framework.

Findings

We examine how Ignite Afterschool, Minnesota's statewide OST network, strategically expanded its role within the Minnesota STEM Ecosystem by deepening family engagement in STEM and strengthening collaboration between in-school and out-of-school STEM programs. Kari and Keem identified a core problem of practice for their partners: families—particularly Black families and those from other underrepresented communities—were rarely meaningfully included in conversations about STEM education or supported in navigating future opportunities for their children. In response, Ignite shifted its strategy to actively engage parents and caregivers, not only as supporters of youth learning, but as participants with critical insight and expertise. The goal was to better understand how families perceive their roles in STEM, identify barriers to participation, and create more

inclusive and connected pathways into STEM programs and careers. This effort involved developing both relational strategies to build trust with families and structural strategies to coordinate programming and communication across organizational partners.

Kari and Keem explained that their work as OST intermediaries was guided by the following questions:

1) How do families perceive their involvement and representation in afterschool programs, particularly in STEM?
2) What are the best practices in community and family engagement in STEM, especially for Black families and other underrepresented communities?
3) How can afterschool programs better engage families to create more inclusive environments that support the well-being and success of both young people and their caregivers?

This case provides a lens into how multi-layered brokering can be used as a strategy for connected learning. We show how Ignite's leadership facilitated interpersonal connections between OST staff and families, while also coordinating interorganizational partnerships across schools, programs, and community organizations. Through this layered approach, Ignite helped to build more coherent, equitable, and sustainable learning pathways that center families as key stakeholders in STEM education.

Problem of practice: Toward a cultural shift of family engagement in STEM

The work of Ignite was grounded in a shared recognition that something fundamental was missing in how STEM learning was being positioned within Minnesota's OST landscape. While many programs focused on broadening participation, few addressed the disconnect between how STEM is framed and how families from marginalized communities see themselves and their children in relation to how STEM is framed. In designing this initiative, Kari and Keem aimed to model authentic family engagement, not only to increase access to STEM opportunities, but also to shift how families envision their role in shaping their children's futures. As Keem described:

> "We were having this feeling that STEM wasn't connecting with who we wanted to connect with – underrepresented young folks and young people from marginalized communities. How do we truly engage those people to introduce them to STEM and have a cultural shift in terms of how folks in the communities think about opportunities in STEM similar to how they think about opportunities in sports?"

Keem called this work a "cultural shift," one that involves reimagining how communities perceive STEM opportunities and who gets to participate. He underscored the long-term nature of this vision, noting, "We might not see the fruit of our labor for a generation or two, but this is something we're really wanting to go to the roots and then build out." Through engaging in Family Listening Sessions, both leaders found that their own assumptions about family engagement in STEM were challenged. Kari reflected that she had initially believed many parents might be "intimidated by STEM" or carry "negative past experiences" with it. However, what she heard directly from families shifted her thinking. She explained:

> "Parents were very much seeing STEM as an opportunity for young people, and they did want to figure out how their young person could be more engaged in STEM. But this is less known. There's more information about how to help your kids navigate sports leagues more than STEM. They might value it, but they didn't necessarily know where to go next with it."

This insight helped refine the problem of practice driving the initiative. The issue wasn't a lack of family interest in STEM; it was the lack of clear pathways, support, and culturally relevant entry points for families to engage in and advocate for their children's STEM learning. Many families, particularly those from communities historically excluded from STEM, face systemic barriers to accessing high-quality OST programs. Yet, as Keem emphasized, families have always played a central role in youth development—and should be recognized and supported as such in STEM learning environments: "We think that parents and families have a lot of untapped potential, as far as how we can engage them to better benefit young people in the field. We see parents as partners in STEM."

Development of the family engagement framework and family listening sessions

To foster more meaningful and inclusive family involvement in STEM learning, Ignite Afterschool developed a four-level *Family Engagement Framework*. This framework describes a spectrum of engagement, from parents having just "Basic Awareness," where they receive information but have limited involvement, to "Leadership and

Co-Creation," where parents actively shape program direction by serving on advisory committees, helping plan events, and recruiting other families. Keem highlighted that, like young people, parents and families "want to feel belonging, they want to feel connected in a way that's meaningful. They want to build relationships with one another."

Central to their approach that engaged parents in STEM were Family Listening Sessions, designed to build trust with families through culturally responsive practices that created space for them to share hopes, concerns, and barriers related to STEM. Keem described these sessions as a way to "shift the power dynamic: We want families to feel like they could guide the work, not just respond to it." The sessions included icebreakers and group activities focused on building relationships and deepening shared understanding of STEM education. Families were asked questions such as: "What motivates you to encourage your child's STEM education?" and "What challenges do you face in accessing STEM programs and activities?"

These sessions were grounded in principles of belonging, reciprocity, and cultural relevance. They were co-hosted with trusted community partners, provided food and childcare, and favored storytelling and reflection over survey-based feedback. Keem reflected on the impact of these sessions, sharing that his most rewarding moments as a facilitator come when families move from passively listening to actively participating: "Oh, they're actually asking me what I think, and you know having this kind of a-ha moment. When it works, it's a quality session when parents are engaged in that way. They're not used to that level of engagement, like, really kind of, you know, asking them what they think, or asking them to participate in a session similar to what the young people are going through."

Through four Family Listening Sessions in collaboration with partners in North Minneapolis and Duluth, Ignite engaged 25–30 family members from diverse communities. The insights gathered directly shaped their culturally responsive Family Engagement Framework and the creation of a facilitation guide that other organizations can use to amplify family voice in STEM programming. Several other state network intermediaries expressed interest in adopting the framework, indicating potential for more expansive impact.

Challenges they encountered when implementing their family engagement strategy included recruiting parents and caregivers to attend sessions, limited infrastructure to support the kind of innovative work they were doing, especially in drop-in or school-based programs, and communication barriers due to geographic distance between the network intermediary and partner programs. Ignite addressed these by leveraging trusted relationships, offering incentives such as food and stipends during the sessions, co-designing program structures with partners, and allowing time to build trust through regular check-ins and strategic communication. Funding for the project was braided across multiple sources and aligned with Ignite's Professional Development Exchange (PDX) initiative, supporting sustainability without duplicating efforts. Most of the investment was in staff time dedicated to partnership coordination, tool development, and relationship-building. Ignite also provided stipends to partners and covered essential costs like childcare and participant incentives to ensure equitable access.

Table 2
Multi-Layered Brokering for Families at Ignite Afterschool in Minnesota

	Resources	**Knowledge**	**Opportunities**
Interpersonal layer: Building trust-based relationships	Ignite Afterschool brokered resources that mitigated **barriers to attendance** at Family Listening Session events, intentionally offering food and childcare	Through the use of the internally developed Family Engagement Framework and listening session guide, Ignite Afterschool gathered **cultural insights** as to how families thought about and related to STEM and afterschool programs	Ignite Afterschool created **opportunities for families to share experiences** in a group setting through a storytelling-based method; asking families to contribute in this way is less common in programming around young people pursuing STEM interests and pathways
Interorganizational layer: Strategic coordination and institutional alignment	Ignite Afterschool brokered **institutional resources** such as a Family Engagement Framework and Family Listening Session guide to support alignment in the	Ignite Afterschool brokered **process alignment** and collaboration through running regular-check-ins, purposefully building relationships with partners, and using shared planning	Ignite Afterschool brokered **strategic partnerships** between in school and out-of-school organizations to support family engagement Ignite Afterschool brokered

	approach to family engagement across the project sites Ignite Afterschool brokered **financial resources through a braided funding strategy** necessary to support staff and facilitators to develop the Family Engagement Framework and implement Family Listening Sessions	documents Ignite Afterschool brokered **institutional and research-based knowledge** to organizations within their network to offer family engagement guidance and spotlight particular programs	the **spread and scale** of the Family Engagement Framework and Family Listening Sessions through their Professional Development Exchange (PDX) structure to support sustainability and accessibility

Multi-layered brokering at the interpersonal and interorganizational layers

Table 2 above illustrates the ways that Ignite Afterschool engaged in multi-layered brokering to support their family engagement initiative. At the interpersonal layer, Ignite Afterschool brokered resources that mitigated barriers to attendance at their listening sessions—for example, offering food and childcare during the sessions. They brokered knowledge such as cultural insights as to how families thought about and related to STEM through the engagement framework they developed, and they brokered opportunities for families to share their experiences with STEM. At the interorganizational level, Ignite Afterschool brokered institutional resources such as the internally developed Family Engagement Framework and listening session guide, as well as financial resources through a braided funding model that helped programs develop and implement their family engagement strategy. They also brokered process alignment knowledge by holding regular check-ins across organizations and brokered research-based knowledge by sharing learning across programs. Additionally, they brokered opportunities for organizations by helping to build strategic partnerships between in school and OST partners, as well as putting effort behind the spread and scale of the Family Engagement Framework and listening sessions.

Discussion

The complex, often invisible, work of state network intermediaries in supporting the development of strategies for making connections at both interpersonal and interorganizational layers is undertheorized. The introduction of a multi-layered brokering framework helps to elevate the interpersonal and interorganizational layers of the brokering work with which these network-level intermediaries engage. By applying this framework across different contexts in which making connections across settings is a shared goal, we can see how the complex work of brokering supports connections in different contexts. This work has implications for pushing theories of connected learning and brokering research and contributes to practice by offering a practical model for organizations seeking to elevate family voice and leadership in OST STEM education.

Elsewhere we have argued that multi-layered brokering supports the development of resilient relational infrastructure (Dahn et al., under review). This resilient infrastructure enables resources, knowledge, and opportunities to flow between and across programs in ways that benefit programs, the youth they serve, and in the case of Ignite Minnesota, their families and home environments. This work contributes to practice by providing practical and actionable guidance for brokering families into STEM. By creating a culturally relevant framework for family engagement, as well as a guide for eliciting family input and experiences through the listening sessions, the Ignite Minnesota leadership has laid a foundation for a sustainable family engagement strategy across the OST network in the state. Overall, this work has potential to support understanding of the processes and mechanisms through which resilient relational infrastructure is created and support more equitable access to learning opportunities in OST for youth and their families.

References

50 State Afterschool Network. (2025). *Our network*. https://50stateafterschoolnetworks.org/

Afterschool Alliance (2021). *STEM learning in afterschool is on the rise, but barriers and inequities exist.* Afterschool Alliance.

Afterschool Alliance. (2022). *Promoting healthy futures: Afterschool provides the supports parents want for children's well-being*. Afterschool Alliance.

Afterschool Alliance. (2025). *Exploring the afterschool STEM educator landscape: Challenges, needs, and opportunities*. Afterschool Alliance.

Allen, S., Kastelein, K., Mokros, J., Atkinson, J., & Byrd, S. (2020). STEM guides: Professional brokers in rural STEM ecosystems. *International Journal of Science Education*, *10*(1), 17–35. https://doi.org/10.1080/21548455.2019.1700317

Anthony, K., & Morra, J. (2016). Creating holistic partnerships between school and afterschool. *Afterschool Matters*, *24*, 33-42.

Barron, B., Martin, C. K., Takeuchi, L., & Fithian, R. (2009). Parents as learning partners in the development of technological fluency. *International Journal of Learning and Media*, *1*(2), 55–77. https://doi.org/10.1162/ijlm.2009.0021

Bevan, B., Michalchik, V., Bhanot, R., Rauch, N., Remold, J., Semper, R., & Shields, P. (2010). *Out-of-school time STEM: Building experience, building bridges*. San Francisco, CA: Exploratorium.

Bodilly, S. J., McCombs, J. S., Orr, N., Scherer, E., Constant, L., & Gershwin, D. (2010). *Hours of opportunity, Volume 1: Lessons from five cities on building systems to improve after-school, summer school, and other out-of-school-time programs.* RAND Corporation. https://www.rand.org/pubs/monographs/MG1037.html

Chew, P., Peppler, K., DiGiacomo, D., Nelligan, P., Sefton-Green, J. (2023). Relational connective tissue: A case study of freedom of movement in culinary learning. *International Collaboration toward Educational Innovation for All: International Society of the Learning Sciences (ISLS) Annual Meeting 2023.* Montreal, Canada: International Society of the Learning Sciences (pp. 218-225). https://doi.org/10.22318/icls2023.404372

Ching, D., Santo, R., Hoadley, C., & Peppler, K. (2016). Not just a blip in someone's life: integrating brokering practices into out-of-school programming as a means of supporting and expanding youth futures. *On the Horizon*, *24*(3), 296-312. https://doi.org/10.1108/OTH-05-2016-0026

Civil, M., & Bernier, E. (2006). Exploring images of parental participation in mathematics education: Challenges and possibilities. *Mathematical Thinking and Learning*, *8*(3), 309–330. https://doi.org/10.1207/s15327833mtl0803_6

Cooper, C. R. (2014). Cultural brokers: How immigrant youth in multicultural societies navigate and negotiate their pathways to college identities. *Learning in Context: Linguistic, Social and Cultural Explanations of Inequality*, *3*(2), 170–176.

Dahn, M., Ito, M., Peppler, K., & Corrigan, S. (Under review). Multi-layered brokering: How a statewide network supports OST learning opportunities for youth.

Dahn, M., Peppler, K., & Ito, M. (2023a). Making connections to and from out-of-school experiences. *Review of Research in Education*, *47*(1), 443-473, https://doi.org/10.3102/0091732X231211271

Dahn, M., Peppler, K., & Ito, M. (2023b). "We hear everyday, 'This isn't me.'" Translating interests toward STEM through entrepreneurial making. *Frontiers*, *7*(2), 1-6. https://doi.org/10.3389/feduc.2022.1033742

Dou, R., & Cian, H. (2024). *Considering the Family-Centric STEM Identity Development (FSID) Model to support cultural inclusivity in the design of STEM learning experiences.* Paper presented at the National Association for Research in Science Teaching (NARST) Annual Conference.

Ennes, M. E., Jones, M. G., Chesnutt, K., Cayton, E., & Childers, G. M. (2023). Family science experiences' influence on youths' achievement value, perceived family value, and future value of science. *Research in Science Education*. https://doi.org/10.1007/s11165-023-10116-7

Gasiewski, J. A., Eagan, M. K., Garcia, G. A., Hurtado, S., & Chang, M. J. (2012). From gatekeeping to engagement: A multicontextual, mixed method study of student academic engagement in introductory STEM courses. *Research in Higher Education*, *53*, 229-261.

Ishimaru, A. M., Torres, K. E., Salvador, J. E., Lott, J., Williams, D. M. C., & Tran, C. (2016). Reinforcing deficit, journeying toward equity: Cultural brokering in family engagement initiatives. *American Educational Research Journal*, *53*(4), 850-882. https://doi.org/10.3102/0002831216657178

Ito, M., Arum, R., Conley, D., Gutiérrez, K., Kirshner, B., Livingstone, S., Michalchik, V., Penuel, W., Peppler, K., Pinkard, M., Rhodes, J., Salen Tekinbas, K., Schor, J., Sefton-Green, J., & Watkins, S.G. (2020). *The*

Connected Learning Research Network: Reflections on a decade of engaged scholarship. Connected Learning Alliance.

Janssen, J., Seaton, E., Jager, J., & Miller, C. F. (2022). Guidance or gatekeeping: An audit examination of racial discrimination in leading STEM high schools: Systems that marginalize BIPOC youth special issue: Dismantling oppression series. *Journal of Research on Adolescence*, *32*(2), 625-635.

Kania, J., & Kramer, M. (2011). Essentials of social innovation: Collective impact. *Stanford Social Innovation Review*, *36*, 41. https://ssir.org/articles/entry/collective_impact

Kekelis, L., Ryoo, J. J., & McLeod, E. (2017). Making and mentors: What it takes to make them better together. *Afterschool Matters*, *26*, 8-17. https://eric.ed.gov/?id=EJ1160841

Kirshner, B., Chang-Order, J., Harris, M., & Horne, K. V. (2019). Building and brokering pathways in new media arts: A new dimension of youth programme quality. In *Young People's Transitions into Creative Work* (pp. 138-156). Routledge.

Koch, M., Georges, A., Gorges, T., & Fujii, R. (2012). Engaging youth with STEM professionals in afterschool programs. *Meridian*, *13*(1).

Kricorian, K., Seu, M., Lopez, D., Ureta, E., & Equils, O. (2020). Factors influencing participation of underrepresented students in STEM fields: Matched mentors and mindsets. *International Journal of STEM Education*, *7*, 1–9. http://dx.doi.org/10.1186/s40594-020-00219-2

National Summer Learning Association (2016). *Community indicators of effective summer learning systems: Quick reference guide*. NSLA.

Pattison, S. A., Ramos Montañez, S., López Burgos, V., Svarovsky, G. N., Wagner, C., Douglass, A., & Allen, J. (2023, June). *Family voices: Learning from families with preschool-age children from historically marginalized communities to expand our vision of engineering.* American Society of Engineering 23 Education Annual Conference, Baltimore, MD. https://nemo.asee.org/public/conferences/327/papers/37501/view

Pattison, S., Ramos-Montañez, S., Tolbert-Smith, D., Cardella, M., Dou, R., Cian, H., Calabrese-Barton, A., Sedawi, W., Tan, E., López-Burgos, V., et al. (2024, March). *Families matter: Family learning as a central component to equity in STEM education.* Paper presented at the National Association for Research in Science Teaching (NARST) Annual Conference.

Peppler, K., Sedas, R. M., & Dahn, M. (2020). Making at home: Interest-driven practices and supportive relationships in minoritized homes. *Education Sciences. 10*(143), 1-28. https://doi.org/10.3390/educsci10050143

Pinkard, N. (2019). Freedom of movement: Defining, researching, and designing the components of a healthy learning ecosystem. *Human Development, 62*(1-2), 40-65.

Rivera, S., Knack, J., Kavanagh, K., Thomas, J., Small, M. M., & Ramsdell, M. (2019). Building a STEM mentoring program in an economically disadvantaged rural community. *Journal of Educational Research and Practice*, *9*(1). https://doi.org/10.5590/JERAP.2019.09.1.29

Roque, R. (2016). Family creative learning. In *Makeology: Makerspaces as learning environments* (Vol. 1, pp. 47–63). New York: Routledge.

Roque, R., Tamashiro, M. A., Mcconnell, K., & Granados, J. (2021). *Opportunities and limitations of construction kits in culturally responsive computing contexts: Lessons from ScratchJr and family creative learning.* In Interaction Design and Children (IDC '21) (pp. 246–256). New York, NY, USA: Association for Computing Machinery. https://doi.org/ 10.1145/3459990.3460728

Stake, R. E. (1995). *The art of case study research*. Sage.

Stanton-Salazar, R. D. (1997). A social capital framework for understanding the socialization of racial minority children and youth. *Harvard Educational Review*, *67*, 1-40.

Stanton-Salazar, R. D. (2011). A social capital framework for the study of institutional agents and their role in the empowerment of low-status students and youth. *Youth & Society*, *43*(3), 1066-1109.

Su, D. (2008). *Resources, religion, and refugees: Observations on hidden capital in two Cambodian American language schools*. Paper presented at the Bridging Multiple Worlds Alliance. CA, San Jose.

Yin, R. K. (2009). *Case study research: Design and methods*. Thousand Oaks, CA: Sage.

Young, J., Ortiz, N., & Young, J. (2017). STEMulating interest: A meta-analysis of the effects of out-of-school time on student STEM interest. *International Journal of Education in Mathematics, Science and Technology*, *5*(1), 62–74. https://doi.org/10.18404/ijemst.61149

Acknowledgments

This research was funded by the Gordon and Betty Moore Foundation and STEM Next Opportunity Fund. We would like to thank our state network and program partners for their time, insights, and collaboration.