International Society of the Learning Sciences

Systems, values, and conceptions shaping computing education in refugee support organizations

F. Megumi Kivuva, University of Washington, megumik@uw.edu
Eman Sherif, University of Washington, emans@uw.edu
Belén Edgar, Northwestern University, belenedgar2026@u.northwestern.edu
Amy J. Ko, University of Washington, ajko@uw.edu

Abstract: Refugee support organizations (RSOs) provide computing education for refugee youth. However, prior work has not yet examined how organizational systems and values shape learning about computing. These dynamics are important because RSOs' structures and practices directly influence access to equitable computing opportunities. We conducted a case study of one Youth STEAM Program, analyzing observations, interviews, and lesson plans to examine computing education through the lens of the Ecological Systems Theory and critical pedagogy. We found that multi-level constraints, such as funding, transportation, and translation, staff content knowledge, and reliance on external partnerships, restricted access to and depth of computing education. Culturally responsive and justice-centered practices built belonging and engagement, but tension at the micro, meso, and exosystem levels curtailed participation. Addressing these limits requires justice-centered coordination that aligns organizational values, resources, and pedagogy.

Introduction

Learning is a central part of resettlement for refugees, as many seek opportunities for computing education specifically (Arawjo & Mogos, 2021; Benton & Glennie, 2016; UNHCR, 2023). Computing skills are needed to safely navigate the digital world, access job opportunities, and shape the technologies and policies that impact their communities (Bagiati et al., 2022; Francis, 2019; Mason, 2018; UNHCR, 2019). We define computing education as teaching and learning computer science principles, such as programming, algorithms, and data, coupled with the socio-technical implications of technology, including how computing shapes and is shaped by identity, culture, power, and equity (Kafai & Burke, 2014; Vakil, 2018).

Refugee support organizations (RSOs) play a pivotal role in providing refugees with computing education opportunities. In our research-practice partnership (Coburn et al., 2013) with a refugee support organization, anonymized as RSN, a specific knowledge need emerged: the organization expressed uncertainty about its computing education programs and wanted to know how its current approaches benefited students' learning. This need may reflect a broader need among refugee support organizations to align their support goals with refugees' desire to participate in the digital economy.

RSOs operate at the intersection of multiple systems, shaped by nonprofit goals, community needs, funding opportunities, and political landscapes (Darrow & Scholl, 2020; Roberts, 2024). Prior work often highlights informal learning in refugee support organizations, but does not specifically examine computing education. Because computing education is relatively new in K–12 learning and labor-market-salient, refugee support organizations face unique gaps in capacity, tooling, and professional development, calling for computing-focused interventions and capacity building. Understanding this gap could help guide program design, enhance student learning, and inform best practices for computing education in RSOs. Because RSOs operate within complex systems, understanding how such organizations shape computing education for refugee youth requires attention to both the content taught and the systems, values, and constraints that facilitate learning about computing (Bronfenbrenner, 1979, 1986, 1992).

Prior work shows that a systems lens on learning is particularly important because it exposes how structures broadly shape learning; this lens is particularly crucial for refugee learning, which is influenced by systems-level interactions (Darrow & Scholl, 2020; Roberts, 2024). Therefore, we ask: **What are the systems, values, and conceptions that shape computing education in refugee support organizations?** We conducted a revelatory single-case study (Yin, 2018) of RSN's Youth STEAM Program through an ecological systems lens, analyzing observations, ad hoc staff conversations, semi-structured interviews with staff and a funder, and lesson plans. We found that tensions across ecological systems constrained equity-centered values, despite youths' strong interest, funding limits, family capacity, and limited instructor content knowledge, which restricted participation in and the rigor of computing education. While our results are specific to RSN, the constraints it faces, such as scarce resources, shifting demographics, and partner dependence, reflect those in the

broader global network of refugee support, suggesting the transferability of our findings (Darrow & Scholl, 2020; Roberts, 2024).

Background

Systems Theory

Bronfenbrenner's (1992) Ecological Systems Theory (EST) provides a framework for understanding human development within the multiple environments surrounding an individual. EST emphasizes how development is shaped by interactions across layers: the microsystem (direct settings like family and school), the mesosystem (connections between microsystems), the exosystem (indirect influences such as community structures and parental workplaces), the macrosystem (broader societal and cultural forces), and the chronosystem (time, including life transitions and socio-historical contexts).

Complementing EST, Freire's (1970) critical pedagogy highlights power dynamics and oppression, emphasizing "conscientization," whereby learners develop critical awareness of social, political, and economic inequities and act to challenge them. In computing education, critical pedagogy helps examine how organizations enact values of equity, inclusion, and access (Ko et al., 2022). Together, EST and critical pedagogy illuminate how organizational values translate into students' emerging critical consciousness, while systemic constraints may limit their realization.

Systems Perspectives on Refugee Learning Support

Prior work demonstrates that ecological systems and critical pedagogy meaningfully shape refugee learning. For example, studies using EST show that leadership at the exosystem level played a crucial role in mitigating negative sentiments about immigration in society (macrosystem) while supporting refugee families at the microsystem level, and ultimately, that collaboration between superintendents and community leaders can promote inclusive policies (McBrien, 2022). Additionally, leveraging students' funds of knowledge and providing professional development for culturally competent teaching further supports student-centered learning (McBrien, 2022; Ryu & Daniel, 2020). Likewise, critical pedagogy creates inclusive learning environments that foster student voice and agency, develop students' critical consciousness, and strengthen belonging and retention (Couch, 2017; Magee & Pherali, 2019). While these approaches illustrate what supportive and responsive refugee learning might look like, little is known about whether and how refugee support organizations implement these practices, particularly in computing education.

Systems Perspectives in Computing Education

Research on computing education shows that systemic inequities operate across ecological levels, shaping access and learning outcomes, and that multi-level interventions are needed to promote equity. Margolis (2017) illustrates how societal biases, district policies, and teacher expectations systematically limit Black and Brown students' access, while Perdriau et al. (2024) show that informal programs can inadvertently reinforce dominant cultural norms despite equity intentions. To address these inequities, prior work recommends centering student voice and identity in the microsystem (Yadav & Heath, 2022), implementing culturally relevant pedagogy in the mesosystem (Eglash et al., 2013), and applying transformative justice principles at the meso- and exosystem levels (Erete et al., 2021). Systems-level analyses further highlight how societal attitudes and political tensions shape teachers' adoption of tools, underscoring the need for coordinated action across ecological levels for sustainable, equitable change (El-Hamamsy et al., 2023; Herselman et al., 2018; Michell et al., 2018). These findings indicate that equitable computing education requires interventions across interacting systems and fostering students' critical consciousness and agency.

Although prior work helps us identify potential research findings, it primarily focuses on computing education in schools of computing. Informal learning environments often address critical gaps in formal education for marginalized communities (Kaukko et al., 2022; Noguchi, 2017). However, the ways these spaces integrate community knowledge and foster critical praxis for CS education remain underexamined. Additionally, we know little about how refugees' diverse lived experiences and cultural and linguistic backgrounds shape their engagement in computing education. Our research aims to fill these gaps by uncovering how systems, values, and conceptions influence CS learning within refugee support organizations.

Context and Methods

Positionality

Our identities, experiences, and backgrounds shape how we approached and conducted this research. The first author is an African immigrant and a PhD student exploring the intersection of refugee support and justice-centered computing education. Having volunteered weekly at RSN for three years and co-developed a research-practice partnership with the organization, they embrace subjectivity as an asset (Finlay, 2002; Koopman et al., 2020), engaging reflexively with participants and colleagues to produce rigorous, responsive insights.

The second author, also a PhD student, studies how students' identities intersect with computing culture and course policies, focusing on equitable computing assessments and the emotional impacts of computing, guided by an asset-based framing and a commitment to centering student voices. The third author, an undergraduate researcher and child of an immigrant parent, investigates computing pedagogy that cultivates inclusive learning environments shaped by student identity, reflecting critically on their own biases to ensure rigor and fairness. The fourth author, a third-generation Chinese-Danish American, draws on intergenerational perspectives shaped by their grandparents' experiences as refugees and immigrants to advise and support the first author's community engagement, actively managing personal biases through curiosity and historical reflection. Our positionalities inform a reflective, participatory, and justice-centered approach to this work. We engaged in continuous reflexive processes, such as in-depth discussion and reflection, enabling us to critically examine how our identities, assumptions, and experiences shape data collection, analysis, and interpretation.

Context

RSN is a refugee support organization located on the Pacific Northwest coast of the United States. RSN provides services across the lifespan, including ESL and digital literacy classes, job search assistance, early childhood education, after-school programs, and college-readiness support. The organization, highly regarded in refugee and social service communities, has served refugees for 40 years and is funded by private donors and city, county, state, and federal sources. Most of its 100+ staff and board members are refugees, immigrants, or people of color, reflecting the diversity of its clientele. This study focuses on RSN's Youth STEAM Program, which integrates computing education and is free, with food and transportation provided. Students include refugees, children of refugees, and other immigrants; at the time of study, half were Asian, a quarter Hispanic/Latino, and a quarter African, with half speaking a primary language other than English. The program has two components: an **after-school program**, meeting twice weekly at two neighborhood schools with homework help, social-emotional learning, and month-long STEAM units (e.g., Space, Movement, Robotics, Life Sciences); and a **summer camp** for grades 2–5, running 5–8 weeks with daily STEAM topics, outdoor play, reading, and math practice. Computing is taught in both programs using Lego Robotics and Ozobots, small, programmable robots that follow color-coded commands. For example, one summer unit on redlining had students use Ozobots to navigate restricted areas and advocate for change through collective action.

Data Sources

To observe systems, values, and conceptions, the first author collected: (1) **Observational notes** to capture how values manifested in the classroom. (2) **Instructor's lesson plans,** which we compared with the observed instruction. (3) **Semi-structured interviews** with current and former staff and a funder of the youth STEAM program team about motivations, CS experience, and values around computing education.

Participants

This study involved six participants across three organizational roles at RSN. The instructional staff included **Noelani** (former, Hawaiian, White, Filipino, Mexican) and **Dani** (current, Asian American, Caucasian). In their role, they were responsible for curriculum development, instruction, and student learning evaluation. Academic case management was handled by **Aisha** (current, Somali/African American) and **Freddy** (former, Latino), who translated and liaised between RSN, families, and schools while providing classroom support. Program coordination and management were covered by **Harriet** (former, White/Caucasian), **Sophia** (current, Black), and **Hannah** (current, Black), who collectively supervised staff, coordinated partnerships, managed grants, and ensured funder compliance. **Beyoncé** (current, Black) served as the summer camp funder from the city's Department of Education, performing site visits throughout the summer. All participants identified as female, except Freddy, who identified as male. We collected demographic information through a self-reported, free-response survey.

Data Analysis

We used the *Framework Method* to systematically analyze our data (Goldsmith, 2021; Ritchie & Spencer, 1994). It involves creating an analytical framework by identifying key themes in the data, both inductively and

deductively, and then applying it to code and interpret the data. The method unfolds through five steps: *familiarization* with the data, *identifying a thematic framework*, *indexing* the data according to the framework, *charting* the data to summarize patterns, and finally, *mapping and interpreting* the findings. All authors comprised the analysis team. Authors 1-3 participated in all data analysis steps, while author 4 provided an external, supervisory perspective, questioning our interpretations and ensuring the rigor and soundness of the analysis, as recommended by Richie & Spencer (1994).

We *familiarized* ourselves with the data by first reading all the interview transcripts, lesson plans, and observational notes. As prior work suggested, we then analyzed a subset of our dataset, Dani and Hannah's interview transcripts. We inductively coded them, identifying significant statements, categorizing them into systems, values, and conceptions, and generating initial themes (Goldsmith, 2021; Ritchie & Spencer, 1994).

To *identify a thematic framework*, we interactively combined inductive themes from the previous step with deductive themes from ecological systems theory. We continued working with a subset of the data, Dani and Hannah's interview transcripts. We explored how they reflected on values, conceptions, and interacting systems, refining our categories and themes to align across transcripts. For example, both Hannah and Dani mentioned the need for coordination across systems to support access to transportation and translation services. We edited our initial codes to ensure consistent language for each code, such as "Organizational Infrastructure" (under the Systems category) and "Equity and Accessibility" (under the Value category). We ensured our framework supported multi-level and cross-category coding by editing the spreadsheet to allow multiple selections. Finally, we tested our framework by applying it to a third transcript, Beyoncé's, comparing themes and categories. We continued refining our framework by renaming, collapsing, and expanding themes until we reached consensus.

During the *indexing* phase, we applied the framework across our dataset (Goldsmith, 2021). We then organized our data in the *charting* phase, with rows in a spreadsheet representing significant statements from each dataset and columns representing the framework themes. This facilitated cross-case comparison and synthesis to help identify patterns (Goldsmith, 2021; Ritchie & Spencer, 1994). We consistently revisited our chart to adjust definitions, combine some themes, and abstract others. With each addendum to the chart, we discussed changes in detail until we reached consensus. To complete this analysis phase, we invited the 4th author to review the chart, serving as a skeptical voice to ensure rigor and soundness.

Finally, we engaged in the *mapping and interpreting* phase, which involved synthesizing the charted data to produce analytical claims. These claims represented findings that explained how systems, values, and conceptions shaped computing education at RSN. We identified patterns, systemic tensions, interactions, and points of alignment, both within and across categories. We framed the findings to illustrate how each theme stems from RSN's commitment to equity, inclusion, and access, and to highlight the systemic and instructional barriers that constrained the program's ability to achieve these objectives.

Results

We identified four themes describing how systems, values, and conceptions of computing intersected within RSN's STEAM Youth Program. Across these themes, ecological systems shaped computing education in ways that reflected the program's commitments to equity, inclusion, and access, and staff conceptions of CS, even when incomplete, were generally oriented toward those same values.

Funding constraints created transportation and communication barriers for staff to serve students equitably

The STEAM program had a value in lowering systemic barriers to participation for refugee youth and their families. While the meso (staff and families) and exosystems (funders) aspired to meet those needs, tensions across these systems prevented the STEAM Program from fulfilling needs such as transportation and translation.

Transportation:

Students and families relied on RSN for transportation home after the afterschool program and to and from the summer program. However, within the meso and exosystems, limited van space, family capacity to provide transportation, and rigid funding structures prevented students from participating in the STEAM Program and limited their access to computing education opportunities. With only two minivans in the STEAM program's possession, RSN had limited capacity to transport students to and from programming.

Hannah highlighted that students who would benefit most from computing education could attend the STEAM program only because RSN provides transportation. She explained:

> *Our parents may not have transportation, so being able to have those couple of vans may seem small to us, but I really feel like it helps us stand out and give certain kids the opportunity to experience this type of learning that maybe they wouldn't get. As a matter of fact, I know they wouldn't get it in school.*

Although the program valued providing transportation, restrictive funding limited the STEAM program's ability to meet students' needs. Harriet recalled a grant with a tight timeline and remarked:

> *It would be incredible to have unrestricted funds. An awesome foundation gave us $10,000 only for field trips. By the time we had those funds, it was the fall, the summer program was over, and we couldn't use up the money in time.*

Even when funding was available, funders often placed restrictions on its use, blocking access to computing education and preventing the program from addressing other needs, such as daily transportation.

Mesosystem constraints, such as families' limited capacity to provide transportation, also affected refugee youth's access to computing education. Freddy explained, *"The program is free, but sometimes just getting there is the problem. Some families don't have cars or time to walk with kids."* interaction between the mesosystem, families, and the STEAM program, in addition to the funding landscape (exosystem), directly shapes students' access to computing education, as they play important roles in determining whether a student can attend the STEAM program. If students could not attend the STEAM program, they did not have access to the computing education it provided.

Translation

Students and families faced language access challenges, creating a high barrier to entry in computing education, as communication among staff, peers, and instructors was complicated, as parents couldn't parse consent/onboarding forms, and students struggled to follow directions without an interpreter. Aisha explained:

> *We often speak one of their languages, but it doesn't cover everyone. Sometimes, the student doesn't understand, and neither does the parent. That can make getting started in the program really hard.*

Although there was funding in the exosystem to hire staff and translators for different languages, the student demographics changed faster than the funding allowed. Harriet explained the tension between funding cycles and shifting student demographics, detailing:

> *Our demographics are changing a lot, and the grants do not change as quickly as our demographics do. That's a bit frustrating for me, because our grant outlines that we hire academic case managers who speak Spanish and Somali. So that's how we have to hire. I think that we should have an academic case manager who speaks Mandarin or Cantonese. That's a bigger need for our students right now. But like, we can't really move like that.*

Because grant funding for translation did not keep pace with shifting student demographics, RSN was well-equipped to serve some language groups but not others, affecting recruitment and retention. These findings show how the organizational goal of reducing systemic barriers is constrained by interacting ecological systems: at the microsystem level, students and families relied on translation and transportation support, while rigid exosystem funding failed to adapt to changing demographics, reflecting broader macrosystem inequities. Together, these tensions shaped which students could meaningfully access computing education and highlighted structural constraints that limited the organization's ability to realize its equity-focused goals.

Staff's varying conceptions of computing and limited content knowledge created barriers to implementing sustained, culturally responsive, and justice-centered computing education

Our findings revealed that the STEAM program valued sustained, culturally responsive, and justice-centered computing education. However, varying conceptions of computing and the instructor's limited content knowledge often constrained what learning was possible. For example, Harriet thought of computing as using computers, explaining that *"Computers are magic and I don't understand how they work.*" Some RSN staff positioned computing as a basic everyday literacy and competence that helped ease students' fears of technology and build the skills they needed for school, work, and their daily lives. Noelani noted, *"part of my role is to help students not be afraid of expanding technology, because computers are in nearly every job, even in the arts."* Similarly, Dani emphasized that: "*Computers are inextricably a part of education nowadays… You need more than just the ability to open a laptop; you need high-level, usable skills*." Harriet shared that computing required physical tools like robots: "*Hands-on technologies like Spheros are important entry points to computer science.*" Hannah viewed computing as a way of problem-solving and critical thinking, emphasizing that it is open to all who wish to learn, *"[Computer science is] breaking down problems that relate to computers, looking at how they work, looking at algorithms, looking at data, and solving problems. There is this view of science nerds. But anybody can partake in computer science activities."*

Dani occasionally connected computing to culturally responsive and justice-centered topics, such as redlining; however, she often struggled to debug or troubleshoot the issues students faced. One of Dani's lessons simulated redlined geography using the Ozobots. Students had to complete tasks within a given map, navigating around *"can't code here zone."* Dani then concluded the lesson by having students advocate for change through collective action. Dani wrote in her lesson plans: *"It will become impossible to complete everything because certain tasks will be placed outside the red-bordered map. Solutions: Map in the Mayor's office and stage a policy sit-in"* Although the lesson was designed for students to understand the impact of redlining on their community and advocate for change, while completing the activity, students faced difficulties with the Ozobots and color-codes. Some robots were not charged, others were broken, and some were not working due to student user error. Throughout the lesson, Dani struggled to adequately troubleshoot students' issues, and many were unable to complete the activity and connect the computing concepts to the broader theme of redlining. Dani expressed that she was not confident in teaching technically rigorous concepts. After completing the first computing lesson using Ozobots, Dani reflected with the first author. Their field notes detailed:

> *"She talked about having less content knowledge than yesterday's thermal energy lesson and mentioned feeling insecure. She said she didn't have 'tinkering time' to explore using the robot, so troubleshooting was a bit challenging during the lesson."*

This shows that at the microsystem level, computing lessons were imbalanced. Although pedagogically strong, Dani's limited content knowledge in computing impeded her ability to fully execute the lesson plan.

Dani's teaching insecurity was exacerbated by the students' strong desire to move past introductory Ozobot lessons (color codes, simple sequencing) into more complex work, such as block-based programming with LEGO Education modules. We observed this during the last week of the summer program, when students had the opportunity to revisit any topics they had learned and conduct a more in-depth exploration. Despite Dani's Ozobot lessons, many students chose to explore Lego Education modules, inspired by a lesson taught by the first author on building robots to create an accessible amusement park for people with disabilities. For example, one group created two grabbers, a small one and a big one. They explored how people with disabilities, along with the affordances of both designs, could use these grabbers. They used block-based programming to code the grabbers and explained to the class how their code worked. Students chose to learn more complex programming, and their projects demonstrated creativity, curiosity, and meaningful engagement with computing concepts.

These tensions operated across multiple levels. Students' curiosity and drive outpaced what instructors could support, and the absence of structured computing professional development left Dani and other staff without a shared foundation for what computing even meant in this context. This gap showed up most clearly in moments like Dani's redlining lesson, where a well-designed, justice-centered activity broke down because she lacked the technical footing to troubleshoot when things went wrong. Dani named the uncertainty herself: "I just don't know exactly how transferable the skills that they got from the Ozobots are going to be when learning how to code." The STEAM program's commitment to justice-centered computing education was real, but without support for instructors to build computing content knowledge alongside their pedagogical strengths, that commitment could not always be fully realized.

Funding limitations and inconsistent community partnerships created barriers to delivering the computing education staff valued

Challenges in securing external funding and maintaining community partnerships hindered the STEAM program's ability to teach computing in service of refugee youth's future success, a key value for RSN. Across ecological systems, participants framed computing education not only as a technical skill but also as a foundational one for career readiness, agency, and future life. For example, Beyoncé explained how career development in computing could help refugee youth understand the transferability of their skills:

> *"Let's just say you've been working in retail or in the food industry, and you're maybe applying for a job where you're not really seeing how that's relevant, like career development is really important because it allows you to really think about how your experiences in the classroom, in internships, in part time and full time jobs, whether they're relevant or not, are going to be transferable to a future career. And so I think that is something that our youth need increased help and support with."*

Beyoncé also emphasized the value of equity underlying this work: *"I think there's a real need to provide BIPOC students, historically underserved students, access to STEM knowledge so they can make their own decisions and aspirations around STEM careers."*

Dani highlighted how computing skills influence many different professions, *"If people know computer science, they can also be more helpful or successful in other areas. Other professional areas, like education, like business?"* Similarly, Sophia framed CS as integral to supporting youth transition into

adulthood: *"It's very important, very important, because I mean, essentially, they're kids now. But you know, we're trying to make the transition to adulthood a lot easier."*

However, staff encountered a funding obstacle to offering computing education to help refugee youth access future opportunities. Sophia plainly stated: *"Funding. That's all the answers to our issues. Getting funding is challenging."* Additionally, Dani mentioned the lack of community partnerships as a systemic gap that stifled their ability to teach computing. Given the staff's limited knowledge of computing education, the organization has largely relied on external partners, including volunteers, STEM-focused community organizations like the science center, and tech companies, to provide computing programming. Dani explained:

> *Having a lot of partners come in, like consistent partners like yourself. But leaning on community partners and reaching out to more partners. Students, other people with those backgrounds. Right now, the volunteers or the people who come into our classroom don't always have that skill set, either. That's why I would like to see it in our classroom.*

These examples demonstrate how barriers within the exosystem (funding) and mesosystem (community partnerships) consistently undermined the STEAM program's ability to provide the enriching computing education that they believed would benefit their students' future success.

Tensions between funder requirements, family expectations, and staff goals created barriers to centering student and family voice

Centering and uplifting student and family voices and agency were central to the program's mission. Many staff members described intentionally designing opportunities for choice and participation; however, their efforts were often curtailed by systemic challenges across multiple levels. Families often had limited capacity for engagement; programmatic requirements were often tied to external funding, and broader cultural norms surrounding the relationship between family and school hindered the STEAM afterschool program from fully centering on family and student voice.

Within the microsystem, staff emphasized the importance of building in choice and autonomy for youth. For example, Noelani detailed the importance of student choice:

> *I'm really big on choice is voice. Once they feel like they have a little more autonomy, as you said, the buy-in is significantly greater because it's something they're naturally curious about, STEAM. We always want to foster curiosity and encourage it.*

Such a philosophy reflects how Noelani incorporated student voice into her pedagogical practices. Similarly, Dani described her ideal classroom, detailing how she solicits student feedback, *"Feedback this summer was really important. I embedded feedback by having it be a part of our morning circles, and they write 3 wishes that they would want to have happen or make real."* Both instructors highlighted how student voice is integral and intentionally embedded in their lessons; however, tensions still prevailed.

Within the mesosystem, Sophia and Dani often felt torn between the learning expectations families held and their goal of delivering developmentally appropriate computing education. In the observational notes, the first author recounts how they were having difficulty accommodating some parental input:

> *There's a tension here with not wanting to say no to families, but also having to ensure you can create lessons that are age-appropriate for younger students, while also challenging for older students.*

Additionally, varying cultural norms regarding parental involvement in their child's education complicate parental engagement. Hannah explained:

> *A little bit of parental engagement is also beneficial because education in different countries takes different forms. And so what I've learned from my parents specifically is that they want us to handle everything, and we're like, 'No, come on board. We want you to be a part of this. We want you to learn about the American education system, so that you're empowered with that information for yourself and for your students.' So yeah, and it's a work in progress. It's always a work in progress.*

Within the macrosystem, staff explained that some funders required RSN to collect survey data on students' experiences. However, they were written in English and thus required a heavy translational burden. This often led volunteers and academic case managers to pull students one by one to fill out the survey verbally. Additionally, the organization had limited input in creating the survey questions. Lastly, this was the primary source of official feedback for the STEAM program, meaning that student and family voices were captured only through narrow, inaccessible surveys, further reinforcing the disconnect between the program's value of student and family voice and the funding requirements it seeks to bridge.

Discussion

At RSN, relational, identity-centered, and culturally responsive pedagogy within the *microsystem* interacted with *constraints in the meso* and *exosystem*s to shape participation in computing. Access depended on transportation and translation, yet scarce van capacity, limited multilingual staffing, coordination challenges with families, and narrow funding timelines meant some students missed lessons entirely. In the classroom, belonging was fostered, but differing staff conceptions of "what counts" as computing, along with limited content knowledge, led to a focus on color-coded commands rather than open-ended programming. Pathways to future opportunity were similarly bounded. Staff framed computing as foundational for agency and careers, but thin, unstable partnerships and funding gaps narrowed offerings. Finally, while instructors invited choice and feedback, family capacity and norms, and funder-mandated surveys muted authentic participation.

Our work represents a single case study of one refugee support organization. Therefore, rather than striving for statistical generalizability, we aim for *transferability,* as factors such as location, staff capacity, funding, and other resources may vary between organizations. To support transferability, we deliberately selected a prototypical refugee support organization, one that is multi-service, grant-funded, multilingual, and youth-focused, so that readers working in similar contexts can identify points of resonance. Finally, we designed the study for analytic generalization, following Yin's (2018) suggestion to examine multiple embedded sub-units (youth, families, instructors, and partners) and triangulate observations and interviews.

We also demonstrate how refugee youths' access to computing depends on alignment across systems, in which *microsystem* supports (transportation, translation), *mesosystem* coordination between families, staff, and schools, and *exosystem* resources (funding timelines) jointly determine who participates in computing education. This aligns with prior work showing cross-system effects of technology access and refugee education (Dryden-Peterson et al., 2017; Herselman et al., 2018). Furthermore, staff's varying conceptions of computing and Dani's limited computing content knowledge constrained what students could access, even when the pedagogical vision was strong. Culturally relevant activities like the redlining simulation broke down not because of poor design, but because gaps in technical troubleshooting prevented students from connecting computing concepts to broader justice themes. Meanwhile, students' curiosity pushed past what instructors could support, with many gravitating toward more complex block-based programming rather than the color-coding Ozobots when given the choice. This points to a need for *exosystem*-level professional learning that builds computing content knowledge alongside pedagogical strengths, so that justice-centered commitments can be fully realized in practice (Grover et al., 2015; Yadav et al., 2022; Everson & Ko, 2022; Ko et al., 2023).

Moreover, pathways to future opportunity were similarly constrained. Staff framed computing as foundational for agency and careers, but thin, unstable partnerships (*mesosystem*) and funding gaps (*exosystem*) narrowed offerings. These patterns echo low-resource contexts, including limited STEM and outdated technology (Baker et al., 2016), unstable afterschool funding and enrollment (Hall et al., 2010), and informal programs reliant on short-term grants and volunteers (Margolis, 2008), underscoring the need for coordinated, stable partnerships and flexible, sustained funding. While instructors invited choice and feedback (*microsystem*), family capacity and norms (*mesosystem*), and funder-mandated surveys (*macrosystem*) stifled authentic participation, demonstrating how systemic frictions can mute justice-centered goals, thus extending Freirean insights to informal computing contexts (Freire, 1970). Our work shows that computing education in refugee support organizations, therefore, requires **coordination across ecological systems**. *Microsystem* practices, *mesosystem* connections, and *exosystem* supports must align to realize meaningful learning.

Implications

There are many implications for research, practice, and policy. Our findings align with prior work showing that many computing educators feel underprepared to teach technical content (Grover et al., 2015; Yadav et al., 2017). While most computing education professional development (PD) emphasizes technical skill-building, our study suggests it should also align with instructors' values and support them in incorporating student and family voices into practice. This means future research and policy should support professional learning that integrates both technical rigor and value-centered pedagogy. Moreover, funding was a consistent constraint, echoing long-standing evidence from K–12 education that inequitable and restrictive funding structures limit access to rigorous learning (Baker et al., 2016; Hall et al., 2010; Jean Margolis et al., 2017). Our work extends this knowledge by showing how, in refugee support organizations, short-term grants and funder mandates similarly constrain staff's ability to design responsive computing programs, underscoring the need for more flexible, co-designed funding practices. Our work also highlights a need for more education about what computing is and what learning about it entails. Altogether, our findings, like prior work, advocate for coordination across ecological systems. By centering students' experiences, amplifying their voices, and aligning values across systems, informal computing education can both challenge structural inequities and cultivate empowered, critical learners.

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Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant No. 2417014, 2031265, 2100296, 2122950, 2023338658, 2024372363, and unrestricted gifts from Microsoft, Adobe, and Google.