"I'm a little less inclined to do it": How Afterschool Programs' Culture Impact Co-Design Processes and Outcomes

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ABSTRACT

The importance of considering local context and partnering with target users is well established in co-design. Less common is an examination of the adaptations needed when deploying the same co-design program *across* heterogenous settings to maximize program efficacy and equity. We report on our experience co-designing educational games with six culturally and socioeconomically diverse afterschool sites over two years, and insights from interviewing ten program administrators across all sites. We found that even within the same afterschool program network, site differences in organizational culture and resources impacted the effectiveness of co-design programs, the co-design output, and expectations for student engagement. We characterize our afterschool partners into different archetypes – *Safe Havens, Recreation Centers, Homework Helpers*, and *STEM Enrichment Centers*. We provide recommendations for conducting co-design at each archetype and reflect on strategies for increasing equitable partnerships between researchers and afterschool centers.

CCS CONCEPTS

• **Human-centered computing** → Interaction design; Interaction design process and methods; Participatory design.

KEYWORDS

Participatory Design, Codesign, Cooperative Inquiry, Children, Design Methods, Afterschool Programs, Informal Learning, Organizational Culture

ACM Reference Format:
Judith Uchidiuno, Jaemarie Solyst, Erik Harpstead, and Ross Higashi. 2023. "I'm a little less inclined to do it": How Afterschool Programs' Culture Impact Co-Design Processes and Outcomes. In *Designing Interactive Systems Conference (DIS '23), July 10–14, 2023, Pittsburgh, PA, USA.* ACM, New York, NY, USA, 14 pages. https://doi.org/10.1145/3563657.3596006

DIS '23, July 10–14, 2023, Pittsburgh, PA, USA

ACM ISBN 978-1-4503-9893-0/23/07.
https://doi.org/10.1145/3563657.3596006

1 INTRODUCTION

Co-design is a form of participatory design where artifacts are co-created with equal input by design experts and the product's end users [16, 17]. It facilitates the creation of effective and engaging products and illuminates valuable insights about the design context and environment. Co-design is especially important when researchers are not members of the same social or cultural group as the intended users; researchers' expertise often does not extend to the cultural and environmental norms of the setting their work will be used in. It invites community members into the design process to provide insight into how products or programs could be designed for better cultural fit. These benefits of co-design also extend to adult-child settings. Rooted in constructivism [51], adult-child co-design allows children's voices and interests to be represented, with the fundamental idea that children actively construct their knowledge through their lived experiences, and that knowledge is vital and impossible to replicate without their active participation in the design process [51, 52].

Afterschool centers are a great environment to conduct adult-child co-design. They cater to students' varied interests including sports, games, arts, STEM, etc., and routinely partner with external organizations to offer programs that students are highly interested in. Such a setting is ideal when designing games, as it requires expertise from various domains and experiences. In recent years, afterschool STEM programs have been intensely promoted. Demand for such centers exponentially increased during the COVID-19 pandemic and has remained strong even as schools have re-opened [1, 31]. These centers are expected to provide safe, supportive adult-supervised environments and academic, personal, social, and recreational development. Many providers are interested in expanding (or introducing) STEM program offerings and routinely partner with local organizations such as universities, museums, non-profit organizations, and individual community members to provide their students with a wide array of enrichment opportunities (e.g., [27]).

Prior studies have shown successful co-design partnerships with afterschool programs. However, they do not shed light on the socio-cultural values and resources that make particular programs a good fit for co-design vs. other design-based research methods. Afterschool programs vary in resources and serve different populations, but it is difficult to determine which provider characteristics are relevant to the co-design of STEM activities without investigation. What provider-level features might designers or implementors need

to attend to, and what design adaptations may be required? The answers to these questions could have significant implications for the types of research programs or products that can be deployed in different spaces. Ultimately, while individual co-design projects can produce insight into designs that work, and the things that make them work, they have difficulty answering questions about critical tacit factors vital to their success but not easily noticed for their ubiquity within the setting where the research took place.

Our research study adopts elements from comparative research methodologies to address these shortcomings. Comparative approaches seek meaning in the differences between mostly similar cases, e.g., comparative linguistics makes inferences about lost languages by examining trajectories of descendant tongues [2], and comparative case studies narrow down causal factors in complex scenarios by looking at similar phenomena that emerge from disparate sources or divergent outcomes arising from seemingly identical origins [3]. We propose that conducting the same co-design program with multiple, intentionally dissimilar afterschool sites would create a basis for comparison and highlight site-level features and norms that impact the success of co-design programs.

In this study, we employ this comparative co-design research approach to examine differences and barriers to implementing STEM programs across six culturally and economically diverse afterschool centers chosen to represent maximal diversity within a single afterschool network. Our co-design program sought to create a robotics programming video game that would be engaging and practical within each cohort's environment (one game per cohort). Each site's implementation spanned approximately 20 weeks and focused on co-designing a robot programming game that the youth in each cohort would like to – and be able to – play in their afterschool center. Unsurprisingly, the co-design process produced design inferences that resulted in games with entirely different genres, mechanics, and thematic emphases. In this paper, we compare the implementations of the co-design program itself across the different settings and highlight practices that maximized our success with each cohort. Further, we also present site administrator insights about their culture, our program, and students' engagement. We investigate the following research questions: *How might an afterschool center's purpose and cultural values affect 1) the ways learners participate, 2) the structure of co-design programs, and 3) student engagement with game co-design programs?*

By comparing these phenomena across our multiple parallel implementations, our research highlights provider characteristics that determine the success of STEM programs of various shapes across afterschool environments.

2 LITERATURE REVIEW

2.1 Co-designing with Children and Diverse Youth

Co-design is a participatory design method in HCI that involves creating social, socio-technical, and technological systems in collaboration with end users [16]. It involves an intentional distribution of design responsibility from the traditional authority figures such as architects, game designers, researchers, software engineers, etc. to other stakeholders and users with diverse perspectives on the system being designed [43, 47]. Through co-design, better ideas, a deeper understanding of needs, increased creativity, and improved outcomes can be achieved [47].

Previous research has demonstrated that kids from various backgrounds bring unique and diverse perspectives to the process of co-designing [30]. In adult-child co-design, all participants work together to develop technology for children, relying on children's expertise about childhood and their personal experience as users [67]. In most adult-child interactions, adults usually have authority; therefore, co-design facilitators employ strategies to deliberately reduce their power and allow kids to have equal participation in the co-design process [44]. The interactions between adults and children in co-design typically span four dimensions - facilitation, relationship building, design through action, and elaboration - with either adults or children having more influence in certain areas [67].

The process of conducting adult-child co-design has been extensively documented by researchers such as Druin et. al [16] ad Guha et al. [23] in several HCI conference and journal publications. They describe different levels of involving children in the design process including users, testers, informants, and design partners. In most co-design studies, children participate as 'design partners' and are involved in all phases of conceiving, developing, and producing technology artifacts [23]. Co-design typically involves small groups of children to adults (2:1 ratio), and uses techniques such as *bags of stuff* where students utilize basic art supplies and play materials to create low-fidelity prototypes. Regardless of the co-design approach, the most important aspect of a design partnership is idea elaboration where adults and children critique and build upon each other's ideas to create effective products [24].

There are several published research studies on successful adult-child co-design partnerships in game design. For example, Bonsignore et al. [6] worked with Black and Hispanic teenagers aged 13 to 17 to co-design a STEM-based alternate reality game for their peers. This collaboration resulted in original game elements and provided new insights into attitudes toward STEM subjects. Similarly, Mazzone et al. [40] collaborated with young people to create a game aimed at helping teenagers improve their emotional intelligence. The study identified the challenge of abstract ideas hindering the participants' ability to contribute. Overall, these studies highlight the value of co-creating products with end users using co-design but fail to highlight the characteristics of the context or the resources required to make these partnerships effective.

2.2 The Benefits of Afterschool Centers for K-12 Students

Afterschool programs in the United States offer care and educational enrichment for K-12 students between the close of school and when families return from work (typically 3:00 PM to 6:00 PM) during the school year [18]. These programs provide a safe environment, supervised by adults, for children to get homework support, recreational development, and art and STEM enrichment [18]. Public support for such programs has steadily increased over the last two decades – since 2002, the US federal government has invested over $3.6 billion to support such programs, and their demand is steadily rising [9]. These programs are especially important for youth from low-income communities where unsupervised time

after school has been linked to increased adverse outcomes such as academic and behavioral problems, drug use, etc. [65]. Research studies show that when youth are engaged in structured enrichment opportunities, it increases positive interactions with adults, teaches them skills that they don't acquire in schools, and increases their willingness to take initiative and contribute on challenging tasks [12, 33]. Lauer et al. [34] reviewed 35 studies involving low-income youth and reported that their math and reading scores improved significantly after participating in afterschool programs. Their literature review also highlighted that afterschool programs lead to increased self-esteem, positive dispositions towards school, and reduced behavioral problems such as aggression and noncompliance in academic environments.

Afterschool programs take place in a multitude of environments. Some programs are run by schools, often requiring an additional enrollment fee, even in public school settings. There are also programs organized by local organizations such as churches, and others run by national afterschool program networks, e.g., the Boys and Girls Clubs, YMCA, etc. Transportation to these programs is often coordinated by the afterschool programs themselves or by families of participating students. In addition, specialized programs are frequently provided by local attraction centers, e.g., museums, libraries, zoos, and aquariums, as well as in universities where afterschool programs are part of their research endeavors [17, 67].

Despite the overwhelming demand and support for these programs, not all afterschool programs have equal resources. Some programs need more space to serve their students effectively, and many parents cannot afford to transport their children to out-of-school spaces [22]. Afterschool programs in urban communities struggle with access to recreational facilities, food insecurity, and often lack culturally relevant engagement opportunities [66]. Researchers such as Marttinen et al. have reported challenges with gathering data in low-income afterschool programs such as low compliance, inconsistent attendance, and struggles with persisting through standardized assessments [39]. These studies show that researchers are likely to achieve different outcomes when partnering with different types of afterschool programs – our research investigates how these outcomes may differ when engaging in adult-child co-design in afterschool spaces.

2.3 The Crucial Role that Program Administrators and Mentors Play in Afterschool Programs

Administrators and mentors in afterschool programs provide many benefits, especially for low-income and racial minority youth. Gordon et al. [20] studied the impact of Afro-centric mentorship in an afterschool program that included structured activities celebrating Black culture among Black male youth to counter academic underachievement. Students who received mentoring had significantly higher grades, higher standardized test scores in math, and a higher GPA compared to the control group, as well as a higher endorsement of racial identity attitudes. Students reported receiving help from administrators across a broad range of values in addition to their schoolwork, such as self-control, respect, responsibility, etc. compared to the control group who only reported receiving help from volunteers concerning their schoolwork. Similarly, Rhodes et al. [53] investigated how mentorships affected academic performance. They matched students in the experimental group with staff based on shared interest, geographic proximity, and same-race match preference, meeting three times per month with relationships averaging 12.9 months. They interviewed the control and experimental groups at the start and 18 months later regarding parent relationships, scholastic competence, grades, attendance, school value, and self-worth. Researchers found that the experimental group experienced improvements in relationships with their parents, decreased unexcused absences, and had higher perceptions of their academic competence.

Administrators also provide valuable insight into the social and psychological issues that youth experience and work on holistic strategies to address them. Lakind et al. [32] conducted interviews with administrators to uncover their perceptions of students' risk factors, their roles in students' lives, and their expectations of students' daily responsibilities. Risk factors identified include unsupportive parenting styles, low parental support due to work schedules and other demands, home-level instability, unstable parental employment, and as a result, unpredictability due to poverty. Administrators shared that it was vital for them to embody behaviors such as kindness, charisma, resilience, humor, personality, adaptation, family support, and perseverance. They saw the establishment of close relationships as the key to supporting youth and accomplishing academic goals. They viewed their primary role daily as "fostering, nurturing, and maintaining close, positive one-on-one relationships with their mentees" rather than simply helping with academic work. Recognizing the importance of administrators in afterschool programs, we interviewed them to gain valuable insights about their program culture, the types of students they serve, and their expectations for student participation. We compare insights gained from these interviews with working with youth over two years and discuss ways to foster more effective co-design partnerships with different afterschool programs.

3 METHODOLOGY

We reflect on our experience co-designing transformational video games with six geographically and socioeconomically diverse afterschool centers during the 2021-2022 academic year. We collaborated with an afterschool organization in the mid-Atlantic region of the United States with 15 clubhouses in demographically diverse regions of the city. The goal of our program was to create a video game where players program robot partners to accomplish goals together. We intended for the game to be an educational product and a pedagogical exercise to foster students' identity as designers and increase their programming and robotics domain knowledge. The entire program ran for 20 weeks and focused on the co-design of game characters and narratives, block programming instruction, and game testing and iteration.

The first 7-8 weeks were dedicated to co-designing the game. In this capacity, students were informed that they were partnering with our research team to create a video game where they collaborated with a robot by programming it to accomplish their in-game goals. Using different co-design instruments and activities, we explored diverse game narratives, co-created game characters and settings, and negotiated game mechanics. The next 8 weeks were

Table 1: Afterschool Site and Demographic Description

Afterschool Center	Neighborhood/Site Description	# Of Students Participants	Student Demographic Information
Green Hill	Low-income town – Predominantly Black, some White, and some Hispanic.	30	10 girls/ 20 boys; ages 5-14;
Central Rise	Low-income neighborhood in the city center – Predominantly Black	12	12 girls; ages 11-14
Golden Grove	Middle-class urban neighborhood – Predominantly White, some Black and Asian	10	5 girls/ 5 boys; ages 7-12
West Creek	Middle-class suburban town - Diverse (including White, Black, Hispanic, Middle Eastern, and multiracial)	48	21 girls, 27 boys; ages 5-12
Sunny Pond	Working-class suburban town – Predominantly White	19	6 girls, 13 boys, ages 7-12
Clear Bridge	Middle-class rural county – Predominantly White	10	7 boys, 3 girls; ages 6-10

focused on block programming instruction to equip students with the skills needed to program their robots. This time also allowed our software development team to create a prototype game version. Finally, we iteratively tested the game with students during the last four weeks of our program. Students tested and critiqued prototype and beta versions of their game, often modifying the game elements, narratives, and mechanics before finalized game versions were presented for testing.

Each co-design session was one hour long and consisted of snacking and icebreakers, scheduled co-design activities, and playing diverse-genre video games from a curated selection e.g., role-playing games, scrolling platformers, racing games, puzzles, first-person adventure, etc. The afterschool staff members sometimes joined our sessions and assisted with their facilitation. We designed our program for attendance by 6-8 students but adjusted it to accommodate much larger groups as necessary. We obtained written consent from students' parents/guardians, and our research was approved by our university's Institutional Review Board (IRB). All site names used throughout this paper are pseudonyms.

3.1 Program Partners and Participants:

Before the start of our co-design program, we interviewed staff members at each afterschool center, as well as some organization-level administrators, to learn about their center's goals and priorities, the culture of their program, the families and students they served, and the resources they had available for STEM programs. We also interviewed some of the same staff members at the end to reflect on the efficacy of our co-design program for their students, and ways to better serve them in the future. We conducted a total of 15 interviews with 10 staff members and administrators – 8 staff members were dedicated to their individual centers while the other two administrators served as STEM coordinators for all the afterschool centers in the network. We interviewed 5 men and 5 women (5 White, 3 Black, 1 South Asian, and 1 Hispanic) with a wide range of experience working with the afterschool program network (1- 20 years). Each interview lasted one hour and was recorded for future transcription and analysis. Participants were not compensated for their time but were informed that their participation will allow our research team to better cater to their students. Table 1 shows a description of each of the afterschool centers we partnered with and the students that participated in our co-design study.

3.2 Data Collection and Analysis:

We draw on data collected from the staff interviews described above, observation notes from each co-design session, internal team meeting notes, and student surveys about their technology usage and programming experience. All co-design sessions were video and audio recorded with consent from the afterschool program administrators and student families for further analysis. Each session was attended by 2-4 researchers (depending on the number of students), with one researcher dedicated to taking observation notes from each session. After each session, the researchers met to discuss the data gathered and clarify any areas of confusion - these meetings were recorded and transcribed as well. All team members attended a weekly data analysis meeting to review all session interactions from the different network sites, design and refine planned session activities, and reflect on the types of adjustments needed to better serve each afterschool center. We recorded these data analysis meetings and analyzed them as part of the data for our research.

We followed an inductive data analysis approach, conducting a thematic analysis [7, 8] to identify ways that the site differences in organizational goals, resources, activity provision norms, and student participation criteria impacted the effectiveness of our co-design program and required different adaptations. We reviewed the interviews, session observations, and meeting notes for data that provided evidence for each identified theme. After this process was completed, the entire team discussed each theme extensively to clarify all areas of confusion. Where necessary, the team watched session videos as a group where multiple perspectives were needed to unpack the interactions, and we triangulated our findings with

student-generated artifacts to ensure that all evidence was mutually supportive.

4 RESULTS

4.1 Afterschool Partner Archetypes:

We organize this results section by first categorizing our afterschool programs into different archetypes (*Safe Havens, Recreation Centers, Homework Helpers, and Enrichment Centers*) based on insights gained from the staff interviews, then we elaborate on how each archetype influenced our co-design process and product. Framing our findings according to these archetypes provides a structure for communicating our results, and hopefully informs researchers on characteristics that are more likely to present simultaneously for different community partners e.g., afterschool programs in low-income, high-crime communities are more likely to have administrators who serve as parent figures, serve students in low performing schools, and have limited access to technology resources.

4.1.1 Safe Havens: We categorized Green Hill and Central Rise as *Safe Havens*. We interviewed three directors from both programs (two Black men, and one Black woman). These afterschool programs are located in high-poverty neighborhoods with mostly Black and brown students attending low-performing schools. The primary purpose of these sites is to provide a safe space for kids to stay after school. Unlike our other clubhouses, all the students in these clubs qualify for financial assistance and therefore, attend the program for free. They have strong partnerships with local schools – Green Hill is physically located in the local elementary school, and Central Rise has liaisons who work in the schools they serve. Staff members in *Safe Havens* served as enrichment coordinators as well as parent and guardian figures. For example, the program director at Green Hill shared that he regularly raised funds from different organizations to ensure students had clothes and school supplies. On several occasions, he invited hair braiders and barbers to the afterschool programs to ensure students had presentable hairstyles. In both programs, administrators sometimes transported students in their personal vehicles, cooked meals for them, and advocated for them in schools and with their families. Taking on this parental role came easier for all three directors as they could personally identify with the students – they all shared that they grew up in similar neighborhoods, faced similar struggles, and attended afterschool programs with adults that made a difference in their lives. In addition to providing a safe space and serving as parental figures, these administrators shared that exposing students to more opportunities regardless of their interests was important to them.

> "This has always been the problem in these types of hoods. It's just the ability to see things. Whether it be resources or supplies or whatever it may be. My kids just don't see it, my kids don't know it. Sushi . . . things like that. Where people will think that's just regular, that ain't regular out here. So for me, the idea is exposure. I remember going to a tennis camp when I was 10 years old. I didn't care about that tennis camp, not one bit, but now that I'm 31 years old, I can see someone playing tennis on TV and I can appreciate that because at a young age I was kind of exposed. I don't think that the exposure was so much about me becoming Serena's [Williams] little homie. It wasn't about that. It was about me experiencing it not me so much soaking in all of it. So for me, I think it's me reaching to as many kids as are out there. We're going on a walking trail tomorrow. And everybody's like, what are we doing because these city kids have no idea what a walking trail looks like. I don't care if they all go and complain for two hours, the experience is going to be right. They're going to get to my age. They're going to have kids that are going to be like, we're going on a walking trail. I did that one time. I hated it. But now I know what it is, that's the point of these experiences."
>
> Program Director, Green Hill

Although Green Hill is part of a larger afterschool program network, they are physically located at least 30 minutes from the city center and is largely inaccessible by bus. Therefore, they do not benefit from the STEM programming and staff available to the other flagship afterschool sites located in the city. They also have very limited computing infrastructure; when we first started working with them there were only three computers available to both students and staff. Due to the limited opportunities for STEM programming, administrators welcomed long-lasting external programs that can accommodate a large number of students and have minimal infrastructure and staffing requirements.

Despite these difficulties, we found evidence for identity transformation as a result of our partnership with them. Green Hill students filled out a scenario-based survey at the beginning and end of our program, where they indicated the jobs they were interested in having in a fictional robotics tech startup company. These jobs were curated from previous conversations where they indicated the jobs they wanted to have in the future. Students could mark each role (e.g., front desk staff, sports medicine doctor, programmer) on a scale representing career preferences: "This is me!" (high) – "This could be me" (mid) – "I could never do this job" (low self-efficacy) and "I am not interested in this job" (low interest). Figure 1 shows the difference in the student ratings after 1 year of working with them. They had initially rated "programmer" very low as a role, with only 23% rating it as "could be me" or "is me". Instead, they chose roles such as cleaning staff (46%) and were less inclined toward STEM careers in general. By the end of the program, career interest had moved up substantially around the four STEM careers on the list (16% positive to 27% positive), with programming seeing the largest jump of all (23% to 65%).

Central Rise is located close to the city downtown and has better access to STEM programming, university researchers, non-profit organizations, and technology companies. However, they too struggle with maintaining consistent STEM programming as they did not have the staff to provide instruction in-house. Throughout the COVID-19 pandemic lockdown, we were the only external partners available to them. Although they had some donated computers, they were all severely outdated and we had to provide technical support while working with them including replacing missing peripherals, operating system updates, upgrading memory, wireless network troubleshooting, etc.

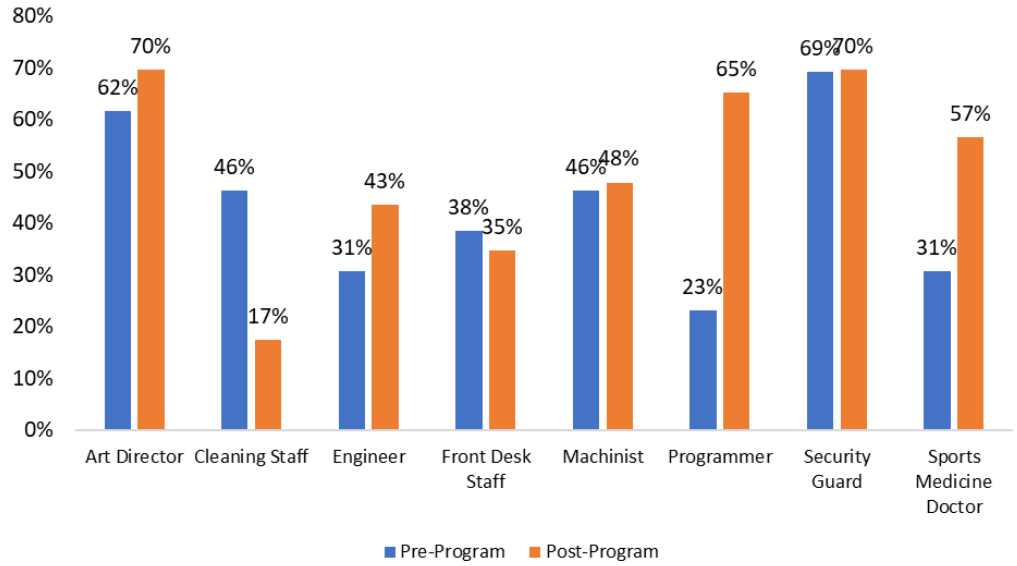

Figure 1: Pre- vs Post Survey Responses on Green Hill Students' STEM Career Disposition

4.1.2 Recreation Centers: We categorized "West Creek" as a *Recreation Center* and interviewed two program directors (one Black man, and one Hispanic man) for this study. Prior to their serving as directors at West Creek, they worked as program directors at Green Hill and at Golden Grove. Therefore, they reflected on their experiences working in different settings.

> "The [previous club] I worked at, there were a lot of people there. We were their father and they, till this day, they call your name and they Facebook you. So, I think that really depends on the neighborhood that you're working in and your role might have to shift depending on the kids that you're working with. [The other director] and I have a bunch of cartoon stuff around our office. And I think that exemplifies the vibe that we have here as kind of a, 'Hey, let's hang out buddy' type of thing. I don't think we have a real patriarchal type feel here. I don't think they look at us as father figure sort of thing. I think we're kind of like one of the homies, you know".
>
> Program Director 1, West Creek

When describing the purpose of their club:

> It seems as if kids either come here for sports or they come here to do the fun kind of hangout things that are happening. So I think that the idea of the club is fun. So when you try to throw something in there that's more educational or something like that. Because I [referring to students], in my mind, I think this shouldn't be happening here. I'm a little less inclined to do it. You know, like when you're in school, if they make a game out of learning, that's exciting. If you go to the club and they make a game out of learning it's like whoa, whoa, what is this? Oh, we don't want to do this.
>
> Program Director 1, West Creek

The culture of fun and youth agency was well understood even by the network-level STEM coordinators:

> West Creek does a lot around maker, but I think some of their structure of programming is a little bit lax as in, um, they very much follow youth voice and youth agency. Sometimes it's harder to run structured programming because they very much adhere to the idea that the afterschool should be fun, and won't participate if it's not fun. It's not that this isn't fun, but sometimes maker and stem initiatives take a little bit of. . . you have to learn to fail before you can get that success, after which it becomes really fun.
>
> Network-Level STEM Director

In addition to a computer lab, West Creek has a gaming room with several video game consoles, board games, and billiards for teenagers. They have an open lobby space with arcade-style video games and consoles, billiards, and table tennis for elementary school-age children. They also have two gyms where multiple sports programs were conducted, an outdoor playground, an art room, and a dedicated maker space. While administrators recommended and encouraged students to join certain activities, the students have the agency to leave and join any other activities in the building at will. We observed several incidents where students joined one activity but were informed by their peers that something more exciting was happening elsewhere encouraging them to leave.

4.1.3 Homework Helpers: We categorized Clear Bridge and Sunny Pond as *Homework Helpers.* We interviewed three directors from

both programs (one white woman, one white man, and one Indian-descent man). Clear Bridge is located in a rural town where White working-middle-class families make up 95% of the population. Sunny Pond, on the other hand, is located in a small town in close proximity to other afterschool programs in the network where working-class White families make up a majority of the population. Although both towns have different economic drivers, several interview participants describe Clear Bridge as the "*more rural version of Sunny Pond*". Families in both clubs primarily signed up their children to get homework help from the coordinators:

> "We are homework help. That's a main one. Parents come to the after-school center for the homework help. They like that we have structure here and that we do the academic things. It's the ability because they [parents] don't understand the math. We do it with them and they think it's quality too. So when they get home, they're not having to worry about rushing around getting homework done. They can actually spend time with their kids."
>
> Program Director, Clear Bridge

Administrators pre-selected students who attended different programs based on their perceptions of student ability and interest – this guaranteed us attendance by some students who were interested in STEM but prevented access to other students who were interested as they could not sign up. At Clear Bridge, administrators gave us a list of students whom they felt were best suited for our program. Kam et. al [28] observed similar behavior from teachers and administrators who tried to "impress" researchers by only offering their "best" students for co-design research. While most of the selected students at Clear Bridge had prior programming experience and game design interests, several other students who could have benefited from the program were left out. During one session, we shared our program information with all the students that attended the club, and seven students (who were not recommended by the administrators) came to us informing us that they were interested in joining the program. Sunny Pond had a more flexible signup structure; like Clear Bridge, the administrator pre-selected the students who they felt were best suited for our program, but they often re-evaluated other students who visited the club and encouraged them to join us.

Both afterschool sites had adequate technology infrastructure and support staff. Clear bridge had a computer lab with touchscreen desktop computers. There was a general space for homework and a maker space with more computers and programmable robots. Sunny Pond did not have a dedicated computer lab, but they had windows laptops available for each student and several classroom-style spaces that were used for different programs. Both afterschool sites had an in-house STEM champion. The program director at Clear Bridge had taught several STEM programs in the past and was regularly soliciting partnerships for new opportunities. Sunny Pond had a dedicated staff member whose job was to facilitate and introduce more STEM programming to the club.

4.1.4 Enrichment Centers: We categorized Golden Grove as a *STEM Enrichment Center*. Golden Grove is located in a mixed-race middle-class neighborhood in an urban city and is the STEM flagship site for all the afterschool programs in the network. They had specialists for the different programs offered at the site e.g., a sports director, an art director, a STEM director, etc. We interviewed two directors whose primary offices were at this site but were responsible for providing STEM programming for all the afterschool programs in the network (two White women). We also interviewed a program staff member (a Black woman) who was responsible for facilitating the STEM programs at that club, and the sports director (a White woman). The culture of the club had been established around the STEM opportunities available to students, sometimes at the expense of other programs such as sports:

> A lot of these kids in our hub right now seem like they come from a stable home, mom and dad both work. So they're a little bit more focused on school. I've noticed they're pretty into STEM. You can't get them to play in the gym. Like they don't want to do that. They want to be on their computers. I mean, I had a kid talking to me about things. I was like, I have no idea what you're talking about, but he was like, I want to be in the robotics program. I just feel like they already bought into it. Like they know that this is the location for STEM because [NETWORK STEM DIRECTOR] is here and she's been doing programs. So it's been a part of the culture here.
>
> - Sports Director, Golden Grove

The building itself had a dedicated maker space, a desktop computer lab, another lab with programmable robots and 3D printers, a game room, and a multipurpose gym. Although their computers were not as updated as those in the Homework Helper sites, they were sufficient for students to engage in all computer-based activities including programming and video gaming. This site regularly had computer science and robotics enrichment options available to students. Enrollment in these programs was typically done by interest-based sign-ups. Flyers were created for each program offering and advertised directly to families in person or publicly via different social media channels. Unlike other sites in the network, families could enroll in each program without attending the afterschool program or having membership in the afterschool network. Despite having two administrators in charge of providing STEM enrichment opportunities for all the afterschool clubs in the network, staff admitted that these opportunities were not (yet) available to all the sites and that they focused on some clubs more than others.

> Currently, we treat every club the same, but in the conversation that I'm having with you, one of the things that I'm thinking about that you just sparked in my mind is that we need really a full-time person, a STEM person at Green Hill, so they can build that culture. The reason that Golden Grove is a little bit further ahead, if at all, is that my first year I really was here at Golden Grove
>
> - Network STEM Director 1

When we asked the other network STEM director about how she distributed her time across all the different clubs in the network, she replied, "*It looks like at this point, I'm going to be three days at the Golden Grove club, and then one day in West Creek, and one*

day in Sunny Pond." Despite being in charge of providing STEM programming for all clubs in the network, she was not always able to provide these benefits to Green Hill and Clear Bridge given that they were located at least 20 miles from Golden Grove.

4.2 Effects of Organizational Resources and Culture on Research Partnerships:

In this section, we reflect on how organizational resources, culture, and goals impacted our co-design process and outcomes with these different afterschool archetypes.

4.2.1 Adapting our co-design process across different archetypes. The number of students that needed accommodation in *Safe Havens* determined whether traditional co-design was practical compared to other design-based research methods. Our program was originally designed for 10 students – this worked well in Central Rise as there were 12 middle school students available to us. However, this was problematic at Green Hill with over 30 elementary school students and no other program offerings. Green Hill staff tried to accommodate us for a while, providing us with 10 students at a time, and sending the other students to play at the gym. After a few sessions, they shared that this arrangement did not meet their definition of equitable provision of programs to their students as they needed everyone to be exposed to all program offerings.

We tried different approaches to exposing students to our program while maintaining the original goal of co-designing with fewer students at Green Hill. We requested half of the students come on one day, and the other half the next day. That was not sufficient as staff members could not guarantee student attendance and regarded every day with each student as an opportunity to expose them to something new. We also requested an extra hour for our program, taking half of the students for each hour. That too was impossible as the students had mandatory homework and dinner timeslots that were not negotiable in the afterschool program. We resolved with doubling the number of researchers so we could offer two sessions simultaneously to accommodate all students. Sometimes we took half of the students for 30 minutes at a time when we did not have enough technology to provide them 1-1 to students. On most days, traditional co-design activities with small groups of students were impossible in Green Hill – condensing students' ideas into cohesive themes was very difficult and the designed games required the most testing and iteration compared to our other groups. The effect of limited STEM program offerings in *Safe Havens* was evident in their familiarity with, and interest in using basic maker materials found in popular co-design programs with children such as cardboard, pipe cleaners, clay [68] etc. Students (especially older boys) perceived these materials as childish and did not understand why they had to create game characters using these materials. They seemed especially sensitive to how their friends perceived them and often engaged in face-saving behavior [15].

With *Recreation Centers*, their goal was to provide a fun space for students that did not feel like school – this made co-design also difficult with this group. Our program was always in competition with other play-based opportunities, so it was challenging to attain student buy-in for the structured portions of our program. This led to our having poor student attendance in sessions where we had to design individual game elements and mechanics, as well as the sessions where we taught them programming skills to play the game effectively. When we started incorporating freestyle gameplay as a way to understand student gaming interests, we saw an increase in engagement and participation from students who typically abandoned our program for other options.

Our co-design program required the least modifications in the *STEM Enrichment Center* and *Homework Helper* archetypes. We were able to cap student signups at the *Enrichment Center* to our capacity of 10 students – the afterschool program had several STEM and non-STEM program opportunities for other students to sign up for. Since signups were based on student interests, we had no problems sustaining student engagement through the game design and programming portions of our program. We also had no trouble with student capacity at the *Homework Helper* site. Administrators signed students up, so we were guaranteed to have enough students but saw mixed reception to our program. Most students were interested in the game design portions of our program as it involved gameplay, storytelling, art, and maker activities. Students sometimes expressed disinterest when engaging in structured activities such as block programming courses on *code.org*, but they persisted and gained the skills they needed to play the games we co-designed. Table 2 shows attendance patterns for students across the different sites:

Table 2 shows that students in West Creek (*Recreation Center*) attended an average of 13% of all sessions, and approximately 4 students were repeats compared to the 48 students we encountered in totality. Despite having 12 students or less, Central Rise (*Safe Haven*) and Golden Grove (*STEM Enrichment Center*) had more than 50% of all students in attendance every week. The table also shows that most students in Green Hill (*Safe Haven*) attended 43% of all sessions - however, this was largely due to months of including some students and excluding others as we tried to maintain a maximum of 10 students in our program. Their attendance became a lot more consistent when we could provide enough research staff to accommodate all students.

Finally, we found that despite our intention to foster equal partnership in our co-design program across all sites, we had to take on different roles to have productive and engaging sessions across the different afterschool archetypes. In the *Homework Helper* sites, we found that we needed to take on the role of teachers as students regarded the space as an extension of school, and identity markers such as gender and race affected students' perception of researchers' knowledge and authority rendering an equal partnership structure ineffective [46]. In the *Recreation Center*, we took on the role of being friends with students to exemplify the culture that they were used to and emphasize we were running a program that was fun to be in and nothing like school. In the *Enrichment Center*, we found that the most effective role was that of a domain specialist - students often came to us talking about related robotics or game design programs that they had engaged in and sought our advice for recommendations for other programs to participate in. In *Safe Havens*, we had to truly become part of the community, serving as parent and caretaker figures just like the other adults in the space. Students' receptiveness of the program increased as we spent more time with them, and this was confirmed by the program administrators.

Table 2: Student attendance patterns across different sites

Club	Archetype	#Students	Avg % of sessions each student attended	Avg # of students per session	Avg # of repeat students per session
Green Hill	Safe Haven	30	43%	15	11.45
Central Rise	Safe Haven	12	71%	8	7.45
West Creek	Recreation Center	48	13%	5	3.95
Sunny Pond	Homework Helper	19	53%	9	5.16
Clear Bridge	Homework Helper	10	50%	7	4.8
Golden Grove	Enrichment Center	10	60%	7	6.05

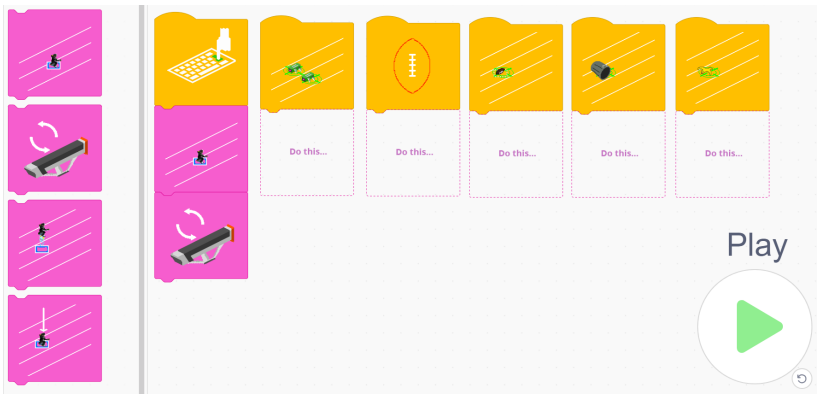

Figure 2: Green Hill Game Programming Interface

> "They [Green Hill Students] were able to just kind of build the relationship with you. My art teacher. . . she didn't come in for the last six weeks. When she comes in, it's like 'art teachers here'. But when you arrive, it's like, 'Miss [1st author] is here'. And I think the more time spent with you was able to kind of get us to like, 'Hey, Ms. [1st Author]'s kind of part of all this'. And they were like, 'yeah, she's part of what we're doing'."
>
> Program Director, Green Hill

4.2.2 The Impact of Different Archetypes on the Co-Design Output. The effect of the limited availability of STEM programming opportunities in *Safe Havens* was evident in students' programming skills, and that in turn impacted the design of the programming interface of their video game. In Green Hill, we encountered only 3 children who had done block programming before. Their programming interface was completely graphical (see Figure 2) as we found that the students were reading and doing arithmetic at one to two grade levels lower than their same-grade peers in other afterschool programs.

The design of each block was a metaphor for stacking interlocking blocks such as Legos or the interlocking cubes used to teach preschool-aged students basic arithmetic. The blocks also featured animated icons rather than text to show students the function of each block as they used them to program their robots. During our playtesting sessions, we accommodated the large number of students by first teaching older students how to do some basic programming with the interface, and pairing them up with younger students so they could provide programming support during gameplay. This was a success – students regardless of their reading levels were able to playtest and provide feedback on the co-designed game. At Central Rise, we encountered only one student who had prior experience with block programming, however, teaching them the basics of standard block programming was relatively easy as they had the prerequisite reading and logical thinking skills. Students in both *Safe Haven* sites had never co-created a game, nor were they familiar with the game design process. Therefore, they expected to create a game similar to the art style and fidelity of commercial games e.g., *Grand Theft Auto* and *Fortnite* (vs. PC browser-based video games). The team had to continuously manage students' expectations of the final product much more than students who had prior game design experience.

At West Creek, most students were dissatisfied with the co-designed game. Based on the very limited input we gathered, we designed a game and hoped that students would find it interesting. They complained that the game graphics looked nothing like their expectations, and they could not see their ideas represented. To help

assuage these complaints, we incorporated items designed by each student into the video game but that had little effect on students' sense of ownership of the co-designed game. Without consistent attendance by most students, it was impossible to reach consensus on any ideas. Some students also found it difficult to play the co-designed game as they had no prior programming experience, and did not attend the sessions where we taught block programming.

5 DISCUSSION

In this paper, we highlight the importance of factoring in organizational goals and culture when undertaking design-based research partnerships with different types of afterschool centers serving K-12 youth. We worked with six afterschool centers in the mid-Atlantic region in the United States over a 2-year period and characterized them into four archetypes: *Safe Havens*, *Recreation Centers*, *Homework Helpers*, and *STEM Enrichment Centers*. We demonstrate using our data that partnering with these different program archetypes requires significant adaptations to research study designs such as the types of research questions that can be investigated, the research staff and resource requirements, the roles that adults play in the space, and the types of products that can be developed as a result of the partnerships. We characterize the different afterschool center archetypes with the following descriptions:

- *Safe Havens:* Afterschool centers whose primary purpose is to provide a safe and nurturing environment for students from low-income neighborhoods, with limited access to STEM resources and enrichment programs.
- *Recreation Centers:* Afterschool centers whose primary purpose is to serve as a play and recreational space for youth, unlike schools, and students are encouraged to only engage with programs that they find interesting on a day-to-day basis.
- *Homework Helpers:* Afterschool centers whose primary purpose is to supplement school instruction and provide homework support on behalf of parents.
- *STEM Enrichment Centers:* Afterschool centers where students enroll specifically to attend advertised STEM programs that align with their interests.

Overall, we found that despite the substantial difficulties we faced with partnering with *Safe Havens*, this archetype had a lot of potential for STEM identity transformation and learning gains. *Safe Havens* will likely require significantly higher staffing and technology requirements, as well as catering to large numbers of students with diverse interests. Students' lower reading, computer programming, and maker skills required significant changes to our program materials and led to a different type of co-designed product compared to other afterschool program archetypes. Despite these difficulties, we advocate for continued investment of research time and resources in *Safe Havens*. University and community partnerships provide access to STEM instruction that students likely do not have access to in school, and expose them to computer science instruction and professionals, narrowing the widening gap between low-income students and their higher-income counterparts. Such programs have been shown to increase the number of students who study computer science in college and increase the number of underrepresented groups in STEM fields [19, 35, 54]. With just 8 sessions of computer programming instruction (30-60 minutes per session), Figure 1 shows that students' interest in a programming job grew by over 150% - these effects are likely to lead to students' participation in STEM fields with continued exposure. Furthermore, research studies show that engaging students in maker activities commonly found in co-design programs lead to several positive outcomes such as increased technology self-efficacy [14], increased knowledge of technical systems [25, 48], and increased technological confidence [57].

5.1 How Afterschool Programs' Culture Impact Co-Design Processes and Outcomes

In *Safe Havens* such as Green Hill where researchers have to work with large numbers of students, traditional co-design programs with low student-to-facilitator ratios may be impractical or too expensive for many short-term projects. The primary goals of such afterschool centers are to keep students safe and expose them to a wide range of enrichment opportunities and life experiences. Therefore, adopting a breath-first approach that exposes students to a broad range of topics in highly engaging ways, rather than focusing on specific learning outcomes may be sufficient. Also, involving children in the co-design as informants [17] rather than design partners that require small student-to-adult ratios may be especially relevant in this context. In situations where researchers have enough facilitators to create small design groups with students, we recommend that groups are formed based on similar age brackets and shared interests. Face-saving behavior was very prevalent in this group, so students may be hesitant to work on projects that seem juvenile or not socially accepted by their peers [15]. Researchers, such as Mechelen et al. [41] have proposed methods for conducting co-design with a large student-to-facilitator ratio (e.g., 1 adult to 20 students) but they require a level of domain familiarity, reading competency, and independent work that the students in our study were yet to attain.

Our research uncovers insights that some traditional co-design techniques such as *Bags of Stuff* may embody assumptions that all students have access to maker and play opportunities that are only available to children from privileged or stable parenting households. Appreciation and enjoyment of such materials as design tools e.g., pom poms, pipe cleaners, etc. may be best utilized by students who have previously engaged in often costly maker programs, or family environments where such materials were available and encouraged for use as play materials. Research studies such as [10, 58] provide evidence that children from low-income families prematurely take on adult roles such as providing care for younger siblings, taking on financial responsibilities, and emotionally supporting their families. Many do not have access to the maker opportunities afforded to their higher-income peers or time to engage in pretend play like children from more stable households. Adapting co-design materials and techniques to be accommodating of children's play experiences may increase their engagement and participation in the co-design process.

Partnering with *Recreation Centers* also posed significant but very different challenges compared to *Safe Havens*. The culture and expectation of the afterschool program as a fun space, with no similarities to school, meant that STEM programs not centered

around play were bound to face very high student turnover and inconsistent attendance. This makes it nearly impossible to gather any pre- and post-test assessments on student learning or identity transformations, and limits researchers' ability to build upon any previous instruction. For such afterschool programs, play is a central part of the co-design process and is especially important for soliciting design preferences that students may not have the metacognition to vocalize. It may be the only vehicle to maintain consistent student participation. Such centers may be best suited for play-based programs with the need for rapid testing and iteration from a diverse group of participants, rather than a traditional design partnership. The high participant turnover in *Recreation Centers* could be approached as an opportunity for proxy first-time user tests since any given individual participant would lack deep familiarity with the co-design activities that had been done so far in the program. One potential strategy to increase student participation was to communicate our program goals, milestones, and output directly to parents so they could encourage their students to attend. However, we did not have direct access to parents and lacked the consistency in output materials per child to make that strategy feasible during our time there.

Finally, we made the least modifications to our traditional co-design program with the *Homework Helpers* and *STEM Enrichment centers*. Student attendance and interest remained consistent throughout our program even through structured instructional materials. Our biggest challenge with *Homework Helpers* was the amount of gatekeeping that students went through to join our program. Administrators primarily signed up students whom they perceived had the STEM interest and skill to benefit from game design and programming instruction. This strategy is likely to exclude students that can potentially make the highest learning and identity transformation gains, which further widens STEM exposure gaps for low-performing and low-income students. It is also more likely to be biased against girls and students of color – research studies show that teachers, despite how well-intentioned they are, often perceive girls and students of color to be less technologically competent compared to their white male counterparts [55]. Researchers in such settings have to regularly educate administrators about the importance of equitable participation in such programs and encourage them to sign up students who may not seem fitting at face value. We also recommend that researchers volunteer themselves to engage with students outside of the co-design activities e.g., helping students with their homework or other recreational activities. Such opportunities might allow researchers to connect with and identify students who can benefit from STEM enrichment programs and advocate on students' behalf to their administrators. Overall, *Homework Helpers and STEM Enrichment Centers* may be best suited for traditional co-design programs requiring consistent attendance by fewer numbers of students but may see limited identity transformations due to students pre-existing high interest in the domain content.

5.2 Toward equitable power and autonomy with different afterschool program archetypes

The primary goal of our paper is to highlight the importance of understanding afterschool program culture to maximize the chances of successful research partnerships. In this section, we reflect on strategies to help researchers engage with afterschool center administrators meaningfully.

5.2.1 Engage program administrators in the design of research programs: When researchers partner with afterschool centers for maker or co-design programs, a common approach is to deploy a preplanned curriculum, rather than involve administrators in the content creation phase [36, 56, 62, 63]. Researchers typically focus on the desired learning outcomes, understanding students' demographic descriptors, and investigating the nuances of the physical environment including available technological tools and experiences [13, 26, 29, 38, 49]. Our study shows that even with an accurate understanding of these factors, co-design programs can still fail without understanding the culture and norms of individual afterschool centers. The failure of top-down approaches in such partnerships is not new or unique to informal learning environments – in 1975, the Rand Corporation conducted a large-scale study on different approaches to K-12 school reform and found that the use of prepackaged programs did not lead to long-term successful outcomes [4]. This approach has also been critiqued by scholarship, including within the HCI community, citing that they exclude the social, cultural, and political subtleties that dictate how afterschool centers run [36, 56, 62, 63]. Uncovering these cultural nuances and values involves engaging with afterschool center administrators, very early in research partnerships, even before the desired outcomes or program materials are developed.

Our research highlights how critical these cultural subtleties are in the success of co-design programs, and advocates for researchers to involve afterschool center administrators in the creation or modification of these programs and partnerships. Similar to studies like [64], we show that administrators in informal learning settings play a crucial role in the engagement culture and students' expectations for participation. Excluding their insights does not take advantage of their expertise in working with the particular student demographic, and potentially leads to missed opportunities for deepening students' learning outcomes. Afterschool administrators are experts at engaging with students – high engagement with youth has been shown to positively impact learning outcomes [60]. Involving afterschool administrators in co-design program creation promotes healthier partnerships, prevents program mismatches with afterschool centers that cost researchers time and resources, and may not be beneficial to the afterschool centers themselves. This increases administrators' domain knowledge, sense of ownership of the program, and makes learning more equitable for the community [64]. It also helps research programs become more locally centered, contextually appropriate, and authentically addresses the needs that communities have [11].

5.2.2 Train educators to be better prepared for engagement: We also advocate that researchers invest the time and resources in training afterschool center administrators to become fluent enough in the domain knowledge to continue instruction after research partnerships are over. The Afterschool Corporation (TASC) conducted a study to uncover common characteristics that high-performing afterschool programs share [5]. Their findings uncovered that in addition to having a broad array of enrichment opportunities, these programs also provided opportunities for administrators to improve

their skills. Training afterschool center administrators accomplishes both of these tasks – it ensures that students have a diversity of enrichment opportunities at the end of research projects, and increases administrators' competencies. Professional development increases administrators' familiarity with teaching materials and can increase their comfort with co-facilitating programs with researchers [37, 50]. This is especially useful and *Safe Havens* where there is typically a large number of students to cater to, and not enough adult teaching resources. In areas where equity considerations are central, improving administrators' skills increases educational justice by making learning activities cross-cultural, and incorporates the values of the community into activities targeted at them [42, 64]. This also promotes the sustainability of STEM initiatives – our research shows that research partnerships may be *Safe Havens* only source of STEM programming [21, 45, 61].

There have been several strategies proposed in research studies that have proven successful for informal educator training. They include regular workshops that provide administrators with STEM knowledge and successful practices throughout the year [42, 59]. Administrators should be offered lots of opportunities for practice in real-world settings, with observations and scaffolding by experts where necessary [42, 59]. When domain experts are not physically available, administrators should be provided with open communication channels for ongoing support [42]. Finally, using data to measure administrator success is crucial [59]. While these strategies have been shown to be successful in different contexts, they are not prescriptive. There might be social and cultural nuances that require different strategies and adaptations. Research data can potentially highlight opportunities for better training and support.

6 LIMITATIONS

The archetypes we present in this paper are not meant to be exhaustive, or comprehensive for describing all possible afterschool program partners. Researchers may encounter partners who do not have any of the factors described, or more likely, partners who have characteristics that span across multiple archetypes. Our research is situated strongly in the context of afterschool programs in the United States – these insights may not generalize to other geographic and cultural contexts. Finally, we do not unpack other intersectional identities that may influence afterschool club culture such as race and gender, or administrators' educational experiences, or community involvement. Exploring these factors will likely uncover richer insights that inform equitable research partnerships with afterschool programs.

7 CONCLUSIONS

We deployed a similar video game co-design program across six heterogenous afterschool settings to uncover how their available resources and cultural values impact co-design processes and output. Based on interviews with ten afterschool administrators and analyzing our interactions with students over two years, we categorize our afterschool program partners into different archetypes: *Safe Havens, Recreation Centers, Homework Helpers, and STEM Enrichment Centers.* Our research uncovers challenges that co-design facilitators are bound to experience with each archetype, and provides adaptation suggestions to foster more effective partnerships with each archetype. Finally, we reflect on ways to improve educational justice and foster sustainable afterschool interventions by involving administrators in the design of co-design programs, and training them on domain knowledge to support their students' enrichment needs.

REFERENCES

[1] Afterschool Alliance. 2016. America After 3PM Special Report: Afterschool in Communities of Concentrated Poverty.

[2] Raimo Anttila. 1972. An introduction to historical and comparative linguistics. 438.

[3] Lesley Bartlett and Frances Vavrus. 2017. Comparative Case Studies: An Innovative Approach. Nordic Journal of Comparative and International Education (NJCIE) 1, 1: 5–17. https://doi.org/10.7577/NJCIE.1929

[4] Paul Berman and Milbrey McLaughlin. 1975. Federal Programs Supporting Educational Change, Vol. 4: The Findings in Review. *Federal Programs Supporting Educational Change 4.*

[5] Jennifer Birmingham, Ellen Pechman, Christina Russell, and Monica Mielke. 2005. Shared Features of High-Performing After-School Programs: A Follow-Up to the TASC Evaluation. Policy Studies Associates, Inc.

[6] Elizabeth Bonsignore, Derek Hansen, Anthony Pellicone, June Ahn, Kari Kraus, Steven Shumway, Kathryn Kaczmarek, Jeff Parkin, Jared Cardon, Jeff Sheets, Carlea Holl-Jensen, and Jes Koepfler. 2016. Traversing Transmedia Together: Co-designing an Educational Alternate Reality Game For Teens, With Teens. In *Proceedings of the The 15th International Conference on Interaction Design and Children*, 11–24. https://doi.org/10.1145/2930674.2930712

[7] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. Qualitative Research in Psychology 3, 2: 77–101. https://doi.org/10.1191/1478088706QP063OA

[8] Virginia Braun and Victoria Clarke. 2012. Thematic analysis. In APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological. American Psychological Association, Washington, 57–71. https://doi.org/10.1037/13620-004

[9] Brian Rinker. 2022. Congress approves more afterschool funding, but advocates say it isn't enough. *Youth Today.* https://youthtoday.org/2022/03/congress-approves-more-afterschool-funding-but-advocates-say-it-isnt-enough/

[10] Linda Burton. 2007. Childhood Adultification in Economically Disadvantaged Families: A Conceptual Model*. https://doi.org/10.1111/j.1741-3729.2007.00463.x

[11] Angela Calabrese Barton and Edna Tan. 2018. A Longitudinal Study of Equity-Oriented STEM-Rich Making Among Youth From Historically Marginalized Communities. https://doi.org/10.3102/0002831218758668 55, 4: 761–800. https://doi.org/10.3102/0002831218758668

[12] Carnegie Corporation of New York. 1992. A Matter of Time: Risk and Opportunity in the Nonschool Hours: Publications | Carnegie Corporation of New York. https://www.carnegie.org/publications/a-matter-of-time-risk-and-opportunity-in-the-nonschool-hours/

[13] Sharon Lynn Chu, Rebecca Schlegel, Francis Quek, Andrew Christy, and Kaiyuan Chen. 2017. "I Make, Therefore I Am": The Effects of Curriculum-Aligned Making on Children's Self-Identity. Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. https://doi.org/10.1145/3025453

[14] Sharon Lynn Chu, Rebecca Schlegel, Francis Quek, Andrew Christy, and Kaiyuan Chen. 2017. "I make, therefore I am": The effects of curriculum-aligned making on children's self-identity. Conference on Human Factors in Computing Systems - Proceedings 2017-May: 109–120. https://doi.org/10.1145/3025453.3025458

[15] Betsy DiSalvo, Mark Guzdial, Amy Bruckman, and Tom McKlin. 2014. Saving Face While Geeking Out: Video Game Testing as a Justification for Learning Computer Science. http://dx.doi.org/10.1080/10508406.2014.893434 23, 3: 272–315. https://doi.org/10.1080/10508406.2014.893434

[16] Allison Druin. 1999. Cooperative Inquiry: Developing New Technologies for Children with Children. In *Proceedings of the SIGCHI conference on Human factors in computing systems the CHI is the limit - CHI '99*, 592–599. https://doi.org/10.1145/302979.303166

[17] Allison Druin. 2002. The role of children in the design of new technology. Behaviour & Information Technology 21, 1: 1–25. https://doi.org/10.1080/01449290110108659

[18] Joseph A Durlak and Roger P Weissberg. The Impact of After-School Programs That Promote Personal and Social Skills The Impact of After-School Programs That Promote Personal and Social Skills The Impact of After-School Programs That Promote Personal and Social Skills Collaborative for Academic, Social, and Emotional Learning (CASEL) 2007. http://www.gse.harvard.edu/hfrp/project/afterschool/evaldatabase.html.

[19] Sheena Erete, Yolanda A. Rankin, and Jakita O. Thomas. 2021. I Can't Breathe. Proceedings of the ACM on Human-Computer Interaction 4, CSCW3: 1–23. https://doi.org/10.1145/3432933

[20] Derrick M. Gordon, Derek K. Iwamoto, Nadia Ward, Randolph Potts, and Elizabeth Boyd. 2009. Mentoring urban Black Middle-School Male Students: Implications for Academic Achievement. The Journal of Negro education 78, 3: 277.

[21] Denise Gottfredson, Amanda Brown Cross, Denise Wilson, Melissa Rorie, and Nadine Connell. 2010. Effects of Participation in After-School Programs for Middle School Students: A Randomized Trial. http://dx.doi.org/10.1080/19345741003686659 3, 3: 282–313. https://doi.org/10.1080/19345741003686659

[22] Jean Grossman, Karen Walker, and Rebecca Raley. 2001. Challenges and Opportunities in After-School Programs: Lessons for Policymakers and Funders.

[23] Mona Leigh Guha, Allison Druin, Jerry Alan Fails. International Journal of Child-Computer, and undefined 2013. Cooperative Inquiry revisited: Reflections of the past and guidelines for the future of intergenerational co-design. Elsevier.

[24] Mona Leigh Guha, Allison Druin, and Jerry Alan Fails. 2013. Cooperative Inquiry revisited: Reflections of the past and guidelines for the future of intergenerational co-design. International Journal of Child-Computer Interaction 1, 1: 14–23. https://doi.org/10.1016/j.ijcci.2012.08.003

[25] Emily Hamner, Tom Lauwers, Debra Bernstein, Illah Nourbakhsh, Carl DiSalvo. AAAI spring symposium, and undefined 2008. Robot Diaries: Broadening Participation in the Computer Science Pipeline through Social Technical Exploration. https://www.aaai.org/Papers/Symposia/Spring/2008/SS-08-08/SS08-08-008.pdf

[26] Emily Hamner, Tom Lauwers, Debra Bernstein, Illah Nourbakhsh, Carl DiSalvo. AAAI spring symposium, and undefined 2008. Robot Diaries: Broadening Participation in the Computer Science Pipeline through Social Technical Exploration. https://www.aaai.org/Papers/Symposia/Spring/2008/SS-08-08/SS08-08-008.pdf

[27] Ross Higashi, Erik Harpstead, Jaemarie Solyst, Jonaya Kemper, Judith O Uchidiuno, and Jessica Hammer. 2021. The Design of Co-Robotic Games for Computer Science Education. dl.acm.org: 111–116. https://doi.org/10.1145/3450337.3483472

[28] Matthew Kam, Divya Ramachandran, Anand Raghavan, Jane Chiu, Urvashi Sahni, and John Canny. 2006. Practical considerations for participatory design with rural school children in underdeveloped regions: Early reflections from the field. Proceeding of the 2006 Conference on Interaction Design and Children, IDC '06 2006: 25–32. https://doi.org/10.1145/1139073.1139085

[29] Eva Sophie Katterfeldt, Nadine Dittert, and Heidi Schelhowe. 2015. Designing digital fabrication learning environments for Bildung: Implications from ten years of physical computing workshops. International Journal of Child-Computer Interaction 5: 3–10. https://doi.org/10.1016/J.IJCCI.2015.08.001

[30] Rilla Khaled and Asimina Vasalou. 2014. Bridging serious games and participatory design. International Journal of Child-Computer Interaction 2, 2: 93–100. https://doi.org/10.1016/j.ijcci.2014.03.001

[31] Anita Krishnamurthi, Bronwyn Bevan, Jen Rinehart, and Vicky Ragan Coulon. Afterschool Matters, and undefined 2013. What Afterschool STEM Does Best: How Stakeholders Describe Youth Learning Outcomes. ERIC. https://eric.ed.gov/?id$=$EJ1016823

[32] Davielle Lakind, Marc Atkins, and J. Mark Eddy. 2015. Youth Mentoring Relationships in Context: Mentor Perceptions of Youth, Environment, and the Mentor Role. Children and youth services review 53: 52. https://doi.org/10.1016/J.CHILDYOUTH.2015.03.007

[33] Reed W. Larson and Suman Verma. 1999. How children and adolescents spend time across the world: Work, play, and developmental opportunities. Psychological Bulletin 125, 6: 701–736. https://doi.org/10.1037/0033-2909.125.6.701

[34] Patricia A. Lauer, Motoko Akiba, Stephanie B. Wilkerson, Helen S. Apthorp, David Snow, and Mya L. Martin-Glenn. 2016. Out-of-School-Time Programs: A Meta-Analysis of Effects for At-Risk Students. http://dx.doi.org/10.3102/00346543076002275 76, 2: 275–313. https://doi.org/10.3102/00346543076002275

[35] Tisha Lewis Ellison. 2017. The Matter of Parents' Stories: Urban African American Mothers' Counter-Stories About the Common Core State Standards and Quality Teaching. https://doi.org/10.1177/0042085917702199 54, 10: 1431–1461. https://doi.org/10.1177/0042085917702199

[36] Silvia Lindtner, Shaowen Bardzell, and Jeffrey Bardzell. 2016. Reconstituting the utopian vision of making: HCI after technosolutionism. Conference on Human Factors in Computing Systems - Proceedings: 1390–1402. https://doi.org/10.1145/2858036.2858506

[37] Breanne K Litts. Making learning: Makerspaces as learning environments. 2015

[38] Lee Martin. 2015. The Promise of the Maker Movement for Education. Journal of Pre-College Engineering Education Research (J-PEER) 5, 1: 4. https://doi.org/10.7771/2157-9288.1099

[39] Risto Marttinen, Kathleen Wilson, Koren Fisher, Maria Beitzel, and Ray N. Fredrick. 2022. Process evaluation and challenges in collecting data from an after-school sports and literacy program in a diverse, low-income community. Evaluation and Program Planning 91: 102052. https://doi.org/10.1016/J.EVALPROGPLAN.2022.102052

[40] Emanuela Mazzone, Janet C. Read, and Russell Beale. 2008. Design with and for disaffected teenagers. In *Proceedings of the 5th Nordic conference on Human-computer interaction building bridges - NordiCHI '08*, 290. https://doi.org/10.1145/1463160.1463192

[41] Maarten Van Mechelen, Ann Laenen, Bieke Zaman, Bert Willems, Vero Vanden Abeele. International Journal of Human-Computer Studies. 2019. Collaborative Design Thinking (CoDeT): A co-design approach for high child-to-adult ratios. Elsevier 130: 179–195. https://doi.org/10.1016/j.ijhcs.2019.06.013

[42] Allison Metz, Mary Burkhauser, Lillian Bowie. Training Out-of-School Time Staff - Part 2 in a Series on Implementing Evidence-Based Practices in Out-of-School Time Programs: The Role of Frontline Staff. 2009. http://www.childtrends.org/wp-content/uploads/2009/02/Child_Trends-2009_02_11_RB_StaffTraining.pdf

[43] Virginia Morrow and Martin Richards. 1996. The Ethics of Social Research with Children: An Overview1. Children & Society 10, 2: 90–105. https://doi.org/10.1111/J.1099-0860.1996.TB00461.X

[44] Virginia Morrow and Martin Richards. 1996. The Ethics of Social Research with Children: An Overview1. Children & Society 10, 2: 90–105. https://doi.org/10.1111/j.1099-0860.1996.tb00461.x

[45] Gil G. Noam and Jodi Rosenbaum Tillinger. 2004. After-school as intermediary space: Theory and typology of partnerships. New Directions for Youth Development 2004, 101: 75–113. https://doi.org/10.1002/YD.73

[46] Judith Odili Uchidiuno, Jaemarie Solyst, Jonaya Kemper, Erik Harpstead, Ross Higashi, and Jessica Hammer. 2021. Negotiating systemic racial and gender bias as a minoritized adult design researcher. CHI PLAY 2021 - Extended Abstracts of the 2021 Annual Symposium on Computer-Human Interaction in Play: 203–208. https://doi.org/10.1145/3450337.3483479

[47] Benjamin Paaßen, Thekla Morgenroth, and Michelle Stratemeyer. 2017. What is a True Gamer? The Male Gamer Stereotype and the Marginalization of Women in Video Game Culture. Sex Roles 76, 7–8: 421–435. https://doi.org/10.1007/s11199-016-0678-y

[48] Sofia Papavlasopoulou, Michail N. Giannakos, and Letizia Jaccheri. 2017. Empirical studies on the Maker Movement, a promising approach to learning: A literature review. Entertainment Computing 18: 57–78. https://doi.org/10.1016/J.ENTCOM.2016.09.002

[49] Sofia Papavlasopoulou, Michail N. Giannakos, and Letizia Jaccheri. 2017. Empirical studies on the Maker Movement, a promising approach to learning: A literature review. Entertainment Computing 18: 57–78. https://doi.org/10.1016/J.ENTCOM.2016.09.002

[50] Mike Petrich, Karen Wilkinson, Bronwyn Bevan. 2013. It Looks Like Fun, but Are They Learning? In *Design, Make, Play: Growing the next generation of STEM innovators* (Routledge), M.H.a.D. Kanter (ed.). Routledge, New York, NY., 50–70. https://doi.org/10.4324/9780203108352-10/LOOKS-LIKE-FUN-LEARNING-MIKE-PETRICH-KAREN-WILKINSON-BRONWYN-BEVAN

[51] Edith Ackermann. Future of learning group publication. 2001. Piaget's constructivism, Papert's constructionism: What's the difference. sylviastipich.com. http://www.sylviastipich.com/wp-content/uploads/2015/04/Coursera-Piaget-_-Papert.pdf

[52] Janet C Read, Panos Markopoulos. International Journal of Child-Computer Interaction. 2013. Child–computer interaction. https://clok.uclan.ac.uk/10899/?template$=$default_internal

[53] Jean E. Rhodes, Jean B. Grossman, and Nancy L. Resch. 2020. Agents of Change: Pathways through which Mentoring Relationships Influence Adolescents' Academic Adjustment. Annual Progress in Child Psychiatry and Child Development 2000-2001: 585–604. https://doi.org/10.4324/9780203449523-29/AGENTS-CHANGE-PATHWAYS-MENTORING-RELATIONSHIPS-INFLUENCE-ADOLESCENTS-ACADEMIC-ADJUSTMENT-JEAN-RHODES-JEAN-GROSSMAN-NANCY-RESCH

[54] Zoeë Richards and Miles Hewstone. 2001. Subtyping and Subgrouping: Processes for the Prevention and Promotion of Stereotype Change. Personality and Social Psychology Review 5, 1: 52–73. https://doi.org/10.1207/S15327957PSPR0501_4

[55] Catherine Riegle-Crumb and Melissa Humphries. 2012. Exploring Bias in Math Teachers' Perceptions of Students' Ability by Gender and Race/Ethnicity. Gender and Society 26, 2: 290–322. https://doi.org/10.1177/0891243211434614

[56] David Roedl, Shaowen Bardzell, and Jeffrey Bardzell. 2015. Sustainable Making? Balancing Optimism and Criticism in HCI Discourse. ACM Transactions on Computer-Human Interaction (TOCHI) 22, 3. https://doi.org/10.1145/2699742

[57] Jean J. Ryoo, Lianna Kali, and Bronwyn Bevan. 2016. Equity-oriented pedagogical strategies and student learning in after school making. ACM International Conference Proceeding Series: 49–57. https://doi.org/10.1145/3003397.3003404

[58] Gina Miranda Samuels and Julia M. Pryce. 2008. "What doesn't kill you makes you stronger": Survivalist self-reliance as resilience and risk among young adults aging out of foster care. Children and Youth Services Review 30, 10: 1198–1210. https://doi.org/10.1016/J.CHILDYOUTH.2008.03.005

[59] Jessica Sheldon, Amy Arbreton, Leigh Hopkins, and Jean Baldwin Grossman. 2010. Investing in Success: Key Strategies for Building Quality in After-School Programs. American Journal of Community Psychology 45, 3–4: 394–404. https://doi.org/10.1007/S10464-010-9296-Y

[60] David J. Shernoff. 2010. Engagement in 7After-School Programs as a Predictor of Social Competence and Academic Performance. American Journal of Community Psychology 45, 3–4: 325–337. https://doi.org/10.1007/S10464-010-9314-0

[61] Diana Sinisterra and Stephen Baker. 2010. A System That Works: Highlights of Effective Intervention Strategies in a Quality Improvement System. Afterschool Matters.

[62] Austin L. Toombs. 2017. Hackerspace tropes, identities, and community values. DIS 2017 - Proceedings of the 2017 ACM Conference on Designing Interactive

Systems: 1079–1091. https://doi.org/10.1145/3064663.3064760
[63] Shirin Vossoughi and Kris D. Gutiérrez. 2014. Studying Movement, Hybridity, and Change: Toward a Multi-sited Sensibility for Research on Learning across Contexts and Borders. https://doi.org/10.1177/016146811411601413 116, 14: 603–632. https://doi.org/10.1177/016146811411601413
[64] Shirin Vossoughi, Paula K. Hooper, and Meg Escudé. 2016. Making Through the Lens of Culture and Power: Toward Transformative Visions for Educational Equity. Harvard Educational Review 86, 2: 206–232. https://doi.org/10.17763/0017-8055.86.2.206
[65] Seth A Weisman. 2000. Exploring attrition from prevention programs: an evaluation of the Maryland after school community grant program.
[66] Laurel Whalen, Kimberly Maljak, Nate McCaughtry, Alex Garn, and Sara Flory. 2020. Challenges and opportunities in urban after-school programming. Before- and After-School Physical Activity Programs: 142–153. https://doi.org/10.4324/9781003051909-12
[67] Jason C Yip, Kiley Sobel, Caroline Pitt, Kung Jin Lee, Sijin Chen, Kari Nasu, and Laura R Pina. 2017. Examining Adult-Child Interactions in Intergenerational Participatory Design. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 5742–5754. https://doi.org/10.1145/3025453.3025787
[68] Jason Yip, Tamara Clegg, Elizabeth Bonsignore, Helene Gelderblom, Emily Rhodes, and Allison Druin. 2013. Brownies or bags-of-stuff? Domain Expertise in Cooperative Inquiry with Children. In *Proceedings of the 12th International Conference on Interaction Design and Children*, 201–210. https://doi.org/10.1145/2485760.2485763