

Examining Adult-Child Interactions in Intergenerational Participatory Design

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ABSTRACT

Prior studies have focused on child interactions in participatory design (PD) with adults and children, but less is known about what specific adult-child interactions constitute a partnership. In this study, we unpack what constitutes an “equal partnership” in PD between adults and children. On the basis of prior literature, we created a new framework that examines the complementary roles between children and adults. Next, we analyzed a case study of a year-long intergenerational design team of children (ages 7-11) and adults. From this analysis, we determined that design partnerships are composed of four dimensions that span from unbalanced to balanced interactions: *facilitation*, *relationship building*, *design-by-doing*, and *elaborating together*. Finally, to demonstrate its utility, we analyzed two focal co-design sessions using our framework. Our analysis suggests that an equal partnership in PD is not a single static interaction but a development over time of design interactions influenced by context, experience, and participants.

Author Keywords

Participatory Design; Co-design; Cooperative Inquiry; Children; Design Methods; Youth

ACM Classification Keywords

D.2.10. Design: Methodologies

INTRODUCTION

Designing new technologies for children is no easy task. As adults, we cannot rely on our own childhood experiences to inform our technological designs for present and future children. Therefore, in the late 1990’s, child-computer interaction researchers began employing participatory design (PD), a method focusing on engaging users in the design process and emphasizing a democratic and collaborative relationship between users and designers to create new technologies [3,15]. By providing agency and opportunities

for users to contribute, PD attempts to ensure that users have an equal standing with designers in the design process [28]. Some researchers, while engaging and viewing children as active contributors in the process of PD, have described this interaction between adult designers and children as an *equal partnership* [8,15,16,26,32,41,44,51,52]. Both Druin [15,16] and Guha et al. [26] state that children can be “equal stakeholders” in design with adults. McNally et al. [32] explain that children can have an “equal voice” in the design process. However, among other researchers – because adults often set the agendas, choose the research project, and organize the design activities – there is a perspective that equal PD partnerships between children and adults are difficult to manage or are not as equal as they seem [30,39,42].

Despite frequent use of the term equal partnerships in PD with children, very little knowledge exists as to how to analyze and explain what an adult-child design partnership is. Equality is assumed to take place in design partnerships by some researchers. However, it may take a more deliberate effort to set up these kinds of partnerships, and often these efforts have only been described implicitly in the literature. To help us understand adult-child partnerships better, our work delves into understanding the nature of equality in adult-child interactions. We explore the meaning of design partnerships through examining equitable interactions that occur in PD sessions. Our research questions are: (1) What range of interactions occurs between children and adults during co-design activities? (2) What practices and interactions occur in adult-child co-design that are equitable?; and (3) How does unpacking adult-child interactions help us to better conceptualize design partnerships in PD?

To answer these questions, we reviewed prior literature and developed a theoretical model that defines how adult-child roles intersect in the design of technologies. Next, we conducted an analysis of 36 co-design sessions over a period of one year. In these co-design sessions, six to ten ethnically diverse children (ages 7-11) designed children’s technologies with four to seven adults. We found that design partnerships can be broken down into four dimensions: *facilitation*, *relationship building*, *design-by-doing*, and *elaboration*. Each of the dimensions varies along a spectrum of unbalanced and balanced interactions between children and adults (i.e., moments when participants dominate or work

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together). To demonstrate the utility of the dimensions, we provide a close analysis of two focal design sessions using the dimensions to examine equitable practices.

Our study highlights the nuances that exist in adult-child design interactions, provides common ground for researchers to discuss the extent to which equal adult-child partnership occurs, and contributes an analytical tool for researchers wanting to examine adult-child design partnerships. A close examination of what constitutes equitable practices can help HCI researchers determine how to support equality in other PD contexts and participants.

BACKGROUND

Equal (Equality) and Equitable (Equity)

Before we begin, the terms *equal* (*equality*) and *equitable* (*equity*) need to be defined for this study. Our approach stems from traditions in multicultural educational research that examines equality and equity between students, teachers, schools, and policies [2]. The term *equality* (*equal*) means “the same”. Adults and children in PD partnerships can have *the same* opportunities to contribute to idea generation, design, and decision-making practices [15,16,26]. However, because adults have unequal access to power, influence, and knowledge compared with children [34], we recognize equality is not a given in these partnerships and that equity must be considered. *Equity* (*equitable*) emphasizes how people in power can allocate resources and commit effort to helping others overcome obstacles to find fairness and success [2]. In adult-child PD, overcoming unequal power dynamics is not a simple task [34]. Therefore, we focus on equitable partnership practices (e.g., guidance, scaffolding) when it comes to supporting children in the context of the design process [26].

When we examine *equal* PD partnerships and *equitable* practices in this study, we take the following perspective. First, everyone’s contribution (e.g., ideas, opinions, artifacts, etc.) can be valued *equally*, but the engagements and interactions to make these contributions need to be *equitable*. Second, participants’ expertise is *equally* important (e.g., knowledge of childhood, domain knowledge, etc.), but tools and techniques that emphasize *equitable* design interactions are needed (e.g., working with arts and crafts materials instead of highly technical prototyping tools). Finally, children and adults can be *equal* members of a PD group, but we need *equitable* practices to support participants’ investments in the co-design group. While the literature points to these needs, less has been documented about how to define equitable interactions in design partnerships. Therefore, the goal of this study is to provide a deeper examination of equitable practices and develop an analytic framework to study design partnerships.

Supporting Democratic Practices in PD

Democratic practices are the foundation for equality in PD. On a theoretical level, Ehn [19] describes PD as a process of creating new “language-games” that make sense to both

users and designers. Design tools mediate participants’ interactions by providing ways for them to access their individual areas of expertise that relate to the shared design practice. Yet, “participation applies not only to users participating in the language-game of design, but perhaps more importantly to designers participating in use” (Ehn [19], p. 68). Similarly, Brandt, Binder, and Sanders [10] frame PD as a third space in which users and designers come together to “playfully participat[e] in a new practice that brings together means and ends in what one could call a new game of possible futures” (p. 171). In translating these ideas of democratic design participation as a shared game between users and designers, researchers have developed specific tools and techniques for PD that mediate their interactions and draw on their specific knowledge [10,47].

Child-computer interaction researchers have different perspectives from each other about what democratic PD interactions look like between adults and children. The *representative democracy* perspective of PD focuses on how children’s ideas are included and represented [39]. In Read et al.’s [39] PD research, they often work with larger numbers of children (about 80 - 100) over shorter amounts of time. The priority in these groups is to emphasize appropriate fair democratic representation in PD. In contrast, we work with seven to ten children over longer periods of time. Therefore, our priority is examining closely how the adult-child interactions support *direct democratic* practices, in which choices and decisions are made directly together during design sessions.

Participatory Design Methods for Working with Children

Along these same lines, researchers who work with children have conceptualized design and interactions between adult designers and children with their own sets of methods and techniques [20,47]. On one end of the spectrum is Scaife et al.’s *Informant Design*, in which adults treat children as native informants [42]. Scaife et al. [42] are clear that adults do not treat children as equal partners. Here, children are considered experts at being children and design ideas can be developed from children, but they cannot contribute equally to the design process compared to adults.

Closer towards equal design partnerships, the ChiCI group works with local schools to run design workshop sessions with children [40]. In addition, the group developed a PD method called *MESS* (Mad Evaluation Session with Schoolchildren) Days in which classrooms of children come to the university to do design activities [27]. Teachers observe and researchers act as facilitators in the process. This method was developed on the basis of the notion that organizing design sessions with children is logistically difficult and that ensuring there is a “representative sample” of children in sessions is challenging [27]. Large et al.’s [30] *Bonded Design* emphasizes that children should play an active role in the design process, that both adults and children have their own expertise, and both adult and child are necessary to carry out design. However, Large et al. [30]

question the extent to which true equality can exist between participants in an intergenerational design team because adults generally lead and control the design session.

Most related to our current theoretical and methodological approach is Druin's [15,16] *Cooperative Inquiry* (CI), also known as co-design. CI is a PD method that focuses on children and adults working together as equal design partners on the iteration, elaboration, and design of new technology for children [15]. In CI, adults and children design technologies *for children, with children*. This method focuses on creating design partnerships in which children should have equal opportunities to contribute to the design process in any way they can [16]. Certain practices in CI are inherent to supporting equitable interactions, such as adults eating snacks together with children, wearing casual clothing, and sitting on the ground with children. However, past literature has not yet explored how these practices are equitable in supporting equal contributions in co-design.

Adult-Child Roles in Participatory Design

The majority of research conducted in this child-focused PD space emphasizes children's specific roles [15,16,24,25,29,51,52]. When children engage in PD, and specifically co-design, children are seen as domain experts in childhood [20]. They take on roles throughout the process that span from user to design partner [15,16]. Children are also learners throughout the design process [15,26,30]. By utilizing specific child co-design methods, children can partake in design activities through prototyping [15], brainstorming [24], critiquing [46], taking notes [15], utilizing subject domain knowledge [50,51], and even facilitating and leading co-design sessions [52].

For the most part, researchers have only incidentally noted adult roles in the design process as facilitators, caregivers, and design and idea contributors [24,26,36,41]. McNally et al. [32] surveyed former child co-designers about their experiences up to ten years after participating in their adult-child design partnerships. These former child co-design participants recognized that adults have different responsibilities than children during the process, such as organizing the co-design sessions and time management. Despite these different adult responsibilities, former child co-designers did not feel that this impacted their ability to have a legitimate influence on design outcomes.

Benton and Johnson [4] carried out an extensive literature review of PD design methods and techniques for adults working with children and disabilities. This review describes the different roles, extensive responsibilities, and complex activities of both child and adult participants in these technology design projects. In the cases they reviewed, adults acted as facilitators who clarified children's ideas; motivators for children to participate in the session; children's caregivers; proxies who participate in design on children's behalf; and as co-designers and design partners who generated individual ideas, scaffolded children's brainstorming, and integrated ideas with the children [4].

Overall, because most literature in this space has studied adult engagement as ancillary and secondary, especially in comparison with child roles, empirical studies are now needed that consider both children and adults. Our work begins to address this need for research by developing a dimensional framework on the basis of a deep case study analysis. This framework conceptualizes the equitable interactions and partnerships between children and adults over a long period of co-designing together.

WHAT IS A DESIGN PARTNER?

In technology design, Druin [16] identifies four roles that children take on (see Figure 1). As *users*, children are observed interacting with technology by adults. As *testers*, children try out technology prototypes and provide adults input on the basis of their tests. As *informants*, children answer questions, co-develop new ideas, and sketch and develop low-fidelity prototypes with adults. Finally, as *design partners*, children and adults are equal stakeholders throughout the entire process of designing new technology.



Figure 1. The roles children play in the design of children's technology [16].

On the basis of our literature review, we claim adults also have four corresponding roles when designing technologies with children. In our model, each adult role is the complement to each child's role: when the child is a *user*, the adult is an *observer* [11,37,38]; when the child is a *tester*, the adult is a *test facilitator* [17,31]; when the child is an *informant*, the adult is an *interpreter* [5,18,48]; and when the child is a *design partner*, the adult is also a *design partner* [16].

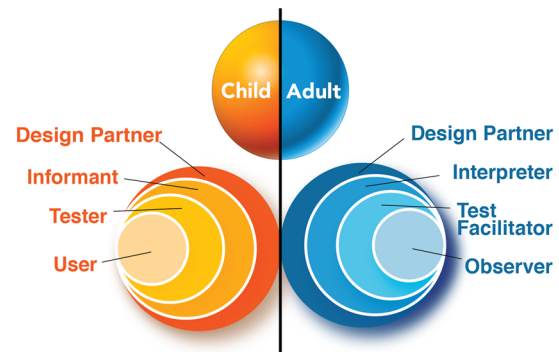


Figure 2. The complementary roles that adults and children play in the design of children's technologies.

Figure 2 shows the relationship between child roles and the corresponding roles we identify for adults. The sphere represents the entire engagement between children and adults in technology design. When the sphere is split open, the different roles between children (left side) and adults (right side) are shown. The circles are concentric as per Druin's [16] framework; each role includes aspects of those roles that historically have come before it. We have purposely created different distances between the complementary roles to indicate the amount of direct interaction necessary

between the adults and children in these roles. We explain this distance for every role in the ensuing paragraphs.

The role of the *adult observer* is based on traditions in anthropology and educational psychology [11,37,38]. Observations of children can occur in naturalistic and laboratory settings [37]. Researchers attempt to understand how children as users of existing technologies react in these settings and what it says about the design of future technologies [16]. In Figure 2, we have placed the user-observer circles far apart because adults do not need to directly interact with children (e.g., adults can watch videos of children, observe from another room or far away, etc.).

The *test facilitator* role is based in traditions of cognitive psychology [17]. If children are testers of prototypes, the adults play the role of choosing the usability tests, determining the child participants, and facilitating the testing session [31]. In Figure 2, the circles are in closer proximity than user-observer roles; test facilitators can directly interact with children as testers, but the adults do not need to engage for very long or closely with the children.

When children are informants, the adult plays the role of the *interpreter*. The interpreter draws methods from anthropology, psychology, and sociology [5,18,48]. While children design, draw, and communicate as an informant, the adult interpreter co-constructs dialogue, listens closely, and learns from the child. The distance of the circles (Figure 2) between informants and interpreters is even closer but still they never touch. While adult interpreters can work alongside with children, they do not necessarily have to claim or strive for equality in partnership with children [30].

Finally, adults can take on the role of *design partner* in the process of designing technology with children. Most importantly, adults and children are *design partners* when they work with each other as equal stakeholders throughout the entire process of designing new technology [16]. To indicate this close partnership, the outer layers of both design partner roles are touching (Figure 2). In comparison with the other three adult-child roles (*user-observer*, *tester-test facilitator*, and *informant-interpreter*), less has been documented about specific interactions that constitute the design partner roles. There are equitable practices in co-design that are largely implicit; therefore, we need a framework that helps researchers understand equity and how to support equality in their intergenerational PD practices.

METHODS

Although we have defined our usage of the terms *equal* and *equitable* in adult-child design partnerships and have shown adult-child roles in technology design, we still need to examine real-world interactions to unpack these conceptions. Therefore, we employed the comparative case study method [33] to examine what equitable practices support equal contributions, expertise, and membership in design partner-

ships. This method allowed us to (1) closely examine what engagements and interactions happen in co-design sessions with adults and children over time and (2) develop a framework to conceptualize adult-child design partnerships. We illustrate the development of our framework through vignettes. Finally, we conduct a deep analysis of two focal co-design sessions to show the utility of our framework.

Context and Participants

We examined an intergenerational co-design group of design researchers and children called *KidsTeam UW*. *KidsTeam UW* consisted of ten children (ages 7-11) from October 2015 to May 2016. We chose ages 7-11 because this age is old enough developmentally to co-design but young enough to think as a child [24]. We recruited child participants through professional connections and word-of-mouth. We strove for diversity in socioeconomic status, gender, ethnicity, and age to promote multiple viewpoints [24]. Four of the children returned in August 2016 for a weeklong session with three new children ($n = 7$). Thus, 13 different children participated in the group over time. Adults in this group consisted of core members and project partners. The core members included undergraduates, graduate students, post-doctoral researchers, and one professor. The project partners consisted of librarians, non-profit organizations, and university researchers. Please see Table 1 for demographics information. From October 2015 to December 2015 and February 2016 to May 2016, *KidsTeam UW* met twice a week on a university campus in 90-minute sessions. In one week in August 2016, *KidsTeam UW* had six 90-minute sessions. The design sessions involved working on multiple research projects with university and non-profit partners, creating branding (i.e., logos, group website), and engaging in exploratory design practice.

Data Collection

Co-design sessions. Each of the 36 co-design sessions began with *snack time* (~15 minutes), in which children and adults ate and interacted with each other (e.g., drawing, playing games). In *circle time* (~15 minutes), children and adults gathered together in a circle on the ground to go over the ‘question of the day’ (to get everyone’s thoughts on a particular topic) and the logistics of the co-design session. During *design time* (~45 minutes), adults and children interacted using PD techniques meant to foster collaborative design [47]. Finally, during *discussion time* (~15 minutes), children and adults all gathered together to go over the designs of the day and make final suggestions. A single video camera recorded each of these sessions and focused on adult-child interactions. The researchers photographed the activities and artifacts and afterward wrote analytical memos for each session. To analyze the videos, a primary viewer (an author) watched five to six videos and took notes on what the adults were doing with the children. Next, a secondary viewer (another author) watched the same videos and added to the primary viewer’s notes.

Child name	Age	Gender	Ethnicity	Adult name	Age	Gender	Ethnicity
Gina	11	Female	Asian	Jason	36	Male	Asian
Aileen	11	Female	White	Caroline	24	Female	White
Athena#	7	Female	Asian/Black	Vivian	25	Female	White
Austin#	11	Male	Asian	Lili	30	Female	White
Riku#	9	Female	Asian/White	Oscar	30	Male	White
Anishinaabe	9	Female	Native	Kung Jin	26	Female	Asian
Animikiik	11	Male	Native	Kari	19	Female	Asian
Simon	9	Male	White	Kiley	26	Female	White
Marlene	7	Female	White	Sijin	19	Female	Asian
Winston#	7	Male	White	Laura	32	Female	Hispanic
Carmen*	9	Female	Asian/White	Edith	19	Female	White
Veritas*	9	Male	Native/Asian				
Martin*	7	Male	Hispanic				

Table 1. Demographics of the core co-designers. Names of all participants are pseudonyms, except authors. Asterisk* refers to children that came in August 2016 only. Hashtag# refers to children that attended all sessions.

Interviews. The lead author conducted two rounds of interviews with the children. The first interviews occurred in February 2016 ($n = 9$), and the second interviews occurred in May 2016 ($n = 8$). For both interview rounds, questions focused on children's perceptions of their interactions in the co-design group and what they thought of the adults. Interviews lasted roughly 10 minutes each. We chose not conduct interviews with the four children from the summer session because they had only been part of the team for one week. The lead author also conducted interviews with the core adult team members ($n = 9$) between July and August 2016. The interview questions focused on adults' perspectives of their interactions with children and their roles in the co-design group. Adult interviews lasted about 30 minutes. All interviews were audio recorded and transcribed.

Data Analysis

To develop a framework to understand what a design partnership between adults and children entails, we used a grounded theory approach with constant comparative analysis [14]. First, the same primary and secondary researchers that watched and took notes on the videos individually started the open coding process. Using a qualitative analysis web application called *Dedoose*, we open coded the adult and child interactions that occurred in each co-design session. From this process, we generated a codebook with the following codes: how adults facilitated the sessions and how children responded, how adults managed children's behavior, how the adults and children co-designed together, how the children and adults talked and interacted with one another, and the kinds of support children needed in design. Next, the primary and secondary researchers recoded their data (interviews, video notes) using this codebook. As we applied the coding scheme, we also made changes to the codebook when a new theme was identified. In a collaborative axial coding session, the researchers then compared and contrasted codes to identify the emerging themes from these co-design sessions. Generally, we placed codes referring to managing children's behavior, organizing the design sessions, and time management under *facilitation*. Friendship and playful behavior codes produced *relationship building*. Design critiques and participating together in design generated *design-by-doing*. Codes for idea suggestions and mixing ideas were grouped as *elaboration*. We further

recoded the data to develop new codes on how adults scaffolded children's designs.

We triangulated our findings with our analytical memos, interviews, and photographs to make sure all pieces of evidence were mutually supportive [33]. To establish validity, we presented our analysis to two external reviewers not closely related to this project to ensure that our comparisons were representative of the ideas and design process of the adults and children. Finally, we engaged in a selective coding process. We developed diagrams to formalize the relationships of the themes and categorized the emergent themes around a set of core categories [14]. These core categories became the four dimensions of our framework.

FINDINGS

The first section examines what adult-child practices constitute a co-design partnership. We present four dimensions of adult-child interactions: *facilitation*, *relationship building*, *design-by-doing*, and *elaboration*. The range of the dimensions are according to Read et al.'s [41] concept of balanced design, which assumes an equal partnership between domain experts (children) and design experts (adults), both engaged in informing and creating their designs. We use the term *balanced* to refer to specific interactions in co-design that are equitable and lead to an equal amount of contributions from both adult and child (i.e., the right side of the dimensions). In contrast, *unbalanced* refers to moments in co-design when either the children or adults are dominating in their contribution, which leads to unequal contributions and inequitable interactions (i.e., the left side of the dimensions). To demonstrate the spectrum of each dimension, we present short vignettes of co-design sessions as examples. The second section of the findings presents a detailed analysis of two focal co-design sessions using the four dimensions. To denote pseudonyms between adults and children, we use superscript A (Name^A) to indicate adults and superscript C (Name^C) to indicate children.

Facilitation

The *facilitation* dimension examines how much support and mediation takes place between the adults and children (Figure 3). The facilitation dimension spans from unbalanced assistance when only adults facilitate the co-design session to balanced partnership when adult and child equitably facilitate together. Facilitation in co-design (by both adults

and children) can include organizing and managing the flow of the co-design session, leading the group discussions, and summarizing the group's ideas [52]. However, adults often have the additional responsibility of refocusing children during co-design, which is an unbalanced interaction. The most common theme in the adult interviews emphasized the difficulty in refocusing children, managing their behavior, and motivating children to design. The following vignette is an example of unbalanced facilitation because only the adult is trying to get the children back on the design task.

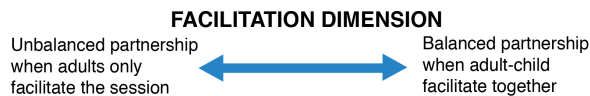


Figure 3. The spectrum of adult-child facilitation dimension.

Towards Unbalanced Facilitation Vignette: Co-design session #13. Children were learning how to collaborate in co-design by taking apart one group's low-tech prototype and remixing it into another design. The goal was to build technologies to help families engage in programming together. The children received a prior group's design of a rocket and a movie theater to remix. The children in the group, Gina^C, Animikiik^C, and Simon^C were distracted. Kiley^A asked the group, "Okay, wait, do you want to build on the theater, or do you want to build on the rocket?" Simon^C called out, "I don't know." Kiley^A told Simon^C, "You have to choose one." Simon^C answered, "I don't like either." Kiley^A replied to Simon^C, "How can we make something you do like?" During this time, Animikiik^C gathered his own materials to make his own robot while Gina^C created a magic wand with pipe cleaners.

Adults and children can also work together equitably to organize and lead the interactions [52]. In the example below, moments of facilitation occurred when the child and adult work together to decide how to lead the presentation.

Towards Balanced Facilitation Vignette #1: Co-design session #21. Children and adults used large paper and markers [24] to design how a Super Mario Maker™ video game could be used for library learning settings. Riku^C and Aileen^C worked with Kung Jin^A on their design. Riku^C directed Kung Jin^A how she wanted to present, "Okay, so when we present it [the design], pretend this [design] has its own big sheet of paper on the wall." Kung Jin^A responded, "I can hold it [the design] too, or you can put it back here," and pointed to a whiteboard. Riku^C reflected, "Actually, can we make it on the wall?" Kung Jin^A answered, "Yeah." Riku^C excitedly said to Aileen^C, "We can make it on the wall!" Kung Jin^A made another suggestion, "Or you can put it here [on a large cardboard sheet]. We can use this thing." Riku^C raised her arms in the air in agreement, "Oh yeah! Let's use that!"

A third example demonstrates that children can, want to, and should be allowed to facilitate and that adults can and should help children contribute as facilitators.

Towards Balanced Facilitation, Vignette #2: Co-design session #36. Carmen^C came to the large whiteboard in the room. The group was using a technique called Stickies to evaluate a children's programming tool [15]. In the Stickies session, adults typically put up the written notes of likes, dislikes, and design ideas on a large board in an affinity diagram. However, in this co-design session, Carmen^C wanted to place her own dislike comment on the board. Lisa^A (female visitor) worked with Carmen^C to decide where on the board this comment should be placed.

Relationship Building

Children need to feel comfortable that adults take their ideas and designs seriously [16,26]. Our findings support that balanced relationships are a necessary component in design partnerships. The *relationship building* dimension examines how much social interaction occurs in the co-design group (Figure 4). This dimension runs from adults being socially distant from children to the establishment of closer relationships between adults and children.

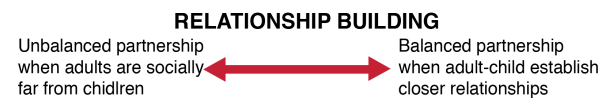


Figure 4. The spectrum of relationship building dimension.

When adults are socially far from children (i.e., when adults and children take quieter non-interactive stances), unbalanced interactions are more likely to occur. Many first time adult visitors have come to work with the team but did not always establish equitable relationships. For example, in the following vignette, a graduate student struggled to shift from a design expert to acting as partner in co-design, even though we invited her to join as an equal partner.

Towards Unbalanced Relationship Building Vignette: Co-design session #29. A new graduate student (female, age 30) worked with our group to understand the relationship between value-sensitive design [23] and children's perceptions of the world and technology. The new student mostly sat on the ground but did not talk to the children. The graduate student later indicated that when working with the children, she was quiet because she had never actually worked closely with children before.

In contrast, social closeness, represented by the right side of the spectrum, helps in relationship development. We identified two types of adult-child social interactions that lead toward more balanced co-design partnerships. First, children and adults often act silly together outside of co-design activities. Such examples in our data include adults playing with children and their toys, adults dancing with children, adults crawling around pretending to be cats, and adults playing games with children. These are genuine and unplanned interactions that cause children to feel more comfortable around adults and break away from traditional adult-child power structures. For instance, in interviews, children noted the adults are "fun" and "silly" and how important this friendly atmosphere was for participating in co-

design. A second type of social interaction is developing strong appreciation and respect between adults and children during co-design. The example below illustrates this point.

Towards Balanced Relationship Building Vignette: Co-design session #10. Riku^C and Anishinaabe^C presented their design ideas about a robot tutorial to the group. Because time was running out, Jason^A told them that if they wanted to continue to share their ideas, they could do so after the session ended. Once we dismissed the children, immediately Riku^C and Anishinaabe^C came to Jason^A to present their ideas, without the rest of the group listening. These two children wanted to continue co-designing even when they had the option to go home. Anishinaabe^C in her interview noted that she liked the close “attention” from the adults because it made her feel “superior.”

Design-by-Doing Interactions

Design-by-doing refers to moments when design activities take place, such as building and evaluating prototypes, creating mockups, and developing scenarios. A design-by-doing approach emphasizes the participation in language games, that is, users and designers engage in a shared activity for better understanding and good design [19]. Here, design-by-doing activities and methods allow both users and designers to use practical skills when participating in design processes. An unbalanced partnership occurs when adults just observe how children engage in design-by-doing but do not participate together with the children. A balanced partnership occurs when adults and children engage together in design-by-doing (Figure 5).



Figure 5. The spectrum of design-by-doing dimension.

The following vignette illustrates how adults can be present in a design-by-doing activity but not actively participate. Here, the adults were still learning how to engage in design-by-doing equitably with children.

Towards Unbalanced Design-By-Doing Vignette: Co-design session #10. Kung Jin^A, Kari^A, and Edith^A worked with Animikiik^C and Aileen^C on the robot tutorial. Animikiik^C and Aileen^C worked quietly while Kung Jin^A and Kari^A watched the group and Edith^A took notes. The adults pointed to specific parts of the children’s designs for clarification, and the children responded back to the adults. However, there was no collaboration in the process between adults and children.

An equitable interaction between adults and children emphasizes balanced design-by-doing collaborations and exchanges in the process. The following vignette demonstrates how a child and adult collaboratively exchanged dialogue and designed together.

Towards Balanced Design-By-Doing Vignette: Co-design session #28. Vivian^A worked with Winston^C to design learn-

ing activities around the technology of Little BitsTM (a snap-in-place electronic building blocks platform). In the dyad, Winston interacted with cardboard and LegosTM to combine them with the Little BitsTM electronics. To create his design, he told Vivian^A, “If we do this [put the LegosTM blocks together in a certain arrangement], but we do it for all of them [put them in that arrangement].” Vivian^A leaned into Winston^C and asked, “How should I build this [design]? Would you like me to do something else?” Winston took a piece of cardboard and said, “Well, we are going to use this one right now and we should cut out that piece.” Vivian^A took the cardboard piece and attempted to understand Winston^C’s direction. Vivian^A used a black marker and drew a series of lines on the cardboard and checked in with Winston^C to see if what she did was okay. While Winston^C put the LegoTM pieces together, Vivian^A cut across the cardboard at the marks she made. She passed the cut cardboard to Winston^C so he could tape together the LegoTM and cardboard for their design.

Elaboration

Elaboration emphasizes adults and children generating and mixing ideas together (Figure 6). While ideation is part of design practice, and thus could be collapsed with *design-by-doing*, we created a distinct dimension for elaboration because of how consistently this theme occurred in our data, distinct from other design activities. An unbalanced partnership exists when children only tell adults what they want or vice versa—when only adults generate ideas.

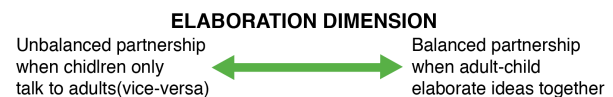


Figure 6. The spectrum of elaboration dimension.

Towards Unbalanced Elaboration Vignette: Co-design session #8. In this session children evaluated the video game Super Mario MakerTM using the Stickies technique [15]. Both children and adults could have presented their likes, dislikes, and design ideas. However, most of the adults spent significantly more time writing down what children were saying. Rather than coming up with their own ideas, adults asked children for design ideas and what they liked and disliked. Here, we did not observe collaborative ideation between adults and children.

Balanced elaboration occurs when active idea exchanges occur between children and adults. Riku^C noted in her interview that it was important for adults to help “build or give ideas” to children. For instance, children and adults consistently “mixed ideas” during the co-design sessions.

Towards Balanced Elaboration Vignette: Co-design session #10. Javier^A (male, age 50, community partner), Jason^A, and Caroline^A worked with Simon^C using large paper [24] to create a tutorial for programming a robot. Simon^C excitedly talked about creating a “random button” on the robot that would sometimes help you or lead you astray. Jason^A asked, “Why would that be helpful to anybody?”

Simon^C insisted it would just be a fun idea. Javier^A pressed Simon^C to think more about whether his random button was helpful. Simon^C defended his idea, “Well, maybe it’s helpful. Maybe it’s not.” Javier^A laughed, “So it’s sorta like a game!” The adults started to mix Simon^C’s idea with the notion of an “I feel lucky” button from GoogleTM.

In this vignette, adults and children worked together to elaborate on and mix their ideas together. The adults did not dismiss Simon^C’s ideas, but treated him maturely by asking him clarifying questions. The adults and children continued to build on the idea of randomness, fun, and gamification.

Focal Design Sessions

To illustrate the dimensions along their spectra, we chose two focal co-design sessions as contrasting cases for analysis [33]. Our goal in this is to not only clarify the dimensions, but to also demonstrate how to apply this framework. Our demonstration will help researchers use the framework in their own PD work. We chose an earlier (Fall 2015, session #9) and a later session (Spring 2016, session #30) to demonstrate how experience in co-design influences partnerships. Both co-design sessions specifically involved designing technology. The first sessions consisted of generating early design ideas, using the co-design technique Bags-of-Stuff (low-fidelity prototyping with arts and crafts materials) [15]. The second session, which took place later in the year, consisted of evaluating a higher-fidelity prototype with the Stickies technique [15].

As a summary of the interactions across the sessions, Figure 7 shows a visual comparison between co-design sessions #9 and #30 along the spectra of dimensions. Additionally, Figure 7 illustrates how a span of points along the spectrum of a dimension can be present in a single design session. It shows how co-design sessions can have diverse interactions, towards balanced *and* unbalanced, within one session. Each of these dimensions shows a continuum of interactions that occurred in the co-design session, as indicated by black (session #9) and grey (session #30) bars. Wider bars along a dimension horizontally indicate a wider range of balanced/unbalanced interactions. The narrower the bars horizontally, the more likely the dimension leans towards balanced or unbalanced for that session.

Focal Design Session 1: Museum Technology

Description. In co-design session #9, we conducted an exploratory activity focusing on how children view museums and what technologies can be designed for the space. Seven children and six adults attended. We divided the children and adults into four groups, where each group had at least one adult and one child. The two remaining adults (the lead facilitator, Jason^A, and a new researcher, Lili^A) moved between groups. The groups created low-fidelity prototypes of their museum ideas, using a variety of art supplies (Bags-of-Stuff) [15]. The groups then presented their designs to the entire group. Finally, the entire team briefly discussed major ideas that arose from the various designs, such as large touchscreens and expert teachers.

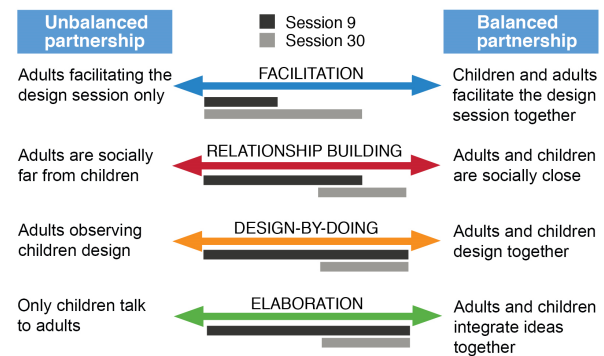


Figure 7. A visual comparison of co-design sessions #9 and #30 along the spectra of the dimensions.

Analysis with respect to dimensions. With respect to *facilitation*, we identified that adults tended to lead more than the children. Adults frequently reminded children to stay on the design task. For example, while designing a museum video game, Jason^A had to keep Winston^C and Simon^C from throwing arts and craft supplies at each other. While designing, Marlene^C and Athena^C started chasing each other and putting things in each other’s hair. Vivian^A had to quickly intervene and get the girls to stop running around. During the group discussion, only adults led the design presentation by prompting the children to speak about the different features of their museum technologies at the appropriate time.

A wide range of *relationship building* interactions occurred in this session. Here, the variety of interactions are more in-between, rather than leaning towards balanced or unbalanced. Some interactions reflected social closeness while others were distant. Vivian^A and Athena^C talked about the USA cartoon *Charlie Brown*TM, joking about how the teacher spoke in an indistinguishable voice. Other adults were quieter and interacted less with children. Lili^A (new member), worked with Aileen^C on her animal museum design, but they did not engage in conversation.

Design-by-doing also varied in this co-design session, indicating more in-between interactions. Some adults worked very closely with the children. While Winston^C and Jason^A were working together, Winston^C suggested that virtual reality (VR) should be included in their museum video-game. Jason^A, an expert with lots of experience in adult-child co-design, grabbed a piece of paper and put it on Winston^C’s head and asked him if this is how his VR should work. Jason^A continued to work closely with children by asking questions, and taking children’s artifacts and adding designs to them. Edith^A and Lili^A, on the other hand, took a more passive role when working with Aileen^C. Edith^A and Lili^A provided Aileen^C with the supplies she needed to work on her animal museum technology, but did not participate in the design activity with her.

The *elaboration* dimension shifted from group to group between balanced and unbalanced. In Winston^C and Simon^C’s group, Jason^A elaborated together with them on their idea to create a room in which museum patrons build

video games. Jason^A mentioned that this room could be composed of holograms. Simon^C created a paper cube and Jason^A discussed how this cube could project holographic images. Winston^C jumped in and talked about how the cube could also project pictures. Within other groups, adults did not elaborate on children's ideas. The adults asked children specific questions about their designs, but no new ideas were generated and mixed together through this process.

Focal Design Session 2: Children's Programming Tool

Description. Co-design session #30 was the seventh session we had developing a children's programming tool for game design [1]. We worked with Ayush^A, a doctoral computer science student (age 35, male) and the lead designer. The children's task was to evaluate a story-based tutorial for this programming tool, using the Stickies evaluation technique [15]. We divided the eight children and four adults into four groups, and had the lead adult facilitator and Ayush^A rotate groups. After the children evaluated the programming tool, the adults and children shared their ideas in a group discussion about how to make further improvements.

Analysis with respect to dimensions. The *facilitation* dimension still tended to lean more towards adult leading. For instance, adults set the pace of the activity, asked the children many questions about their evaluation of the programming tool, and led the presentation during the group discussion. However, moments of balanced adult-child facilitation did occur. For example, as Ayush^A introduced the changes to the programming tool, children immediately directed the conversation. Aileen^C asked if characters and sprites could appear instantly. Riku^C suggested creating and deleting the sprites. As Ayush^A discussed more about the sprites, Riku^C jumped into the conversation about the magical items in the tutorial. Ayush^A shifted the conversation to answer Riku^C's question. She continued, "And then on the characters the water, I saw water, the water blocks." Ayush^A noted that she was asking about a feature she saw in the interface and said, "Yes, you call it water blocks." In this example, all the children's questions facilitated and directed the discussion of how the adult designer should discuss the features.

In terms of *relationship building*, because this was adults' and children's 30th co-design session together, their social distance was closer, both in friendship and design. For instance, during snack time, Athena^C acted like a cat and Kiley^A asked whether her "cat name" would be "Fidget." Aileen^C and Caroline^A played a smartphone game together. During the co-design evaluation, Winston^C called Ayush^A over and asked him to see and play his design from the programming tool. Athena^C asked Kung Jin^A to look at her design too. Both adults and children felt comfortable working and playing with each other.

Although session #30 focused on an evaluation technique, the adults and children also engaged in the *design-by-doing* dimension. Here, both the user (child) and designer (adult) expressed propositional knowledge and practical under-

standing of the technological tool [19]. Both the adult and child critiqued the design together in the activity by creating ideas for new features. For instance, Kiley^A and Winston^C evaluated the programming tool's tutorial. Kiley^A critiqued the system's tutorial, "Could that be a rule? Like when you click something back, it [sprite] gets bigger, can you, like, resize it?" Winston^C replied "Yeah, I think you might be able to [have that]. Yeah, totally." Kiley^A replied, "I think that would be cool to teach resizing [in the tutorial]." Similarly, Kari^A asked Riku^C if an indicator about changing font usage would be helpful: "Maybe we can have, like, an indicator, saying, telling you which spot you are on." Riku^C said, "Yeah, that'd be helpful," and Kari^A wrote it on a sticky note. In both examples, adults were not worried about suggesting their ideas to the children.

Finally, for the *elaboration* dimension, children and adults mixed their ideas together during the larger group discussion. Jason^A summarized the findings with respect to the likes, dislikes, and design ideas. Winston^C soon commented that he wanted to see "invisible blocks" to help with the mechanics. Jason^A clarified Winston^C's position, "Like a transparent block?" Ayush^A added on, "Like a trigger, so when something moves through there, you can go to a new scene, something like that?" Winston^C confirmed the clarification. Ayush^A then asked the group how many would like to see a transparent block in the interface. All the children enthusiastically raised their hands. Aileen^C called out loudly, "Invisible blocks would be cool, but it would be a lot easier if we [the sprites] could just jump." From these ideas, Jason^A asked, "Would it help [in the tutorial] if Ayush^A had a list of mechanics in the game?" The children all agreed with this mixed idea.

DISCUSSION AND IMPLICATIONS

We argue that deeper understanding of design partnerships requires an analysis of both designer (adult) and domain expert (child). Previous work tends to focus on the important role of children [15,16,24,25,29,51,52]. However, the adult designer is not an invisible partner to be ignored, but rather key and instrumental to how the partnership runs. It is of great importance for designers to self-reflect on their roles in PD [6,7]. We believe our framework of adult-child complementary roles (*user-observer*, *tester-test facilitator*, *informant-interpreter*, and *adult-child design partner*) (Figure 2) contributes to the field of HCI research because it represents design partnerships in a more holistic fashion. By augmenting Druin's [16] framework on children's roles with adults, we allow for deeper examination of both children and adults in PD (which we exemplified in this research). Because we conceptualized the adult-child roles as complementary, we focused our analysis on how both children and adults facilitated, socialized, designed, and elaborated together. This allowed us to theorize about what interactions constitute equitable practices in co-design.

Our work also shows that describing adult-child PD partnerships as either 'equal' or 'unequal' is too simplistic. In-

stead, the term ‘equal partnership’ for adult-child PD needs to be broken down into specific and observable equitable interactions. Our results illustrate how dimensions of adult-child interactions (*facilitation*, *relationship building*, *design-by-doing*, and *elaboration*) can range from unbalanced to balanced. Furthermore, the range of interactions along each dimension can exist in the same session among different groups, with different people, or at different times. Ultimately, our four dimensions allow researchers to refine their understanding of where equitable co-design practices manifest and where they do not.

We claim that the concept of equality in adult-child co-design is not static, but is rather dynamic, contextual, and participant sensitive [41]. Instead of describing PD partnerships as binary either-or, we believe it is more productive to discuss how adult-child PD partnerships are working towards equality as a goal along a spectrum. We believe the best way to explain equal adult-child partnerships in PD is to look at the overall trend of balanced and unbalanced partnerships through interactions within our dimensions. Design partnerships that have more balanced contributions in the dimensions are more likely to be demonstrating shifts towards equality. In contrast, more unbalanced interactions in the design partnership dimension mean that it is unlikely supporting equality. Describing interactions via these dimensions can aid in clarifying what researchers mean by “equal” design partnerships between children and adults.

However, equal partnerships and equitable practices do not occur instantly, even when there is an attempt to establish the necessary conditions. In our first focal case, following Guha et al. [26], novice adults struggled to have equitable interactions and to establish themselves as equal partners. Similarly, children need time to acclimate towards equitable practice. In the second focal case, children and adults had spent many sessions together. Thus they could work together to facilitate the session, demonstrate close ties in relationships, physically design together, and elaborate together without hesitation. More importantly, we now have a set of observable and explicit interactions that researchers can use to support new adults and children to engage in equitable practices. For instance, we can emphasize to novice adults the importance of design-by-doing or helping children find ways they can co-facilitate the sessions [52].

Finally, this study demonstrates that design partnerships cannot be described by one dimension or one type of interaction. We posit that the dimensions in our framework are tightly connected, and one dimension does not supersede another. For instance, if adults do not engage in *relationship building* with children, then it is unlikely the group will have equitable *facilitation*, *design-by-doing*, and *elaboration* practices. On the other hand, an adult and child may have a close relationship outside of the design sessions, but they might not know how to engage in *design-by-doing* or *elaboration* either; thus, they cannot be design partners. Our dimensions help triangulate and assess the state of co-

design partnerships. For instance, if there are close *design-by-doing* interactions and strong *relationship building*, but there are fewer moments in *elaborating* together (e.g., adults quiet, children talking) and less shift towards helping children *facilitate* the co-design session (e.g., adults lead the sessions only), over time the sessions may become more playful design workshops, rather than fostering equality and equity in a co-design partnership.

LIMITATIONS

Our dimensions of adult-child design partnership are meant to be used as an analytic tool and not as a quantitative scale to measure if adult-child PD groups have reached or not reached equal partnership and equitable practices. Additionally, the framework is highly context-dependent. Therefore, we advocate that researchers from varying design philosophies working with children use our four dimensions as a contextual guide, rather than an objective measurement to determine if PD with children and adults lean towards equal partnership and equitable practices.

FUTURE WORK AND CONCLUSION

Our adult-child co-design partnership framework has strong potential for future HCI research. For instance, researchers can begin by examining how to adapt our framework to other contexts that have power imbalances in PD. Such PD contexts include design experts working with medical patients [13], office workers [35], teachers [12], senior citizens [9], families [49], people with impairments [43,45], neurodiverse children [21,22], and other stakeholders. Additionally, our framework may need to be examined on a scale of years to determine how equality in PD partnership evolves over time. Future work also needs to examine whether balance in our dimensions could be established within hours, days, or weeks. Furthermore, potential future research can determine the extent to which our framework’s dimensions are related to each other and how it applies to other more diverse and complex interactions. Finally, our dimensions were developed in a case study of a co-design group of seven to ten children and four to six adults. Future research can examine how these dimensions may be utilized in analyzing differently sized groups in PD.

In conclusion, our study has provided a comprehensive model to better understand adult-child roles in technology design and a clear framework for researchers to examine equitable practices and equal contributions in co-design. These analytical tools give us better insight into what constitutes a design partnership. Furthermore, they will be useful to researchers interested in ensuring equitable practices and setting an equitable agenda in future PD work.

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