Co-Design with Older Adults: Examining and Reflecting on Collaboration with Aging Communities

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Co-design methods have involved older adults in the design process to fill the knowledge gap that younger adult designers might encounter when designing for an aging population. A focus of co-design means establishing equal and equitable relationships between users and designers. To understand the factors that contribute to equal collaborations between older adults and student designers, we conducted 12 co-design sessions with 16 older adults and 11 student designers. We examined their interactions by adapting a framework initially aimed to understand the child-adult design partnership. We also analyzed student designers' reflections to understand their experiences and learnings from designing with older adults. Our findings demonstrate that developing a design partnership is complex. The framework helped surface factors like sharing life experiences and role ownership that influenced balanced or unbalanced interactions. Through the student designers' reflections, we found that student designers identified challenges they encountered and the assumptions they had about the older adult population. We believe that immersing students in a co-design experience with older adults and leveraging reflection activities provides an educational and meaningful experience to the design students.

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI)**

KEYWORDS: Co-design; Participatory Design; Older Adults; Reflection

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1 INTRODUCTION

Participatory design (PD) approaches have been a way to ensure that technologies better meet the needs of older adults [46,65] and push against the assumptions about their abilities to contribute creative ideas [13,54]. Prior studies in PD approaches and co-design approaches have included older adults in a range of design activities, including expressing their needs [14,31] and creating and evaluating prototypes [15,20,29,32,46]. Sharing the design process with people who may use technology is essential to PD approaches and the co-design approach, and researchers have provided frameworks [37,43], considerations, and lessons learned [13,31–33,46] to facilitate successful collaborations with older adults. However, understanding interactions, such as when facilitating, building rapport, and collaborating between older adults and designers remains an

area of need to facilitate equal and equitable collaboration during design activities. The distinct differences between older adults and designers are often their ages and life experience. This gap can influence team dynamics and participation, so it is important to identify and understand aspects that contribute and distract from building a design partnership. While explorations in equal and equitable design partnerships have taken place with children e.g., [17,72,74], fewer studies are available to make sense of the dynamic collaborations between designers and older adults.

Our study aimed to address that gap by understanding the interactions between older adults and younger adult student designers in a series of co-design activities. We also wanted to understand student designers' experience in co-designing with older adults. This paper addresses three research questions:

1. What types of interactions occur during co-design with older adults and student designers?
2. What types of activities lead toward balanced or unbalanced interactions?
3. How might co-design sessions impact student designers' perceptions of designing with older adults?

Our paper extends knowledge about collaborating with older adults in designing technologies that better meet their needs and adds to the growing efforts in the CSCW community to support older adults' agency [42]. CSCW research has a long engagement with PD methods [6,34] to understand better the designers' social interactions and users of technologies, such as teens and members of the deaf community [3,51]. We adapted Yip et al.'s [74] framework to investigate the factors contributing to design partnerships in intergenerational collaboration between older adults and student designers. This framework emphasizes an equal and equitable collaboration between children and adults in designing new technologies for children. While it has only been adapted in the context of children and librarians [73], we were inspired by how the approach levels power differentials between designers and participants in co-design sessions [74]. In this paper, we adapt this framework to understand better the collaboration between older adults and student designers.

We also offer insights about how co-designing with older adults impacted student designers' assumptions and heightened awareness of the value of co-design compared to other methods. Young adults often have preconceived notions of older adults associated with negative stereotypes [36,41]. Interestingly, other studies have demonstrated that engagement with older adults can positively affect and broaden college students' perceptions of aging [28,34,51].

2 BACKGROUND AND RELATED WORK

Our work has been informed by prior literature in co-design and participatory design approaches with older adults. Further, our understanding of collaboration in co-design teams was guided by Cooperative Inquiry [17,74] and literature that discuss participation by people who use tech in the design process. Additionally, we referenced prior work that explores the value of experiential learning and the reflection for design students.

2.1 Designing for Older Adults

Light, Leong, and Robertson [42] acknowledge active aging "as the work of preparing for new life stages when interests, values, conditions, and capabilities may change" (p.296) [42]. CSCW and HCI researchers have been prominently interested in addressing aging; supporting the development of assistive technologies that can supplement, support, and compensate for older

adults' needs that arise with aging [54]. There has been an emergence of technologies that support social and emotional engagement, physical activity, and mobility, memory aids, health, and wellbeing for older adults [67]. Although this approach addresses older adult needs in living independently and longer, it can miss individuals who may not consider themselves reliant on such technologies and continue to contribute to society and their communities [54]. The focus of integrating assistive technologies into the lives of older adults is in need of methods that acknowledge the contribution this community can make toward the future innovations by being active participants in the design process [54].

2.2 Co-designing and Participatory Approaches with Older Adults

The introduction of digital technologies into the lives of maturing communities, promise to improve the quality of life by supporting health, well-being, ability, and promote ageing in place. However, there seems to be a discrepancy between digital technologies that are developed and what older adults want and need [42]. Negative stereotypes associated with the older adult community often influence the invited participation of them in research and design of digital technology, thus expanding the digital divide [42]. Light et al. [42] argues that the inclusion, rather than exclusion, of older adults in the design process and research is essential for technology to fulfill the promise of improving well-being.

To further promote this, we contribute to the growing body of literature that adopts participatory design approaches to support the integration of older adults into technology design processes, normalizing them as producers of digital technologies, rather simply than consumers [70]. We employed PD approaches as a practice that focuses on engaging users in the design process and emphasizes a collaborative relationship between users and designers to create new technologies [17,35,74]. Co-design prompts the clear indication of collective collaboration and creation applied across the entire span of the design process. "In a broader sense, co-design refers to the creativity of designers and people not trained in design working together in the design development process" (p. 6) [58]. Users are subject matter experts of their life experiences and in the collaborative process are perceived as valuable partners [1,48].

2.3 Benefits of Designing with Older Adults

Participatory design approaches with aging communities is a practice that has proven much value and significant contribution [24,48,54]. This dynamic partnership changes the role of designers, developers, and/or researchers, who now have to view themselves as "facilitators" using appropriate methods to allow older adults to make their own decisions and to express their own perceptions [58]. In contrast, co-design emphasizes values that individuals embody that inherently influence the technologies in which people they deem worthy of pursuing and attaining, based upon encounter [30].

PD approaches have the potential to remove negative age-related stereotypes and connotations of ageism as modern techniques targeting older users' engagement and impressions of digital devices [50]. A key advantage of interacting with older adults is learning from their instances of nostalgia and storytelling. Seniors who choose to participate in design projects can illustrate the value of lived experiences to the design process. Carroll and colleagues [8] noted, *"they are the ones with the many years of memories, as well as with time and motivation for sharing these. By doing so, they can evoke commentary, community bonding, and reinforcement of community identity from other community members".* In our study, we aimed to incorporate

conversations about lived experiences through activities that encouraged team members to share events throughout their lifespan that impacted their current perceptions of health and well-being.

2.4 Power Dynamics and Design Partnerships

In traditional forms of design, individual homogeneous contributors typically hold the power of decision making. Even within the user-centered design process, the practitioner can prioritize decisions of design practice even when they are tailored towards a specific community. Within HCI, navigating power dynamics between designers is a well-known challenge, especially as it relates to social desirability bias, soliciting honest feedback, and overly eager acquiescence [62]. In Cooperative Inquiry (a PD method), Druin [17] illustrated the four roles that a child could have in designing technologies: user, tester, informant, and design partner [17]. Yip et al. [74] expanded upon Druin's [17] description of a child's role in the design process by adding corresponding roles for designers, including observer, test facilitator, interpreter, and design partner. The roles are sets of concentric circles, one for the child's role and one for the adult's part. The circles also represented the child's level of interaction as user and adult as an observer as the smallest and most distant circles to design partners as the largest and closest circles [74], see Figure 1.

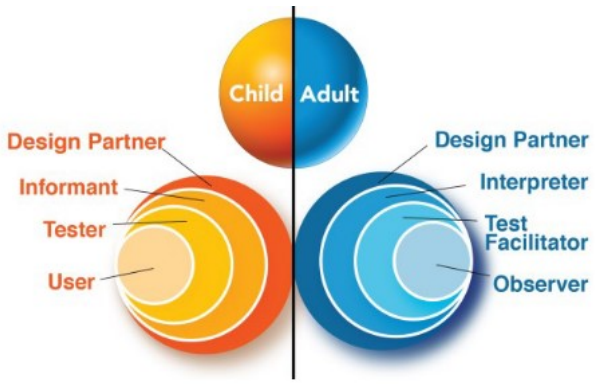

Figure 1. Image of corresponding roles for designers and children in co-design [74]. Reused with permission.

Unlike studies in co-designing with children, collaboratively engaging with older adults shifts the dynamics of power and expectations 1) as many senior citizens can be older than the designers; 2) designers' interaction employ a heightened sense of empathy, respect, and care with them; and 3) older adult needs and physical capabilities can affect their involvement, as lack of consideration can lead to reluctancy of participation [64]. Building toward a partnership between designers and older adults is essential to equal and equitable collaboration is at the center of Cooperative Inquiry [16]. However, there has been little work examining the interactions between older adults and designers that contribute to understanding design relationships. Our study aims to fill this gap by investigating factors that lead to balanced or unbalanced interactions between older adults and student designers through a six-week co-design collaboration.

2.5 Reflection in HCI Education

Designers often create technologies for people different from themselves, so it is typical that students in HCI education engage in project-based learning, where they involve users like

themselves in their process [38]. Project-based learning offers students the opportunity to experience real-world situations by engaging with stakeholders and users [38]. The experience with engaging people who may use the technology being designed leads to understanding the value of including users in the process rather than relying on one's own experience and assumptions [38]. We aimed to extend students' learning affordances by designing with people who were not like them in a real-world setting.

Roldan et al. [55,56] deepened our understanding of the value of involving users in HCI education through examining interactions in co-design activities between graduate students and children. They [55] advocate for reflection activities in HCI education to support meaning-making of graduate students' experiences and understand how they build and navigate the complexities of interacting with users. Our study used reflection activities to understand undergraduate and graduate students' experiences in co-designing with older adults over time.

Reflection has been incorporated in experiential education programs like service-learning, which involves students taking part in a community-based project where all partners equally benefit [25,40]. Prior work has found service learning opportunities have increased positive attitudes toward aging and increased interest in working with older adults in the future [26,28,51]. Educators in HCI and computer science have also used service-learning to enable students to apply their knowledge to real problems and interact with users [44,49,63]. Despite challenges of recruiting community partners [44], the learning outcomes and community benefits of service learning are worthwhile. While our study was not a service-learning project, we had the components of community partnership and reflections as a key part of the course. Our study contributes to prior work by sharing the students' experiences of participating in experiential learning.

3 METHODS

We examined team collaboration from two sites across six weekly co-design sessions, specifically focusing on student designer experiences from weekly audio reflections and artifacts from reflection activities. We conducted our study from January-March 2020. This study was completed prior to the state restrictions put in place because of the COVID-19 pandemic. The 12 total co-design sessions across two sites occurred once per week, over six weeks, within that time frame. This study received approval from the University of Washington's Institutional Review Board (IRB).

3.1 Context and Participants

Our study took place at two sites in a city in the US Pacific Northwest at a senior center and a senior living community. A researcher met with coordinators at each location to discuss this study and ensure that it would fit their older adults' community. We recruited people who self-identified as older adults because the term "older adult" could been interpreted in different ways and not necessarily associated with biological age [5]. Other criteria included were people interested in technology and willing to collaborate with students to brainstorm new technologies. Our study had a total of 16 older adults who participated in study activity sessions, however two older adults dropped out after the first and second sessions (Table 1). A majority (81%) of the older adults in this study were retired. Many of the older adults (n=10) reported using technologies like computers, smartphones, or other devices to access the internet several times a day, some older adults (n=6) said they used technologies almost constantly. However, only half of older adults

(n=8) reported being somewhat confident, while seven older adults reported that they were confident.

We recruited 11 student designers through a directed research group course offering that allows design students to gain research experience for course credit (Table 2). In the prior quarter, three students participated in the study design. These students reviewed prior literature about PD and co-designing with older adults and engaged in discussions brainstorming the types of activities for the study sessions.

3.2 Data Collection

Co-design sessions with intergenerational teams: We conducted 12 co-design sessions (six sessions at each site) with seven smaller teams made up of older adults and student designers (2-3 older adults and 1-2 designers). They stayed in this team throughout the six sessions. However, we grouped several teams for some sessions due to team member absence. Each session was 90-minutes in length. We used two video cameras to record team interactions during the sessions, along with pictures of the activities and artifacts.

The sessions were aligned to the human-centered design process and had a general theme around designing technologies for health and well-being. Each session was successively aimed at building team cohesion and ultimately co-creating a low-tech prototype of a new health and well-being technology. Some of the design activities were influenced by the Life Course approach, which stresses the need to consider life's context by examining individuals' life stages, transitions, agency, time, place, and relationships [19] . One of our activities was tailored for teams to travel through each person's health and well-being histories (Table 3). We also encouraged teams to consider their histories and future needs as they narrowed in on their design area and target user.

At the start of the sessions, we presented an overview of the human-centered design steps [18] alongside the sessions to provide participants with a roadmap of how we would arrive at the low-tech prototype and showed them examples of a low-tech prototype. The steps were termed *Discover* (Sessions 1 and 2), *Define* (Sessions 3 and 4), *Ideate* (Session 5) and *Prototype* (Session 6). Before each session, we set-up the room, including hanging prior activity artifacts, placing name cards, and writing supplies on the table. Generally, each session started with people settling in and eating snacks and chatting with each other (~5 minutes). As a large group, we shared the agenda, described the activity and how it related to the study roadmap (~10 minutes). Then, everyone went into their teams to work on the activity (~45 minutes). After the activity, groups shared their artifact or engaged in a larger group conversation to reflect on the activity (~15-20 minutes). The session ended by letting everyone know what to expect next week (~5 minutes). There was variability in the session structure depending if teams needed more time to work on activity from the prior session.

The activities within each session were adapted to the session goals and to accommodate our intergenerational team, see Table 3. For more details about the adapted activities, see Appendix A1. We looked to prior work [31,32,37,43] for guidelines in designing with older adults and ideas for encouraging equal collaboration like encouraging sharing personal experiences with technologies, engaging them in design activities like prototyping and persona building, providing concrete examples of design artifacts and bringing technologies to experience and evaluate. Overall considerations included implementing the study in a location that was convenient for older adults and partnering with site coordinators on session format (i.e., length of time, time of day, expressions of gratitude, and session activities) [45,47]. Some overall activity considerations

were, using familiar tools to design like art supplies, sticky notes, paper and pens [17,68] and larger font sizes in handouts [21].

Table 1. Demographics of Older Adults (n=16). Asterisk* refers to older adults who reported they were retired

Age Range	Prior and Current Work Experience	Gender	Ethnicity	Highest Level of Education Completed
55 – 59	Business Owner	Woman	African American	4-year college degree
60 – 64	Design Consultant	Prefer not to answer	Prefer not to answer	Post graduate degree
65 – 74	International Development and Government Assistance*	Man	White	Post graduate degree
65 – 74	IT System Architect*	Man	White	Post graduate degree
65 – 74	Secondary Teacher*	Woman	White	Post graduate degree
65 – 74	Federal Government*	Woman	White	4-year college degree
65 – 74	Educator*	Woman	White	Post graduate degree
65 – 74	Graphic Artist and Business Owner*	Woman	White	2-year college degree /Technical Training
65 – 74	Librarian*	Woman	White	Post graduate degree
65 – 74	Registered Nurse and Volunteer	Woman	White	Post graduate degree
75 – 84	Director/ Technical*	Woman	White	4-year college degree
75 – 84	Secretary and Educator*	Woman	White	4-year college degree
75 – 84	Educator*	Woman	White	Post graduate degree
75 – 84	Educator*	Woman	White	Post graduate degree
85 years and over	Clinical Psychologist*	Woman	White	Post graduate degree
85 years and over	Educator*	Woman	White	2-year college degree /Technical Training

Table 2. Demographics of Student Designers (n=11)

Age Range	Student Status	Gender	Ethnicity
18 – 24	Undergraduate	Woman	White
18 – 24	Undergraduate	Woman	Asian
18 – 24	Undergraduate	Woman	Asian, White
18 – 24	Undergraduate	Woman	White
18 – 24	Undergraduate	Man	Asian
18 – 24	Undergraduate	Man	Asian, White
18 – 24	Graduate	Woman	White
25 – 34	Graduate	Woman	White
25 – 34	Graduate	Woman	Asian
25 – 34	Graduate	Man	Asian
45 – 54	Graduate	Woman	White

Student designers' reflection activities: Student designers each participated in six co-design sessions at one site, and there was one designer who participated in sessions at two sites. Student designers also attended ten weekly research team meetings. After each co-design session, student designers' audio-recorded a short reflection about their experience. For our weekly meetings, students participated in a range of reflection activities focused on a specific session or broader learning experiences. Each week students engaged with a different reflection activity. We asked students to complete the 20-minute reflection activities prior to the weekly meetings. Students shared their reflections in small groups during the session, and later in a larger group discussion.

The learning goals of the reflection activities were two-fold: 1) To scaffold students in reflecting on their engagements with the older adults; and 2) how their collaboration influences their design approaches. We adapted many of the activities (Table 4) from Roldan et al. [57] and received guidance about using them for our co-design study (W. Roldan, personal communication, January 16, 2020). See Appendix A2 for detailed description about reflection activities. For most of the activities, students filled out an exit survey with one question asking them to rate the activity and a space to add comments.

3.3 Data Analysis

Co-design sessions with intergenerational teams: The analysis of the co-design sessions was conducted by the lead researcher and nine students who participated in the sessions. In this study, we take an interpretivist stance believing that people who took part in the study can engage in sense-making of the data [71]. To strengthen rigor and credibility, the student designers did not analyze video data of them and their team. Additionally, we wrote memos and had peer debriefings to discuss the application of codes, discrepancies in codes and conducted member checks [61].

We deductively analyzed the session videos our teams' collaboration using Yip et al.'s framework that examines design partnerships in intergenerational teams, specifically between children and adults [74]. The framework was developed through Cooperative Inquiry, an approach that has addressed power dynamics in intergenerational design, primarily between adults and children, through building a partnership [16,17]. The framework has four dimensions that describe design partnerships: 1) facilitation, 2) relationship building, 3) design-by-doing, and 4) elaboration [74]. Each dimension of the framework is on a spectrum that describes interactions between older adults and designers from unbalanced to balanced.

The lead researcher started analysis with deductive coding to a subset of the co-design session videos. As a result, we had an initial codebook consisting of the four dimensions and 23 sub-codes such as leading, managing conversation flow, humor and grouping ideas. Next, the lead researcher and the nine student designers coded a small sample of the video data to validate the codes. We further added sub-codes for a total of 30 sub-codes, including snowballing, sharing life stores, and unbalance interactions. Then, the researchers independently reviewed and coded all sessions. Throughout this process, we met weekly for peer debriefing. We drew codes across the sessions to develop initial themes [9]. The lead researcher refined the themes by triangulating the coded data with the analytical memos and determining whether interactions were balanced or unbalanced.

Table 3. Summary of Session Activities

Session #	Activity
1	Stickies [68]. We adapted Stickies for an exploratory activity. Teams captured individual perceptions of health and well-being and then sorted it to create a shared meaning of health and well-being.
2	Personal History [4]. Participants compared and contrasted their memories of changes to technology across their lifetime. We adapted this activity into a timeline of health and well-being events across each team member's lifetime and considering future goals.
3	Line Judging [68]. We adapted the line judging activity to accommodate physical limitations and spark discussions about technology rather than narrow in on an idea. Teams also had a questionnaire to guide their conversations.
4	"How Might We" [11] and Persona creation. A fill in the blank activity used in ideation to explore and brainstorm ideas. The goal of this session was narrow down on a design area within health and well-being and create a persona based on their past session artifacts.
5	Ideation. The goal of this session was to brainstorm ideas for a new health and well-being technology. We presented the team with different ways to ideate such as sketching, jotting down ideas and storyboarding [12].
6	Bags of Stuff [17,68]. We made small adaptations to this activity. Teams used an assortment of craft supplies that we brought to translate their design ideas in a low-tech prototype.

Table 4. Student Designers Reflection Activities [57]

#	Activity	Description
0	Looking Ahead Activity	This activity was completed the week prior to the start of the session. We aimed to understand students' expectations for their first session.
1	Micro-Reflection	This was a worksheet activity where students were asked to create a picture, diagram or representative that captures something they learned in their second session.
2	A Photo and Haiku	We asked students to take a photo that captured how they felt about their second session, add a description of their photo, and create a haiku of their session two experience.
3	Reflecting Back	We asked students to listen to their past audio reflections. Students got into groups of 3 where each took on a role of either the facilitator, notetaker or responder. The facilitator asked the responder a question and the notetaker took corresponding notes.
4	Collective Meaning Making	In this activity, students responded to three prompts. Each prompt had a three-square grid where they could write or use images to express their answers.
5	Making a Zine	Students wrote a 250-300-word description about things they think were the most important from their experiences in this study.
6	Supporting future designers	Students were asked to create an artifact (i.e., letter, poem, collection of images) to share with future designers who want to co-design with older adults.

Student designers' reflection activities: The analysis of the student reflections was a separate effort from the co-design session. To analyze this qualitative data (transcripts and activity artifacts), one researcher conducted a thematic analysis [9]. The lead researcher opened-coded

transcripts from the student designers' weekly audio reflections to develop codes. The coding process was influenced by the principles of reflective design presented by prior work and the impact of reflections on designers [55,59]. The researcher refined the analysis by identifying patterns between codes and then developed themes. The analysis of the reflection activities and the co-design sessions occurred in tandem. We iterated on the themes when the researcher compared them to the artifacts from the reflection activities.

4 FINDINGS

In this section, we provide findings in two parts, co-designing with intergenerational teams and student designers' reflections.

4.1 PART 1: Interactions present when co-designing with intergenerational teams

We described the interactions between older adults and students through adaptations to Yip et al.'s [74] framework. Balanced interactions are when both older adults and designers contribute equally to the discussion, generating ideas and creating their designs [74]. Whereas unbalanced interactions are when older adults or student designers lead or dominate the collaboration [74]. Given the fluidity of the team dynamics, we observed how teams could interact toward unbalanced and balanced ways within the same session. As such, we use contextual examples given in the findings as moments within a session. Here, we denote pseudonyms between the older adults and student designers by using superscript Student (Name^{SD}) for *student designers* and superscript OA (Name^{OA}) for *older adults*.

4.1.1 Facilitation

The facilitation dimension is defined as "how much support and mediation takes place between adults and children." [74]. It includes leading and managing the flow of the sessions. An unbalanced interaction is when only the adults facilitate the session, whereas a balanced interaction is when both the adult and child equally facilitate together [74]. Yip et al. [74] point out that adults have specific responsibilities when collaborating with children, keeping them on task, managing their behavior, and motivating them to engage in design.

In our analysis, we found that Yip et al.'s [74] facilitation dimension was too broad for our interactions. We differentiated between *facilitating the **activity*** and *facilitating the **discussion***. We observed ownership of roles, student designers as experts in design and older adults as subject matter experts.

Facilitating the Activity

This dimension examines how the activity or task is carried out. A balanced interaction is when both the older adult team member and student designer equally negotiate their approach to an activity or task. An unbalanced approach is when either the student designer or older adult decide the direction of the activity or task.

Towards Balanced Facilitating the Activity

There were several instances when student designers shared this role leading toward a balanced interaction. For example, Session 5 focused on ideation. We encouraged teams to go with an ideation method that best fit their team's creative process. Team 1 had two student designers, Jessie^{SD} and Olivia^{SD} and two older adults, Nina^{OA} and Darlene^{OA}. After the general introduction

of the ideation process, Olivia[SD] asked Darlene[OA] and Nina[OA] about their thoughts. Darlene[OA] commented that brainstorming far-out ideas may lead to useful ideas. Olivia[SD] asked both older adult team members, *"Which method did you like in order to think of far-out ideas?"* Olivia[SD] listed the options that were presented during the general introduction. Nina[OA] suggested that they start with one piece of paper where one person writes an idea and passes it onto the next person, so that all of them could discuss the ideas.
Instead of suggesting an approach to the activity, Olivia[SD] opened it for discussion with Nina[OA] and Darlene[OA]. This interaction is toward a balanced interaction because discussing how to approach the design activity was open to both the older adult team members and the student designers. This interaction is not fully balanced because the designer guided the conversation rather than an equal collaboration of ideas.

Another example happened in the Stickies [68] activity when the older adults started grouping when sharing their perceptions. When Jake[SD] shared his sticky note, Michelle[OA] surveyed the table and suggested a grouping. Lily[SD] indicated that grouping would happen later, she said, *"Later in the session we are going to put all the sticky notes on the wall."* However, Lena[OA] chimed in with a similar sticky and passed it to Michelle[OA]. Jake[SD] said, *"I think we are grouping afterwards, right?"*, Lily[SD] confirmed. However, Lena[OA] and Michelle[OA] continued to group and so Lily[SD] and Jake[SD] went with it. They both handed Lilly[SD] a succession of similar stickies. Lily[SD] accepted them and said, *"Oh wow!" "These are great!"* Michelle[OA] said, "*We are doing our group thing over here!"* This example is towards balanced *facilitating the activity* because the older adults pushed for a different approach to the activity. The student designers tried to push back, but ultimately, they decided to go with the older adults' suggestion.

Towards Unbalanced Facilitating the Activity

Throughout we saw student designers take on the facilitator role by setting the direction of the activity. When everyone broke into their respective teams, the students often provided further explanation of the activity and suggested an approach. For example, during Session 2 (timeline activity) Tammy[SD] suggested that they could start with 1930 to 2010. She would write and share her events on the timeline first to give Joanne[OA] and Colleen[OA] time to think about their events. This interaction is towards an unbalanced interaction because the approach to the activity was set by one team member and not negotiated.

Older adult team members typically looked to the student designers as experts. For example, in session 4, teams were tasked to narrow down their design space and develop personas. A team with two student designers (one was missing that day) and two older adults sat at their table and worked on the "How Might We" statement, a design activity to help explore a design space and target user [11]. Dorothy[OA] was quiet. Lauren[SD] asked, *"How do you feel about that [indicating a draft of the How Might We statement]?"* Dorothy[OA] replied, "*Well, I'm just thinking I would approach this differently and so I'm just kind of*". Marie[OA] wanted to know more so Dorothy[OA] continued, *"I mean it's just probably because of my background in writing and so forth I would probably create the person and then think about, sort of what we're doing. I mean, all of this is fine, I'm just saying."* Then Marie[OA] chimed in and said, *"Oh, let's do the person, I'd like that."* Lauren[SD] started to say something, but Dorothy[OA] interrupted and said, that this approach is incremental, more logical, and then said, *"I'm random and abstract."* Lauren[SD] mentioned that the order of the activities could vary and that they could continue to iterate on the "How Might We" statement and on the persona as they went along. This is toward an unbalanced interaction because although

Dorothy[OA] suggested an alternate approach there was no negotiation between the older adult team members and student designers.

4.1.2 Facilitating the Discussion

This dimension examines interactions that support or manage the flow of conversations, such as prompting, asking follow-up questions, summarizing, and refocusing team members on the task. Our sessions included both exploratory and generative design activities. The exploratory activities focused on discussions, such as gaining team consensus around their perspective of health and well-being. We examined interactions such as who started, managed, and maintained the conversations. A balanced interaction is when older adults and designers are actively engaged in discussions. An unbalanced exchange is when a student designer or an older adult manages the dialogue, and other team members are quiet.

Towards Balanced Facilitating the Discussion

In general, student designers and older adult team members were actively involved in conversations responding to and asking each other questions. For example, during their discussion about health and well-being, Tammy[SD] asked Joanne[OA] and Colleen[OA] about a sticky note that said "music". Joanne[OA] raised her hand and said, *"Music is mine, music is #1."* She explained that she was physically impacted by music. Colleen[OA] shared that music helped her when she had insomnia, she noted *"Music refreshes my spirit and soothes my soul."* Tammy[SD] also shared the influence music has had in her life and said that she used to do musical theater. This conversation demonstrates interactions towards balanced *facilitating the discussion* because the student designer and older adults were both contributing to the conversation.

Next, we observed older adult team members extending the conversation by asking probing questions. During Session 3, the teams watched a video of a humanoid robot that imitated human facial expressions and gestures to have simple conversations. One team of two older adults and two students discussed the potential of this innovation. Cindy[SD] asked what they thought about the robot. Lynn[OA] thought it was creepy. Bob[OA] said he did not understand how someone would use the robot. Lynn[OA] said, *"I want the robot to assist, I don't want the robot to have control."* Bob[OA] suggested, *"Ah so say you have a robot, and you want it to assist, and you would say to it, remind me that I need to take this pill every four hours, and you would want the robot to remind you."* Lynn[OA] agreed. Bob[OA] asked Lynn[OA], *"What if it could read you, audiobooks?"* Lynn[OA] said, *"That would be nice."* This is a snippet of an interaction that is toward a balanced interaction because while Cindy[SD] started the discussion asking for feedback, Bob[OA] took the lead in furthering the conversation by following up with Lynn[OA].

Towards Unbalanced Facilitating the Discussion

While many of the conversations were towards a balanced interaction there were some moments when the student designers and older adult interactions were towards unbalanced. Sandy[OA] shared her sticky note, *"I just have this [sticky note], I was in a group, and someone said old has negative connotations, she said we have all short shelf life, right now, I have an expiration date! So that has stuck with me that now I'm at this short shelf-life stage of my life."* The rest of the team was quiet with no follow-up; instead, the student designer moved the conversation on by prompting another team member to share their sticky note. A student designer in their reflection explained that they were unsure of how to respond to that comment because it seemed like a sensitive topic.

This interaction was towards unbalanced because there was no follow-up to what the older adult team member shared by the other team members.

Another example was when one team member expressed frustration about the direction of the conversation. During their conversation about health and well-being, Denise[OA] asked Rachel[SD] about the student designers' involvement in the study. While they talked, Carol[OA] said, *"I'm going to ask that we focus and get our tasks done, you folks can talk after class but, I want to get this done."* Denise[OA] and Rachel[SD] both agreed, and they adjusted their conversation to grouping and organizing their sticky notes. This is toward an unbalanced interaction in facilitating the discussion because one team member was not engaged in the conversation and steered it in a different direction. However, the team member did steer the conversation back to the activity.

4.1.3 Relationship Building

We observed relationship building across the sessions through interactions such as, story sharing and humor. However, we saw the strongest impact on relationship building during the timeline activity, when team members shared events in their lives that influenced their perception of health and well-being. Older adults and student designers shared personal stories, including physical and mental health challenges, the loss of loved ones, professional achievements, current struggles, as well as lighthearted times and future goals. One example, Marie[OA] shared that she lost her husband in the Vietnam War. Dorothy[OA] asked, *"How long have you been married?"* Marie[OA] replied, *"six years."* The team nodded and listened. It was quiet for a moment, Marie[OA] said, *"It sounds so depressing."* The team responded, *"no", "it's okay".* Dorothy[OA] said, *"it is a huge thing."* Marie[OA], apologetically repeated that it was depressing. Dorothy[OA] said, *"whatever it was it turned into a lovely person."* Lauren[SD] and Jenny[SD] agreed. Marie[OA] said, *"thank you."* This is an example towards balanced relationship building because of Marie[OA]'s willingness to share a personal vulnerable event, and her teammates' response of supportive words.

Relationship building was also illustrated through comments about the timeline activity:

> "The members in our group, all of them, have gone through so many things and they were really open to share some of the events, the kind of things I couldn't even imagine how to go through if it happened to me. For example, losing their spouse, losing their siblings, being diagnosed with cancer or other health problems. So, I was surprised by how open and willing they were to share."- KelsieSD

> At the end of the timeline session, LynnOA said that it was nice to see everyone's stories and that it was fascinating. She told her teammates, "Thank you for being here." CindySD responded, thank you. LynnOA said, "We are all amazing in our survival."

Towards Unbalanced Relationship Building

Over time, our sessions enabled relationship building because the teams worked together to develop common ground on their perspective of health and well-being, shared life experiences and designed together. However, there were some interactions that were towards unbalanced relationship building. One example was when teams worked to define their design area and create a persona. At one of our sites, two teams joined together because team members were missing that day. This newly formed team had two student designers and three older adults. The two student designers co-facilitated and guided the team through the activity. One older adult team member provided most of the content for the persona. The other two older adults provided some guidance and shared related stories. However, they were mostly quiet throughout the session. One older adult seemed disengaged during persona development. A few times, she checked her watch and

fixed her sleeve. This interaction was towards unbalanced relationship building because several older adult team members seemed distant and disengaged from the team.

4.1.4 Design-By-Doing

This dimension describes interactions during design activities such as ideation, evaluating, making prototypes and creating scenarios [74]. Balanced interactions are when team members are engaged together in the activity, while unbalanced interactions are when team members are disengaged from the design activity or may be just observing [74].

Towards Balanced Design-By-Doing

We saw balanced interactions happen in most teams, where older adults and student designers actively engaged in building their prototype. For example, two student designers and two older adults worked together to create their prototype of a smart-toilet (Figure 1). In the week before their last session, Sarah[OA], refined the smart-toilet's sketch. During the session, she took the lead by providing her perspectives on the prototype's overall structure but was collaborative and flexible to her team members' ideas. For example, when Sarah[OA] and Rose[SD] discussed cutting out the smart-toilet structure, Sarah[OA] suggested a measurement, Rose[SD] suggested cutting a larger piece. Throughout the session, the team members huddled together at their table, sometimes standing and sitting. They worked together by listening to each other's ideas, providing feedback, and negotiating the materials to use and different ways of constructing parts of their prototype.

Figure 2. Team's ideation sketch of their smart-toilet low-tech prototype. Team working together to construct their low-tech prototype. Finished smart-toilet low-tech prototype.

Another example was a team that built a recipe application that helps older adults learn how to cook meals on a budget. The app customizes recipes according to the older adults' dietary needs and preferences. It also included a character called the buzzy bee who motivated users to be healthy. All the team members designed screens for the app and the idea to have a buzzy bee occurred while they were making their prototype. While they worked on their screens, Nina[OA] said, *"I was just thinking it would be really swell to have, [in a sing song voice] I'm the working man, I'm the healthy man, remember an apple a day keeps the doctor away."* Jessie[SD] said, *"You want to create a character."* Olivia[SD] said, *"An avatar."* Nina[OA] said, *"Yes, a character that we put in just before the recipes."* She explained her idea of a short 1-minute video of a bee that encourages healthy habits. Everyone nodded in agreement.

This example illustrated negotiation between older adults and students to translate their design idea into a physical prototype. This back-and-forth dynamic of constructing the prototype seems different from the exchange between adult and child in the Yip et al. [74] example, in which

an adult and a child worked together to design technology. However, unlike the interaction, we saw with the older adults and student designers, the adult mainly carried out the child's vision with little push back or suggestions [74].

Towards Unbalanced Design-By-Doing

Throughout the ideation and prototyping sessions interactions observed were towards balanced rather than unbalanced design-by-doing. However, one example toward unbalanced design-by-doing interaction occurred in a team with two older adults and two student designers. In making their medication management prototype, Rachel[SD], Carol[OA] and Denise[OA], discussed the system interface template, while Pat[SD] started to build the prototype. The seniors discussed how prescription pills and other medication would be refilled and organized using the machine. Pat[SD] was attaching felt to the prototype when Carol[OA] turned away from her conversation, looked over at Pat[SD], and said, *"I like the way that whatever we say he doesn't give a sh**, he does what he wants. I'm going to make it look grey like this. I'm like okay, whatever."* Pat[SD] replied, *"You all are working on the interface."* Carol[OA] continued, *"You're kind of bossy; you're such a man, you took over."* There was some nervous laughter as they discussed the prototype.

We described this example as an unbalanced interaction because it seemed that Carol perceived that Pat was building the prototype independently. Carol[OA] voiced her discontent and seemed to express her desire to contribute to building their low-tech prototype. The interaction here illustrates the importance of communication and shows that Pat[SD] and Carol[OA] have a relationship where Carol[OA] feels comfortable enough to express her feelings.

4.1.5 Elaboration

This dimension examines interactions during the ideation process, where team members generate and mix ideas [74]. A balanced interaction is when both older adults and student designers are contributing and building upon each other's ideas. An unbalanced interaction is when only the older adults or student designers generate and share ideas.

Towards Balanced Elaboration

We found that interactions toward balanced elaboration can happen in situations other than ideation, such as in discussions of life experiences. Throughout the study, team members built upon each other's experiences by sharing a similar experience. For example, during the first session, teams engaged in a Stickies activity to develop a shared meaning of health and well-being. One team demonstrated interactions toward balanced elaboration when they were sorting the sticky notes of their health and well-being perceptions and grouping similar ones together. Lily[SD] picked up one of her sticky notes and said, "excitement", Lena[OA] said, *"Yes!"* and Michelle[OA] added, *"Absolutely!"* Lena[OA] and Michelle[OA] handed Lily[SD] similar sticky notes, including curiosity, lively, and active.

We also found that life experiences played a role towards balanced elaboration. For example, a team with two student designers and two older adults focused on transitioning from independent living to an assisted living community for their ideation and prototyping sessions because Sandy[OA] was in the planning stage of this transition, while Cheryl[OA] already made that transition. In the ideation session, they developed solutions for this life transition and decided to focus on downsizing. The team discussed how people organize things they are willing to let go, such as donating, selling, and giving away. Cheryl[OA] suggested a color-coding idea for their design. Sandy[OA] asked, *"How do you give it to the person?"* Steve[SD] suggested posting it on social

media. For items with the emotional attachment, Mark[SD] said that they have digital storage for pictures so people could have a digital memory. Cheryl[OA] liked that idea. They worked on detailing how to catalog items and listed ways they can let go of things. They created a mobile app called De-Clutter (Figure 2) that helps older adults transition from independent living to an assisted living facility by allowing them to donate, give away, sell, or keep items. This example is towards a balanced elaboration because both older adults and student designers contributed and expanded upon each other's design ideas.

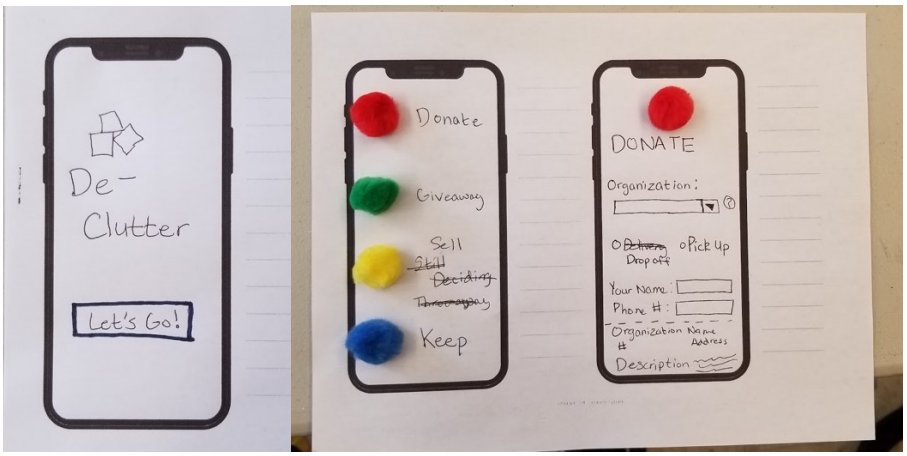

Figure 3. Screens from team's low-tech prototype of a mobile app called De-Clutter. First image is the home screen, and the second image is of two selected screens showing options (Donate, Giveaway, Sell and Keep) to let go of personal items.

Towards Unbalanced Elaboration

Interactions that were towards unbalanced elaboration were less frequent than towards balanced elaboration. However, here are two examples of moments when the team's interaction was towards unbalanced. This first example happened in a team with three team members, two older adults and student designers. They developed a smartwatch low-tech prototype. In this session, one team member drove the design with little generation or mixing of ideas from others on the team. Before the session, Joanne[OA], created a multi-page document with design requirements and used it to lead their prototype's design. Tammy[SD] developed their low-tech prototype using a small notebook to sketch smartwatch screens and contributed to the design by asking questions such as, *"I'm thinking, how are we going to get from screen to screen on the watch? Do we want a big button, or do we want to swipe?"* Joanne[OA] replied, *"I'll think about that. Why don't we go over the features and come back to that."* Colleen[OA] contributed by sharing related life experiences but was mostly quiet. When Tammy[SD] reflected on this session, she noted that she was proud of the prototype but felt their design was like smartwatches on the current market. She said if they had more time, they could have taken their design further. It is notable that Joanne[OA] took the time and effort to create a document to guide their low-tech prototype. However, the document may have inhibited collaboration.

Another example occurred in a team with one student designer and two older adult team members during creating their persona. Carol[OA] pushed back on creating a persona and defining a design area. She questioned the need for specific characteristics like age and sex because the medication management technology they were thinking of could be applicable to a range of

people. Rachel[SD] suggested they start with defining their design areas through the *"how might we question"* activity. They discussed a target audience and goals. After they defined their area, Rachel[SD] suggested creating their persona. Carol[OA] said, *"Feel free, go ahead."* Rachel[SD] guided the conversation. She asked Carol[OA] and Denise[OA] questions about their persona characteristics. In the end, they created a persona. This is an example towards unbalanced elaboration because of the difficulty to engage and elaborate as a team on ideas for a design space and persona.

4.1.6 Older adults' views of co-design and involvement in the design process

At the end of the last session, we asked older adults questions about their overall experience in the study. Older adults expressed surprise and enjoyment about their participation in the co-design sessions.

"This is much more fulfilling, much more and fun." [How is it is more fulfilling?] Well, you're actually planning for a new technology rather than sitting around and just evaluating old technology. I think really to be in the process of designing something or a possibility of designing is really much more integrating into the whole idea of being involved in technology and the overall process."- Lena[OA]

"I had thought that there was going to be more of sense of being test subjects that you were going to bring pieces of new technologies to us and ask us to evaluate that, but this was way much more fun and I was surprised by what we came up with"- Nina[OA]

Older adults' advice to future designers who create technologies for an aging population was to include older adults in the design process.

"Talk to seniors, don't try to invent from your own observations or stereotype or whatever, ask people what do they want, that's the most effective way you'll bring about anything." -Denise[OA]

"What I think is interesting is that at your age, I didn't know what's ahead and each one of us has something a little bit different and yet their similar and you will never know what to develop unless you do talk to different ones of us that are going down these crazy roads." -JoanneOA

The older adults in this study also shared what worked in the study and areas for improvement. Nina[OA] said that she enjoyed the timeline activity. Denise[OA] liked that the teams had two student designers and two older adults. Also, working with the same people gave her a sense being a team. The suggestions for improvement were to provide an overview of all the sessions to have a clearer sense of the design process. Another suggestion was to extend the number of weeks to design and longer session times.

4.2 PART 2: Understanding student designers' perceptions of co-designing with older adults through reflection

Student designers engaged in reflection activities after each session and during weekly meetings. We found reflection activities helped student designers process their experiences in co-designing with older adults. This includes broadening their perspective on aging, identifying challenges, and recognizing the value of co-designing with older adults.

4.2.1 Elaboration

Our study used different reflection activities to explore both specific session experiences as well as broader learnings. We also wanted to keep the activities fun and engaging. Some students noted that reflection activities were a valuable tool for their learning experience. They liked discussing their reflections with their other students and appreciated the variety of reflection activities.

"[To future designers] Continuous reflection will help you identify assumptions/biases you may have had going in. Assumptions are ok but it is useful to understand them, so they don't lead the conversations you have with your co-design team." -CindySD

As the student designer noted, reflection is an important practice for designers to acknowledge the values and assumptions they bring into their designs and when engaging with people who may use their technology [59]. Reflection activities in our study were important because of the persistence of aging assumptions across society. As the student designers collaborated with older adults, it was important for the students to check those assumptions and understand how it may affect their collaboration with their senior team members.

4.2.2 Broadening Aging Perspectives

Prior work has demonstrated that when young adults engage with older adults, it positively affects their perceptions of the aging population and reduces negative stereotypes [26,28,51]. In our study, student designers acknowledged their assumptions, identified similarities with their older adult team members and realized that the differences in life experiences could make it difficult to connect with each other.

"Before attending my first session with the older adults, I had this assumption going into it that I would have to do a lot of explaining, talking slowly, facilitating more, etc. because that is my experience when talking with my older grandparents. However, working with these older adults was very different, because "older adults" is a huge age range where these people will have very different capabilities."- JakeSD

Co-designing with older adults challenged the student designers' frame of aging and of older adults. The later phases in life can span a long period of time [60]. As people age, moments and events are experienced through different life circumstances, making the older adult population more diverse than alike [67]. When the student designers first engaged with the older adults, the students' expectations and assumptions of the seniors quickly shifted.

4.2.3 Balancing Roles

Student designers identified balancing the role of facilitator and co-designer as a challenge throughout the sessions.

"It was also hard for me to kind of figure out what my role is in the activity because you know I wanted to facilitate and make sure we chose a persona that everyone liked but I also wanted to make sure that it was matching with what our older adults wanted and needed as well." -Cindy^{SD}

The student designers also wanted their older adult team members to take more ownership of the design process.

"Some things I wish I could have improved would be having my older adults present more of their work. Having them feel more like they can step into the shoes of the designer and that it wasn't just my job. That they had more control over their project than I even did."-Jenny^{SD}

4.2.4 Value of Co-design

The co-design sessions provided students with the opportunity to engage with people who may use technology that were not like them and apply methods and techniques they learned in class. Some of the student designers compared their co-design experience with other methods such as surveys, interviews, and observations.

"The first key learning from this co-design process is that sending out a survey is not enough to inform your research when working with older adults. I learned that from talking to the elders, they have so many stories and life events to share about a topic or an idea. Therefore, if we just take a written response at its face value, we may likely miss the point." -Mark[SD]

Surveys, interviews, and observations would not have gotten anywhere near what I was able to get and collect by working with my user group." - Steve[SD]

Student designers described the value of developing a design partnership with older adults:

"These weekly sessions have truly impressed upon me what it means to design in collaboration with others, especially those in a different demographic than you. In earlier sessions, I frequently heard comments like "you're the designer" encouraging me to take the lead on writing down insights or presenting to the group. The whole point of co-design, though, is to break down the barriers between "designers" and "non-designers"-- in our sessions, everyone's a designer! And as we have moved into the design phase of personas and ideation, I've noticed my group taking more ownership of their ideas and becoming confident in their processes of design."- Rachel[SD]

At the end, student designers turned their experiences into lessons learned for future designers who plan to co-design with older adults, such as to recognize the differences among older adults, encourage team bonding through activities that explore life span, clarify co-design and facilitator roles, encourage older adults to take ownership of their design ideas and consider physical limitations like hearing issues. These learnings demonstrate the lasting impressions that co-designing with older adults left on the students.

5 DISCUSSION

This paper examined the interactions between older adults and student designers by adapting a framework [74] to understand interactions in intergenerational collaboration that lead to building a design partnership. We also learned the impact that co-design can have on a student designers' perceptions of older adults and designing with them. This section is presented in two parts, the first discussing the use of this framework to identify interactions and build toward an equal collaboration between older adults and student designers. The second part discusses the value of co-design and reflection to human computer interaction pedagogy.

5.1 Part 1: Using the framework to understand interactions when co-designing with intergenerational teams

Our work adds to the growing literature of PD approaches to designing with older adults by examining the interactions in intergenerational collaboration and extending it by adapting a framework [74] to understand better design partnerships. The five dimensions, 1) facilitating the activity, 2) facilitating the discussion, 3) relationship building, 4) design-by-doing, and 5) elaboration, made us aware of the differences in collaboration between teams and how the design activities can play a role in contributing to design partnerships. We explain the impact of balanced and unbalanced interactions in facilitating the activity and relationship building and provide considerations to promote balanced interactions in intergenerational co-design teams. In this section, we discuss considerations for designers and researchers who are collaborating with older adults, including the need to set role expectations, incorporating activities that support team bonding and implications for building design partnerships. We acknowledge that our understanding of collaboration in this study is influenced by the people who participated. The older adults bring with them experiences such as in their past or present professional lives as a graphic artist, IT systems architect, educator, or clinical psychologist. These and other experiences

may have influenced how they interacted with other team members and collaborated in the design process.

5.1.1 Power Dynamics in Facilitating the Activity

We observed power dynamics at play, weighing more heavily toward designers to facilitate the design activities. The unbalanced interactions demonstrated that there was little negotiation or collaboration on how to approach the design activities. It seemed natural that student designers took the lead in facilitating the activity because of their design knowledge. While co-design activities aim to support equal and equitable collaborations, researchers often control the choice of activity and how it is conducted [66]. We could have taken a more open approach like placing emphasis on the flexibility of roles in the activities to support Dorothy^{OA}, who expressed that she would have created a persona differently but backed away from advocating for it. In future co-design collaborations, we can have expectations of each person's role on the design team and communicate that the approach for the design activities can be negotiated to best meet the team's relationships and dynamics. For example, when presenting activities such as the "How Might We" [12] and persona building future designers can explicitly state that the order of activities are flexible and each team has the freedom to determine their design approach.

5.1.2 Life Experiences Build Team Bonds

Sharing life experiences supported interactions towards balanced relationship building. It was especially prominent during our timeline activity when team members shared events across their lifespan that impacted their health and well-being perceptions. Personal histories revealed individual differences, thereby challenging the homogenization of older adults and strengthening team bonds [22,23,67]. Our study supports prior work advocating for using the life course perspective in designing with older adults [23,67]. We extended this work by applying the life course perspective to design activities in intergenerational co-design teams. It should be seen as a way to learn how social forces shape our lives and lead us to be more different than the same and not as "understanding the shadow of the past"(p. 1) [60].

We saw the importance of design partnerships when the students recognized the age gap between them and their older adult team members. The students realized the life experiences they have not yet experienced, emphasizing that is not enough to rely on their previous experiences with older adults. Bennett and Rosner [2] examined how designers may perform empathy techniques to understand users with disabilities, arguing that, in reality, they may be distancing themselves. For instance, designers wearing a blindfold to simulate the experiences of blind users. Bennett and Rosner [2] explain that designers might focus on their experience wearing the blindfold rather than the experience of users with disabilities [2]. They recommended forming design partnerships with users to build empathy and understanding rather than methods that rely on designers to interpret experiences of users with disabilities [2]. We suggest co-design activities like the timeline activity we did in this study to support sharing experiences that offer team members opportunities to discover and learn more about each other to help build team bond and partnership. What our findings suggest for future designers and researchers is the value of investing into intentionally building space for sharing life experience to strengthen the design partnership among all team members and include more perspectives.

5.1.3 Implications for building design partnerships in intergenerational co-design teams

Involve older adults in study planning

We worked with the site coordinators and students to plan this study. Therefore, we got feedback on the design activities, the session's length of time, and the number of sessions. These meetings helped us to ensure that the study was a good fit for their clients and residents. However, we learned from the older adults that they wanted longer and more sessions because it took time to get into the flow of the activities. Engaging older adults in the study planning can help to define better session parameters, support ownership in the design process and promote balanced interactions in facilitating the activity. It could also clarify the activities and process, which was an area for improvement mentioned by the older adult participants. This consideration also points to questions that Pradhan et al. [53] raised about whether design training should be offered to older adult participants because prior experience with creative methods can help make workshops more successful.

Preparing for sensitive conversations

Our study observed that when Sandy^{OA} shared a sticky note about the later phase of her life, her team members were quiet. The student designers moved the conversation forward without responding to that comment. This observation indicated a need to support teams in facilitating a discussion around the realities of aging and ensuring that people feel heard. It is also important for researchers to reflect upon their own assumptions about older adults because it could influence their design choices and perpetuate negative aging stereotypes [27].

Maintaining team consistency

We learned that keeping teams consistent throughout the study helped support interactions toward relationship building. An older adult mentioned that she appreciated working with one team throughout the study and like the ratio of older adults and student designers. We found that merging teams together due to absences may have contributed to interactions toward unbalanced relationship building. Thoughtful consideration of the team, including the number of team members, the balance of younger and older adults on the team and maintaining the same team throughout the study can bolster team bond and relationship building. Relationship building can build trust allowing team members to take risks in voicing opinions and sharing ideas [73].

5.2 Part 2: Co-designing and Reflective Activities on the Learning Experience

We found that co-designing with older adults and engaging in reflective activities provided an impactful learning experience for the student designers. We suggest co-design as an experiential learning activity in HCI education to allow students to apply their learnings outside the classroom, engage with older adults as people who may use technology, and be open to challenging their stereotypes about aging [55]. One program to consider is service-learning, a teaching approach where students participate in a community service project that enriches their community while engaging in instruction and reflection activities [51]. Although our study was not formally a service-learning project, we had elements of it in our study. Student designers experienced a positive shift in their perceptions toward older adults, broadened their ideas of the aging process, and provided realistic experiences working with people who may use technology who are different from themselves.

Reflection is recognized as an essential practice for designers in HCI to raise awareness of their values and assumptions in the design process [59]. Reflection activities are gaining attention

as an education tool in HCI to support students in assessing tensions and complexities in designing with users who are different from them and re-understand their role in the design process [55]. These principles are relevant to student designers, especially when they do not have the same frame of reference that older adults do in life-long topics such as health and well-being. Older adults as a community are quite diverse with age uniquely differentiating them from other societal groups due to life experiences and physical conditions [10]. A life course approach elevates the urgency to study long-term, preferably lifelong, changes in abilities, physically or cognitively [39].

We found that integrating reflection activities as part of the course provided regular opportunities for student designers to think deeply about their interactions with their older adult team members [59]. It also broadened those understandings by comparing their experiences with other student designers in our weekly discussions. Some of the reflection activities had students step back to look across sessions and think about overall learnings about designing with older adults. Through reflection, student designers identified challenging moments, such as not knowing how to respond to older adults when they bring up sensitive topics. The reflection provided the student designer the opportunity to return to that moment and examine the reason for the action they took [55]. These reflections are critical to bringing issues to the forefront for educators. In our case, we were made aware of the need to prepare students for sensitive conversations. In our weekly meeting, we discussed this issue as a group and suggested different ways of handling it.

In general, engaging with users brings complexity, and it is difficult for students to prepare for every situation. Reflection can provide students with the opportunity to think critically about their engagement with people who may use technology and are different from them [55]. The generation gap between older adults and students brings an added layer of complexity, including the distance in life experiences, especially in time and place in an individual's personal histories and current life circumstances. Reflection activities can help students process their experiences in collaborating with older adults and allow educators to know how to better support students through those experiences.

6 LIMITATIONS AND FUTURE WORK

We conducted our study at two locations in a large city on the U.S. West Coast, which reduces the reach of our findings to other communities. We also recognize the diversity of the aging population. The experiences of the older adult participants in our study (i.e. expressed comfort and familiarity with technology, prior professional experiences in creative fields) likely influenced their engagement with the study [53]. More work is necessary to gain a broader perspective of design partnerships with older adults in different communities, cultures, and levels of technology experience. Another limitation was while we provided structured reflection activities for the designers, we did not structure similar activities for the older adults to honor the time the older adults were already offering us. Working with community site coordinators, we determined the length of the session was just enough time for the design activities. However, across the sessions, the integrational teams had opportunities to share their artifacts and respond to questions. We also had large group discussions after some of the sessions like about the technologies they tried out, and at the end of our study the older adults reflected on their participation. We believe future research could build in reflection activities into the co-design sessions with older adults and student designers. Sengers et al. [59] suggested that when we support users in reflecting on their lives, it can invite them to challenge cultural and social norms that design might enforce.

7 CONCLUSION

Co-design has been a method researchers and designers have used to involve older adults in the design process. It has led designers to understand the needs of older adults better and has pushed back against stereotypes about older adults' ability to engage in design activities. A central element of co-design is the design partnership that fosters equal contributions from stakeholders in the design process. More work is necessary to understand the interactions that contribute to developing a balanced collaboration, and our research starts to build that understanding. Our work adapted a framework [74] to examine equal collaboration between older adults and student designers in co-design. We expanded the facilitation dimension into two dimensions—*facilitating the activity* and *facilitating the discussion*—because we found that student designers would often determine the direction of the design activity. However, during discussions, older adults would share the facilitating role by asking follow-up questions and prompting team members. Also, we found that using a life course perspective in design activities provides opportunities for older adults and student designers to share life experiences throughout their life span, which helped strengthened bonds between team members.

Our study explored student designers' reflections of their co-designing experiences with older adults. We found this experience challenged student designers' previous notions of aging and about older adults. Student designers also reflected on their role in the design process and contemplated ways to balance that role. They became aware of the distance between them and the older adults in the years of life and admitted that it was hard to relate to someone when they have not yet experienced similar things. The student designers reflected on the co-design method and ways it was different from other methods such as interviews and surveys. We believe that there is value in students engaging in experiential learning to apply their knowledge to a real-world context and collaborate with users different from them. Co-designing with older adults was a great way for student designers to engage in experiential learning. The reflection activities were essential to the student designers' sensemaking of their values and assumptions and ways it shows up in their collaboration with older adults and their designs.

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