

“With a hint she will remember”: Collaborative Storytelling and Culture Sharing between Immigrant Grandparents and Grandchildren Via Magic Thing Designs

AMNA LIAQAT, Department of Computer Science, University of Toronto, Toronto, Ontario, Canada

BENETT AXTELL, Department of Computer Science, University of Toronto, Toronto, Ontario, Canada

COSMIN MUNTEANU, Institute of Communication, Culture, Information, and Technology, University of Toronto Mississauga, Mississauga, ON, Canada

The timeless social activity of passing down oral stories preserves family memory, identity, values, and culture. Existing tools for family memories often take a techno-determinist approach by focusing on the mechanics of connecting families and the resulting documentation, rather than the social process of sharing stories and morals, and largely without considering the specific needs of immigrant families. For immigrant families, cultural exchange, particularly crucial across grandparent and grandchild generations, is threatened by the language and cultural barriers emerging from displacement and migration. As a result, immigrant grandparents and their young grandchildren struggle with fostering social kinship, leading to social disconnect and loss of cultural heritage. In our research, we collaborate with multi-generational and culturally-at-risk immigrant families through Participatory Design activities towards the design of reminiscence tools that support their needs focusing on language and cultural connection. We report on the designs created by families and propose design guidelines supporting cultural resilience, focusing on flexible, visual storytelling.

CCS Concepts: • Human-centered computing~Collaborative and social computing

Additional Key Words and Phrases: Cultural exchange, participatory design, digital storytelling, older adults

ACM Reference format:

Amna Liaqat, Benett Axtell, and Cosmin Munteanu. 2022. “With a hint she will remember”: Collaborative Storytelling and Culture Sharing between Immigrant Grandparents and Grandchildren Via Magic Thing Design. *Proc. ACM Hum.-Comput. Interact.*, 6, CSCW2, Article 268 (November 2022), 37 pages, <https://doi.org/10.1145/3449172>

1 STORYTELLING AS CULTURAL RESILIENCE IN IMMIGRANT FAMILIES

Storytelling is a powerful medium for fostering social connection within families and for preserving memory through generations. Across cultures, older generations pass down values and cultures to younger family members through stories, which creates intergenerational links between family historians [31, 40, 67]. The act of sharing stories, even if the exact details change upon retellings, plays a critical role in forming young children’s sense of personal identity in relation to their collective family memories [32]. Though a key component of social family life throughout history and across cultures, storytelling is a complex task.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.

© 2022 Association for Computing Machinery.

2573-0142/2022/11 – Article#268... \$15.00

<https://doi.org/10.1145/3555158>

The storyteller must present their narrative compellingly to engage the listener, while the listener must support the narrative through question asking and other displays of interest for a mutually enriching two-way social exchange. Several apps exist to support this complex yet valuable activity, including interview-like memory prompting (such as StoryCorps [31]) and a variety of picture- or heirloom-based tangible interfaces (e.g., [46, 51]). However, many are limited by their reliance on pre-existing physical or digital artifacts, whereas the process of immigration often results in family photographs and other heirlooms being left behind [50]. Few existing tools have explicitly included both older and younger generations in the design process and many of these tools assume that family members have a shared language and culture, which is not the case for the large population of intergenerational migrant families who exist in diasporas around the world.

Young immigrant children living in the same household as their grandparents must negotiate multiple dimensions of identity [3]. With limited fluency in their heritage language and minimal exposure to their heritage culture, grandchildren can struggle to find common ground with which to connect with their grandparents [35]. Grandparents are already at high risk of social isolation and the resulting consequences, such as loneliness and depression, as they generally migrate later in life and lack social networks outside their immediate families [11, 67]. In contrast, children are faster to learn about and adjust to a new culture [59, 62]. Cultural resilience, which is the ability to adapt to change while maintaining one's identity, is positively linked with heritage culture preservation [29, 60]. However, with the social gap widening as grandchildren grow up, cultural and language division within a family leads to loss of collective memory and destabilizes family identity, as has been found in other HCI research with immigrant families [57]. Because of these dimensions of intergenerational social interaction that are particular to nearby families, we focus here on grandparents and grandchildren that are collocated.

In this paper, we investigate the needs of immigrant grandparents and grandchildren for a reminiscence tool that supports storytelling and cultural exchange. We engage grandparents and grandchildren together in participatory design (PD) workshops to explore potential novel designs that motivate families to find common ground amidst their individual histories and unique experiences. From these design sessions, we uncover guidelines for fostering cultural resilience in immigrant families and supporting designers of reminiscence tools.

This work brings to light a perspective which has received little attention despite urgent need: that of immigrant children and older adults. Using a Magic Thing approach (a role-playing co-design technique that guides participants to imagine beyond existing form factors [30]), we build on a grandparent's oral storytelling with sensemaking activities. These activities engage both grandparent and grandchild in processing the shared stories and encourage designs that do not need to conform with what participants feel is normal or feasible for current technologies. As seen in previous works, Magic Thing studies are particularly powerful when working with digitally underserved populations [24, 33], such as older adults and immigrants. Through our methodological approach, children and older adults are provided with a platform to creatively and collaboratively express their ideas. With our guidelines grounded in this human-centered approach that has only recently started to be utilized in the HCI social research context, we illustrate how they provide critical, nuanced insight to support developers in designing technology that is robust and well-suited for real world contexts.

1.1 Resilience at the Crossroads: Research Context and Positionality Statement

Research on immigration is often characterized by either a socio-economic approach or a techno-solutionist approach. Yet many aspects of immigration, such as cultural resilience across generations, are at risk of being overlooked by such approaches, especially from a technology design perspective. This is in part due to design and development being largely carried out within colonial, techno-optimist, views of technology as a functional tool rather than culture mediator. Within this context, our broad research agenda aims to understand the barriers to preserving (and transforming) culture (and language) across generations post migration, and to explore new methods for designing interactive technologies that benefit this space.

As part of this broad agenda, this paper captures one project dedicated to uncovering immigrant families’ needs for collaborative tools that foster culture and language exchange between grandparents and grandchildren. Our goal for this paper is to present findings from participatory design sessions with immigrant families in which the Magic Thing process was followed. The particular focus is on bringing to light the designs produced by the families, and the role such cooperative intergenerational activities have in supporting storytelling that aids in cultural sensemaking. The findings presented in this paper complement our previous research, in which we focused on the interpersonal and social dynamics that emerged in our participant families as a result of engaging in the Magic Thing process.

2 RELATED WORK

Storytelling has the potential to foster social connection in immigrant families where language and culture divides are present. We discuss the key role storytelling plays within families, and survey tools that aim to support such reminiscence activities in related contexts. We then present an overview of participatory design methods with a focus on the Magic Thing approach which we leverage in our study.

2.1 The Unique Role of Storytelling in Immigrant Families

Storytelling is a powerful activity for fostering family social connectivity [64]. As with other such symbolic, affective activities that organize family life, stories are generally passed down relatively unchanged through generations and serve many critical roles [21]. They impart a sense of identity, promote group cohesion, and play a significant role in keeping grandparents involved with their families [49]. For immigrant families, storytelling can play an additionally influential role by cultivating and maintaining cultural connections [41, 43, 66, 75]. However, migration can trigger language and culture barriers between younger and older generations, leading to the breaking of family practices [21]. In this context, storytelling can be used to build cultural resilience, which allows families to better cope with transitional events like migration [14].

Immigrant families employ storytelling in unique ways to explore culture and language differences. This includes immigrant youth carefully curating their stories to broach taboo subjects with their parents [3], parents passing on cultural-specific morals and values to young children [54], preserving family legacy [75], and collectively making sense of family identity within a radically foreign and unexpected landscape [26].

For immigrant grandparents, migration can trigger adverse social consequences, such as feelings of disconnect and uncertainty about the value of their contributions to their families [66]. Traditionally, grandparents have served as family historians [40]. With their young grandchildren

adjusting faster to the new culture and language [59, 62], immigrant grandparents are unable to share their stories and maintain their role as family historians [44]. These barriers strongly shape the immigrant grandparent-grandchild relationship, such as by limiting interactions to be purely functional, which can trigger feelings of hopelessness and isolation for older adults [37]. **We know the powerful role storytelling plays in maintaining intergenerational family ties and here we investigate the potential for fostering digital cultural exchange between generations.**

2.1 Intergenerational Family Digital Reminiscence

Though there are examples of HCI research around immigrant family social reminiscence or connection, most focus on input only from grandchildren in the design and assessment (e.g., [13]). Little co-design work has been done in this area with collocated intergenerational family participants. However, many digital tools have been proposed to support general reminiscence between grandparents and grandchildren in non-immigrant families and in distributed families.

Odom et al. design three new digital devices as technology probes to explore how multi-generational families imagine digital pictures and other digital artifacts becoming heirlooms for future generations [46]. The tangible aspect of their designs and the ease of access prompted questions and storytelling across generations. Dib et al. explore creating specifically speech-only artifacts with families and the distinct reminiscence emerging from non-picture based reminiscence [17]. Tangibility is an essential aspect in shared reminiscence across generations in immigrant families, especially for re-creating heritage through artifacts related to physical spaces, as shown in recent work [57]. Tangible design work like drawing or crafting engages and empowers children. For instance, Mobeyou, a block-based digital tool for multicultural storytelling among children, resulted in children creatively demonstrating ownership over the tool [56, 61]. There are advantages to visual support for adults as well. Visual artifacts can be a powerful prop in multicultural group collaboration, as they reveal cultural differences in semantic networks between collaborators, leading to more productive and diverse brainstorming [74]. Given the observed benefits of tangible and visual sensemaking in other contexts, it is possible that collaborative drawing and designing may be an effective support for mediating intergenerational culture exchange and storytelling.

Past works have explored the needs of grandparents and grandchildren with a geographic barrier, some including immigrant families, in terms of communication [22, 23], reading books [19, 52], and playful interactions [69]. Another project explored sharing cultures through music in separated grandparents and grandchildren in immigrant families [65]. Others have explored family storytelling over a distance with participants from the same generation [28], as well as with grandparents and grandchildren [73]. There are few examples that explore these same aspects of socialization across cultural and language barriers in collocated families.

Jones and Ackerman explore the motivations of collocated grandparent “tellers” and adult grandchild “listeners” to preserve memories together [32]. They find that existing preservation tools may not save enough context to allow for meaningful interpretation by future generations, especially in terms of social signals within stories. Listeners were active co-creators of the storytelling process and worked together with tellers to actively seek out and make sense of stories, as well as reconstructing them to meet needs of current and future listeners.

More needs to be done towards fostering the in person intergenerational connections that strengthen and sustain continued reminiscence. This is a key aspect of digital storytelling, as recognized by the participants in the works presented in this section. **In this paper, we extend these works by uncovering what intergeneration communication looks like in immigrant families, and by identifying the role digital storytelling can play in strengthening these communications.**

2.2 Intergenerational Participatory Design Methods

It is well known in HCI research that designing together with potential users is essential to creating meaningful designs. Especially when working with underrepresented groups, a lack of participant input will likely lead to solutions that do not support their needs and that build on external, often colonial, assumptions rather than their own experiences [15]. Recent research has been working to remedy these issues [77]. Co-design or participatory design (PD) is a commonly employed method with underserved groups [71] as it is designed to directly elicit participants’ input and voice through hands-on design workshops. PD workshops reveal the specific needs and desires of the included participants beyond the immediate aspects of technology adoption, and have been used, for example, to design supports for health and wellness with immigrant women [10] and to assist in rebuilding social capital with recent refugees [2]. Participatory methods have been employed to empower children’s voices in both the design and evaluation processes (e.g., [20, 24]). Though PD has also been employed in research with older adults (e.g., [70]), it has not been leveraged to explore the needs of older immigrants specifically, including fostering cultural identity, preserving value-rich stories, and maintaining social participation through enabling meaningful family connections [39].

Some work has developed co-design methods specifically to facilitate intergenerational interactions between unrelated older adults and children [78]. Others have investigated the intergenerational interactions in PD between adult researchers and child participants. Birch and Demmans Epp find that power differentials and misaligned values can be significant barriers to the effectiveness of PD, and that these challenges can be mitigated methodologically through better communication of shared values and by strengthening the role of the design mediator [5]. Yip et al emphasize the need to develop meaningful partnerships across the entire co-design cycle in order to address the imbalances between adult researcher and child participant [80].

Technology probes are a form of PD designed to engage families in design work [36]. Families work directly with simple functional prototypes early in the design cycle and provide both qualitative and quantitative feedback. In this way, participants across generations (and cultures) can contribute to the iterative improvement of an envisioned technology [36]. Technology probes have been used to design diverse tools, such as for fun communication between grandparents and grandchildren [58] and for family management of a child’s asthma [88]. In this paper, we ground our research in these PD methods, especially Magic Thing PD [30] (discussed in detail next), to empower grandchildren and give them a space to express their thoughts, beliefs, and needs for intergenerational culture sharing and knowledge exchange. **Our research employs PD with immigrant, collocated grandparent-grandchild dyads, and as such we build on the work with non-related intergenerational participants reviewed here.** To support our approach, we draw methodological knowledge from intergenerational co-design research.

2.3 The Magic Thing

The Magic Thing PD methodology, developed by Iacucci et al and sometimes called Dream Design, uses co-design methods to guide participants to create designs that, rather than being based in an existing form factor (e.g., a smartphone), are based either in a magical form (e.g., a magic bracelet or button) or are unlimited in order to encourage diverse designs [30]. This has been used to engage participants in a broad variety of spaces. This method is particularly effective when potential users are unfamiliar with standard technology and when specifically seeking designs that can go beyond users' and researchers' expectations of what is technically feasible or "good" design [24, 33]. Magic Thing and other related role-playing-based co-design methods are often used with children and families, as adults are generally less comfortable with the idea of imagining a magic design, while young participants produce creative, meaningful designs [18, 20, 27].

Past works incorporating magic ideation have demonstrated how the process creates a space for socialization between users, especially children and families [7, 20]. **In this research, we engage immigrant grandparents and grandchildren with Magic Thing PDs to foster social reminiscence and cultural exchange activities towards the design of a digital (or magic) support tool for that project.**

3 METHOD

To investigate design solutions for a tool that supports reminiscence across cultural and language divides, we conducted ten participatory design workshops with grandparent-grandchild dyads in locations across Canada. Families were led through a structured Magic Thing PD activity. Ethical considerations informed all aspects of this research design, with protocol provisions to avoid unpleasant memories that may cause stress to participants and to protect the consent of the children who could feel pressured to participate by family. No participant withdrew from the study. This protocol is approved by our university's Research Ethics Board.

3.1 Participants

Families were recruited through flyers posted in community centres, distributed by community partners working with immigrants, or through a researcher visiting events held at community centers (e.g., language learning classes held at the library). The children in the study had spent all or most of their lives in Canada and were between 7 and 13 years old. This age range is standard for similar participatory design studies [7, 80]. Grandparents were either visitors or had immigrated to Canada as adults. Grandparents received \$50 (CAD) in cash for their participation and grandchildren a \$15 gift card to a retailer selected by their parent. Parents were given \$10 (CAD) in cash for facilitating the session. Participants received full compensation even if they chose to withdraw, though none of the participants in our study withdrew.

Grandparents' ages ranged from 63 to 85 ($M = 71.5$, $SD = 5.4$), with nine grandmothers and five grandfathers. Grandchildren's ages ranged from 7 to 13 ($M = 9.4$, $SD = 1.9$), with nine girls and five boys. 14 grandchildren and 14 grandparents participated in our study for a total of 28 participants. Participant demographics are shown in Table 1 with gender omitted to maintain participant confidentiality.

Table 1: Participant Demographics

Family ID	# GPs	# GCs	Heritage Country	Heritage Language
1	2	1	India	Punjabi
2	2	1	Pakistan	Urdu
3	2	2	Pakistan	Urdu, Punjabi
4	1	1	India	Punjabi
5	2	2	India	Punjabi
6	1	2	Afghanistan	Farsi
7	1	1	Philippines	Tagalog / Pangasinan
8	1	1	Philippines	Tagalog
9	1	2	Philippines	Tagalog / Ilocano
10	1	1	South Korea	Korean

In this paper we use the term families to refer to the grandparent and grandchild relationship (i.e., parents are not included unless explicitly stated). Additionally, though some families had two grandparents or two grandchildren take part, we singular form for both for conciseness. We use GP as shorthand for grandparent and GC as shorthand for grandchild throughout. Finally, to protect families’ anonymity, we do not identify the ages and genders of specific participants within a family, and will refer to individuals generally as, for example, *the grandparent in F4*.

3.2 Procedure

Sessions took place in the participants’ homes and lasted 1.5 - 2.0 hours and were audio recorded. Sessions were conducted in families’ living or dining rooms, and as all homes were arranged for multigenerational living, the two or three members of the research team were easily accommodated. Participants could choose to have the design activities video recorded, or could opt to have the researchers pause the session at multiple points to take pictures of the design artifacts. Video recording was done from directly overhead to capture the design activities while excluding participant faces. A small tripod was used for this and was set up to be out of the participants’ work space. Families were informed before the day of the session that there would be audio recording and were presented with the option of video or photo documentation. The researchers made clear to the participants that recordings could be paused at any time during the study, that all data would be fully anonymized, and that collection of personal data would be kept to a minimum.

The study procedure consisted of seven steps, described next. After the first two sessions (F1 and F2) which were more exploratory, the protocol was lightly revised. We make clear where our official protocol differed in F1 and F2.

3.2.1 Part One: Introduction

The first author hosted every session with a research assistant to help the video and audio recording. Sessions were held in the family’s language of choice. All the children opted for English. The first author was fluent in English, Urdu, and Punjabi and was familiar with South

Asian cultural conventions. In cases where the first author did not speak the grandparent's language, an independent language interpreter also attended the session to facilitate communication between the researcher and grandparent. An interpreter was present at seven of the ten sessions (no interpreter was present for F1, F2, and F3). When the researcher could not communicate with a participant, the interpreter took on the same role as the researcher as they were trained to use the same script and question set. The researcher and interpreter did not interfere in interactions between grandparent and grandchild (i.e. did not translate between participants). The researcher went over the consent forms with the grandparent, grandchild, and parent. After signing, the parent was not present for the session to keep the spotlight on the interactions between the grandparent and grandchild.

3.2.2 Part Two: Demographic Interview

Demographic data such as age, education level, and heritage language were collected. Participants self-reported their fluency in English and their heritage language. Grandparents discussed the ways in which they have tried to preserve their cultural heritage and language. The researcher also inquired about families' daily routines and shared social activities to get a sense of the level of connection between the grandparent and grandchild.

3.2.3 Part Three: Memory Hinting Activity

Common storytelling probes, such as a photo album or toy from a grandparent's childhood, are uncommon in immigrant families, as displacement can require some items be left behind, including family pictures and other family artifacts. Incorporating arts and crafts into multicultural storytelling can promote creativity and collaboration in children [56, 61]. As such, we centre our design process around creating visual representations of selected family memories.

Participants brainstormed some stories they were interested in sharing, guided by question prompts from the researcher. On index cards, participants created a small design for each of their chosen stories that could preserve and prompt the story in the form of a hint (e.g., a simple drawing or short phrase in their preferred language) that can prompt remembrance of the story and help their family retell the story. Participants generated 3-4 hint designs each using index cards, fine point markers, and pens. Fine point markers, which are similar in form to pens, were intentionally selected for the first activity to break the drawing barrier faced by many older adults. We provided four questions as ideas and prompts for the initial stories and hint designs. The researcher read each question out loud and provided a blank index card for the hint design of the current question, with clarification offered as needed. When the family had completed their designs for that question, each participant shared their hint design with each other, and were encouraged to give an idea of what the full story was about without sharing the whole story. The researcher then read out the next question and provided new blank index cards. The four question prompts for the hints are (hints that were adjusted for the grandchild are in parentheses):

1. What is a funny memory you have from high school? (What is a memory you have of your first day of school?)
2. What is a memory you have about moving to Canada (What is something you experienced visiting your heritage country OR What is something have you have heard about your heritage country that you want to experience?)
3. When is a time that family was important to you?

4. What is your favorite story? This can be your favourite folk tale, movie, book, soap opera, or religious story.

Question three was omitted for families of three or more. For F1 and F2, these explicit question prompts were not used and families could share any story. We found that leaving the initial selection of memories completely open was overwhelming for participants as there were too many to choose from, so for following families we developed these four questions from the stories shared by F1 and F2. These question prompts were selected to support and guide families in reminiscence, which was especially challenging for the grandparents when trying to retrieve old memories. Including multiple prompts allowed more opportunities for participants to develop design ideas, provided multiple design artifacts for the later parts of the study, and gave families more options to choose from when expanding on the story hints in part four, as we explain next.

3.2.4 Part Four: Memory Sharing Activity

At the end of the hint design activity, participants had created a selection of tangible artifacts (i.e., hinting designs each containing a hint for an actual story). These act both as the starting point of the cultural exchange design, which will be expanded on through parts five and six of the study, and as reminders of the chosen stories and how each participant represents them.

The grandparent was then asked to pick a story from the grandchild’s hint designs, which the grandchild shared in full. This activity was repeated for the grandparent’s stories. This activity provided a recent experience of collaborative reminiscence that will be the basis for next step of the design and gave families the opportunity to interact with their own and each other’s hint designs as they picked the other person’s designs and shared from their own. Theoretically, this results in two shared stories by two narrators. However, the nature of storytelling is that it itself prompts storytelling. So in practice this resulted in a range of stories being shared by a range of narrators, both collaboratively and sequentially, which we discuss in the Findings section. As time allowed, we did not interfere with the sharing of more stories and encouraged families to engage with reminiscence as they wanted to.

3.2.5 Part Five: Sense Making Activity

Next, families created a shared representation of a story that they collectively picked from the hint designs and the memories shared from them. More index cards, post-it notes, and markers were provided. First, the grandchild was prompted to think about the most important parts of the story, and to draw those parts out. While the grandchild drew, the researcher brought the grandparent into the process by asking if the grandchild had missed any parts of the story. The grandparent was asked to help fill in the missing parts if they were not collaborating in the drawing process. The researcher highlighted that families could create whatever they wished to show what took place in the story.

This created an expanded version of one story (corresponding to one hint design), meaning the family now had design artifacts for both creating and presented hints for a variety of memories and a fuller representation of a single story. With these completed, the family was ready to bring them together into a full design.

3.2.6 Part Six: Memory Board Activity

In the main PD activity, participants envisioned a tool for supporting their cultural exchange on a blank piece of posterboard (24 x 36 inches). F1 and F2 were provided with multiple standard

pages of paper which we found was too small a space to for facilitating collaboration, so we provided a posterboard for the remaining families. Magic Thing studies will often provide a starting point for the design to focus the task in some way (e.g., a magic wrist band [33]). We choose a magic poster board for this study because it avoids implying common story metaphors, like a book or movie, without eliminating them as potential inspirations. The poster board also provides sufficient space for drawing and other story visualizations. Index cards, sticky notes, markers, scissors, tape, a stapler, and glue were available to all families.

By this step, families had a large collection of hint designs, represented by index cards and one story visually represented in detail. The researcher laid these artifacts out randomly so participants would not feel constrained to a certain ordering. It was explained that the posterboard was a memory board for the family to remember all their stories. The researcher encouraged the family to work together and come up with a way to place and combine the design artifacts they had already completed (i.e., hints designs and the full story) in a way that made sense to them and would be easy for other family members to understand in the future. The researcher emphasized again that there were no rules in for the design of the memory board, and that they could cut, glue, tape, draw, and arrange however they wished.

The researcher introduced the Magic Thing during this activity. First prompting the grandchild, the researcher described the memory board as a magical object that could do anything. The researcher made clear that they could make up anything and add it to the board, even if it did not exist yet. These instructions were left intentionally open so that the participants could suggest any form factor they imagined, whether or not they believed it to be technically feasible. The grandparent and grandchild were encouraged to discuss their design ideas with each other and to reach a consensus.

As the family collaborated, the researcher encouraged participants to verbalize their processes by asking questions such as:

- How would you find a memory in here?
- How would that help you tell the story?
- How do you know which memory is whose?
- How would you understand something written in a different language?

3.2.7 Part Seven: Follow-up Interview

Once everyone felt the memory board design was complete, a follow-up interview was conducted for participants to reflect on their experiences. The researcher prompted them to think more about how they would like to engage with each other through cultural exchange and how their designs could support that. Participants were then asked if they had any questions or concluding thoughts, and compensation was provided.

3.3 Data and Analysis

From these sessions we collected several types of data, consisting of audio recording of the entire session, verbatim transcripts of the audio recording, video recording or photographs of the design activities, and artifacts created during the PD activities (hint design cards, story representations, memory boards, additional Magic Thing design items, etc.). The PD artifacts are composed of both design elements and story elements, which can overlap. For example, a hint

design on an index card is a design element as part of the memory board, and also contains a story artifact in the form of the drawing or phrase that prompts the story. Because of the interactive natures of both collaborative storytelling and PD, designing and reminiscing interactions between families were often overlapping. For example, experimenting with how a design would work by moving a hint card to the top of the pile would prompt storytelling. In particular, drawing could be either a part of designing (e.g., drawing a button or magic wand on an interface) or storytelling (e.g., sense-making and creating a visual representation of a story without a pre-existing visual aid like a photograph). Throughout the Findings section, we will use “drawing” to refer to the creation of story representations, not the creation of design elements, which we will call “designing”. Additionally, a “story” as part of an activity or as part of a design refers to the drawn (or written) representation of that particular memory.

From the ten sessions we recorded almost 15 hours of audio. These files were transcribed verbatim by independently hired translators. The translators transcribed the English portions, transcribed and translated the non-English portions, and provided a transliteration of the non-English portions. The transliterations were used to conduct quality tests of the translations through spot-tests. In total, 15 on-site interpreters and audio transcribers were involved in the data collection process.

In qualitative research with highly targeted research areas, McDonald’s et al. recommend that coding be performed by the researchers who conducted the study sessions as they have the required context for making sense of the transcripts that an outsider would not [42]. Following this recommendation, the transcripts were iteratively coded by two researchers (the first and second authors). The inductive coding process was grounded in the approach proposed by Braun and Clarke [8]. The researchers independently coded one transcript each and developed their own initial codebooks. They went through both transcripts and codebooks together to reach a consensus. They then coded one more transcript together to confirm the equilibrium of the combined codebooks. At this point, the codebook was stable and the researchers split the remaining seven transcripts to code independently. Through this intensive, iterative process, 344 codes emerged.

For the first five sessions, we recruited participants with South Asian heritage. Once we confirmed the process and initial findings were sufficiently stable, we expanded to include a broader range of heritage backgrounds. To confirm that our findings are not specific to one of these groups, we performed a separate analysis of codes unique to South Asian families, those unique to the remaining families, and those bridging the two groups. The resulting themes were mirrored in all three family origin groups, showing that our findings apply beyond requirements that may be specific to South Asian families. This is consistent with previous works with similarly diverse family origins [32]. Future work can expand on the represented cultural backgrounds to further confirm this generalizability.

4 FINDINGS

We present here our four emerging themes encompassing the participants’ designs and highlight what is essential to their digitally supported cultural exchange, especially as revealed by the Magic Thing. Below we present a detailed empirical breakdown of each theme and sub-theme (see Figure 1), with participant quotes and artifact images to provide context. In section 4.5, we present a summary of our thematic analysis and key insights.

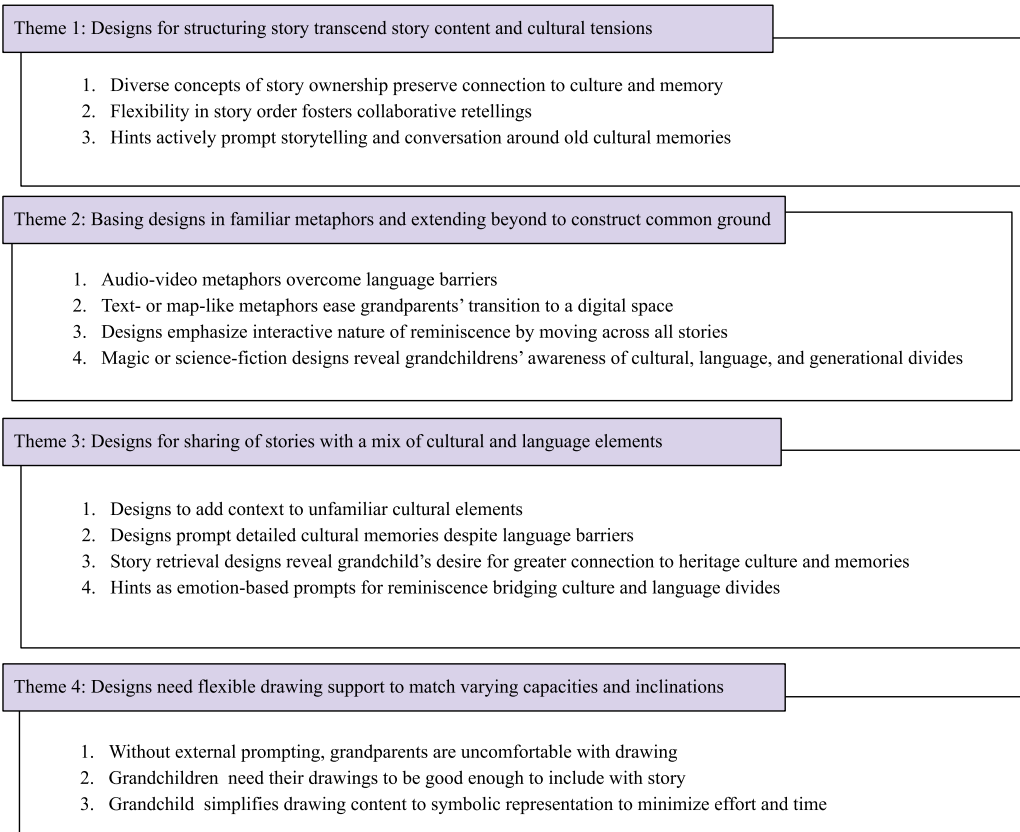


Figure 1: Mapping of themes (purple rectangles) to sub-themes (numbered points below each theme).

4.1 THEME 1: Designs for structuring story transcend story content and cultural tensions

Families collaborated to decide how they wanted to preserve the stories and utilized a variety of structural elements to incorporate them into the story representations. Interestingly, whether through drawing or writing, all families included characters, a setting, and a plot in their stories, all key elements of family narrative [45, 53]. Other digital family history tools are focused around existing artifacts, most commonly photographs, so users do not create their own representations of characters, settings, and plot of their stories from scratch [36, 51]. In contrast, in our study, grandparents and grandchildren worked without pre-existing artifacts, and therefore needed to create them in order to have lasting visual prompts. Despite the lack of existing artifacts, these core story elements were employed by both grandparents and grandchildren, suggesting that there are common design patterns (e.g. characters, plot, setting) between generations and cultures that can be leveraged as a shared starting point for storytelling. Differences emerged during the memory board activity, as families worked together to organize and combine all the different design and story artifacts together in their board design. This process was often influenced by the cultural differences between the generations and by the stories themselves, as seen in designs that emphasize the organization of stories based on location (heritage country or Canada). This theme

covers the structural elements families designed to preserve individual stories and to curate their collection of stories.

4.1.1 Diverse concepts of story ownership important for preserving personal connection to culture and memory

Multiple definitions of story ownership emerged between families, similar to those seen across family narrative activities [45]. For five families, it was important to write down the narrator of each story (F3, F6, F8, F9, F10). One family, F3, organized by both the narrator and the artist who had drawn the story by sectioning their board into quadrants, with each family member assigned an equal amount of space for their story representations and their part of the overall design (See Figure 2). A GC from F3 also believed that while anyone could draw a representation of someone else’s story, further details should be added in the design by the narrator. The GC stated, “*You were the one who was there so you can write more details about it.*” These details often included elements that established cultural context (e.g. a certain type of cooking utensil). The accurate representation of these cultural cues was important to grandparents. The GC in F5 drew a tree from a GP’s story. However, the GC drew a Canadian style tree. The GP pointed out that trees in their heritage country did not look like that, and then drew an example of the correct tree, which had drastically different branches than the GC’s conception of a standard tree. This underlying assumption was brought to the foreground through the drawing activity, creating opportunity for discussion and highlighting the GP’s desire for accurate cultural representations. An individual’s story was easily identifiable through these cultural clues and the visual partitioning of the space. These visual distinctions incorporated by families suggest that cultural memories are viewed as an individual’s stories rather than a collective family story.



Figure 2. Four quadrants are visible on this memory board. The GP directs the GC to draw in the GP’s quadrant.

For three families, explicit author attribution was unnecessary as the story owner was clear by the drawing or the writing (F4, F5, F7). As noted by the GC from F4, “*I think you can tell because I drew most of the time and [GP] wrote in Punjabi.*” One GC used color coded cards on the board to indicate story ownership (F10). While each family negotiated their own approach to story attribution, having the capacity to define and implement a concept of ownership was important to all. Thus, we observe how grandchildren in particular mentally categorize their grandparents’ stories as belonging to an individual which they may interpret, but not take equal ownership of.

4.1.2 Flexibility in order and chronology of story structure fosters richer and collaborative retellings

In six of the families (F1, F3, F4, F5, F8, F10), a single story was represented across multiple cards (e.g., sticky notes, see Figure 3, left), which were then arranged chronologically on the board. When retelling the story through the memory board design, the narrator would use the cards to structure how they presented the story, filling in the gaps between the scenes as needed. These snapshots acted as anchor points that prompt remembrance and guide future retellings. In three other families (F2, F6, F9), each story was represented on its own, as a single card or space within the memory board design. In this case, the story drawings were used as broader prompts for reminding the narrator of key details, rather than the structure. Examples of both these approaches to story structure are shown in Figure 3. In the figure on the left, the memory board design guides the narrator to retell the story step by step and adding in details as needed. On the right, however, the structure within the design is left open-ended. For example, the narrator can choose to begin the story by explaining the context behind the “not fair” speech bubble in the background, or by describing the festive scene in the foreground. The remaining family, F7, did not create any drawings as part of story representations, using keywords and other written content instead.



Figure 3. When a story is visualized as a series of events (left), the cards were placed sequentially on the board. Other families visually represented their stories as a single, detailed scene (right).

For three families, the collection of stories was not as strictly organized as in other families (F7, F5, F10). This randomness can make searching through stories a fun, social activity. GC from F7 explains that when family gathers for special events, such as birthdays, they could “*find stories about them*”, which they currently do with photo albums. Another advantage of randomness is the flexibility. The GC from F7 did not tape down the stories (on cards) onto the memory board in case they wanted to “*move them around*”. Flexibility in the story structuring within the design encourages greater collaboration as family members support each other in adding in details and prompting remembrance.

There was diversity in how families chose to organize their collections of stories. Three families organized their stories by narrator (F3, F8, F9), one family by the artist (F3), and four families by theme (F4, F5, F6, F7). F5 labelled the location of each story (in heritage country or

Canada), and F10 suggested they would like to order their stories by age-appropriateness so their grandchild can access the stories in order as they grow. Four families drew borders to divide the different sections on their board (F3, F4, F6, F9).

4.1.3 Hints actively prompt storytelling and conversation around old cultural memories

Detailed preservations of a story are not always necessary for prompting cultural discussion. In six families (F2, F3, F4, F5, F6, F9) the process of creating the hint designs prompted storytelling, despite the researcher emphasizing that the hint designs were intended to include short descriptors of a longer story. Sharing the completed hint designs and the included stories often reminded others of related stories, particularly of early childhood memories for the grandparents, which they excitedly expressed. When GP1 from F2 was sharing a story from their hint design, GP2 added on “*I have another story...you used to steal some other’s lunch*”. A similar dynamic was observed with grandchildren. When GC1 from F9 explained their hint design, GC2 interrupted to share: “*Oh, that just reminded me! Remember when the dog ate two chicks?*”

Another way hint designs prompted conversation was a family member chiming in to mention that they recognized the story represented in the design. GC1 from F6 interrupted GP’s storytelling to say “*I heard that story when you were telling it before. When you were sad because of uncle.*” We observe that the creation of these hint designs and the contained hints creates a sense of excitement in the families as they build on each other’s thoughts in an impromptu brainstorming session. The hint design activity in this process highlights how a semi-structured ideation phase before sharing a complete story generates conversation from grandparents’ old memories and guide families towards content of shared interest.

4.2 THEME 2: Basing designs in familiar metaphors and extending beyond to construct common ground

The Magic Thing prompt led to a variety of designs, many of which build on familiar existing interactions (like books and smartphones) and extend them to create novel interactions, which reflect the specific needs of cultural exchange, such as magical long-distance connections between family.

4.2.1 Familiar audio-video metaphors, like speech interactions, overcome language barriers

Many designs emphasized the speech-based nature of storytelling and incorporated speech interaction. These speech-based interactions were typically designed to overcome language barriers, such as when grandparents wrote in their heritage language on the memory board. Four families’ designs preserved stories in the form of videos (F3, F7) or recorded audio (F1, F2). Others included magic or AI-like interactions that could translate between languages (F4, F6) or make the Magic Thing a conversational interface (e.g., to read aloud with you) (F5). The importance of orality to storytelling is reflected in these designs and demonstrates the continuing preference for spoken over written story, which would also be a limitation for grandparents with limited literacy. Examples of audio-video metaphors developed through the magic thing approach are shown in Figure 4.

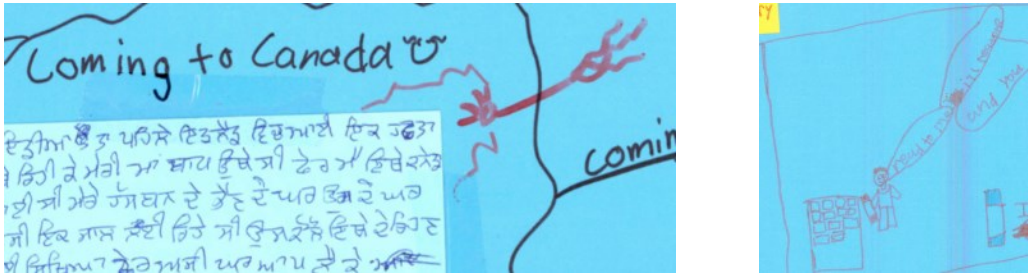


Figure 4. Two magic thing designs made by grandchildren. On the left, a magic wand (in red) that translates the story written in their heritage language by their grandparent. On the right, an interaction with a magic thing design. GC is standing next to their magic board and they say to the magic wand “Reud [sic] to me and I’ll reud [sic] to you”.

4.2.2 Familiar text-based and map-like metaphors ease grandparents’ transition to a digital space

Some designs used the familiar form factor of books to organize stories together (F1, F3, F5, F7). Others used elements of books to support their designs, including labeling stories with titles and authors to distinguish between them (F1, F3, F4, F5, F6, F8, F9, F10), organizing using a story index (F9), and representing stories with illustrated plot points (e.g., like book covers or comic book panels) (F3, F4, F5, F6, F8, F9, F10). The metaphor of a book is familiar, not only to storytelling generally, but particularly to the relationship between grandparents and grandchildren. This type of familiar metaphor may be helpful to introduce a digital cultural exchange tool, which will be unfamiliar simply because there is currently no equivalent tool, into existing social spaces. This may be particularly familiar to grandparents, as our grandparent participants felt out of date with technology and unsure how to design for what is often seen as just an oral storytelling process.

Other families used visual metaphors, largely adapted from what grandchildren learned in school, to link stories together into visualizations. Grouping stories by theme (F4, F5, F6, F7), indicating the strength of connection between stories (F4), and memory map organizations (F4) create visual and structural links between stories that create a whole interconnected space of stories (See Figure 5). These metaphors are chosen by the younger participants because they are particularly familiar, meaning they can guide grandparents through the interaction.

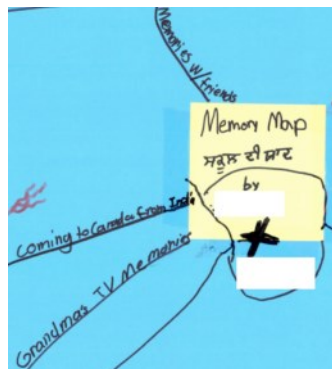


Figure 5. A memory map with links grouping stories by thematic elements was used by this family to organize their stories.

4.2.3 Designs emphasize interactive nature of reminiscence by moving across all stories

The designs created by families were not static storage objects and included interactivity in a number of ways (Figure 6), indicating how cultural exchange is an ongoing process. Story interactions include moving stories around by not taping anything down (F7), teleporting between stories with a magic button (F9), and interactive flaps build onto the memory board (F3). Common physical tools, like photo albums or scrapbooks, are largely static, though they prompt social interactions, but our families designs do not use this style of static documentation. They create interactions directly with stories to create an organic and ongoing storytelling space.

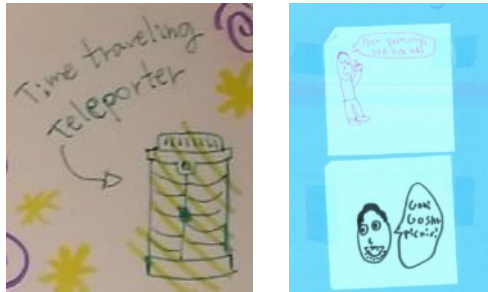


Figure 6. On the left, a teleporter is an artifact for generating interactivity with the board. On the right, sticky notes are used to create flaps that can be lifted to discover the surprise twist in the story.

4.2.4 Magic or science-fiction designs reveal grandchildren’s awareness of cultural, language, and generational divides

As the name suggests, Magic Thing studies are intended to allow participants to create whatever they want without feeling restricted by what they think would be feasible. As expected, we saw many designs that used magic or science-fiction elements, mostly to work around physical and cultural barriers, including time travel (F3, F6, F9), teleporters (F4, F5, F6, F9), and magic wands (F5). These designs, usually proposed by grandchildren, expose what can be done for cultural exchange beyond the familiar abilities of existing tools. They also emphasize grandchildren’s awareness of the barriers to fostering a deeper understanding with their grandparents and the sentiment that those can only be fixed by magic.

4.3 THEME 3: Designs for telling, preserving, retrieving, embellishing, and sharing of stories have a mix of cultural and language elements

As they added stories and reviewed them, families began thinking about how their board would be used in the future, with a conscious reflection of the cultural and language dimensions of their boards. They thought about how to mitigate issues surrounding access, retrieval, and preservation. Families, particularly grandchildren, incorporated designs that added context to enhance the user experience of family members’ future reminiscence, including considerations for how cultural knowledge will be understood without a grandparent present. We also saw more Magic Thing ideas emerge as families thought about the long-term access, remembrance, and curation of their stories, as a particular interest of immigrant families who have often experienced loss of family history through immigration or other external causes, such as war.

4.3.1 Designs to add context to unfamiliar cultural elements

After organizing their stories on the board, many families went back to add details that provided context, especially relating to language and cultural elements the grandchildren did not

understand. These added design elements show how story drawings could be augmented through interactions with the memory board designs. These additions do not change or even touch the story drawings, demonstrating their separation from the drawing-as-sense-making process. Three families added captions to their drawings (F3, F4, F6), including text describing the scene, a label identifying an object in the drawing, or a note on additional information not clear from the drawing. An example of captions is shown in Figure 7a, which was added to provide context to a valuable possession, in this case a bag, from the grandparent’s childhood which required cultural knowledge to understand the significance.

Some families took a “dust jacket” approach to text (F3, F6), using single words to refer to key characters or emotions in the story that were not anchored to an artifact, rather than captions (see Figure 7b). This design is similar to the text found on book dust jackets to intrigue readers without revealing too much of the story.



Figure 7. (a) Left image: Captions and extra details are used here to add contexts to the drawings. (b) Right image: Example of dust jacket designs

Two families used symbols to convey the emotional dimensions of a story (F4, F6). Examples include hearts to convey happy family memories or smiley faces to convey fun memories. We observe how this emotional expression between generations is used to create shared understanding despite a lack of cultural or language connection. An example of symbols is shown in Figure 8.

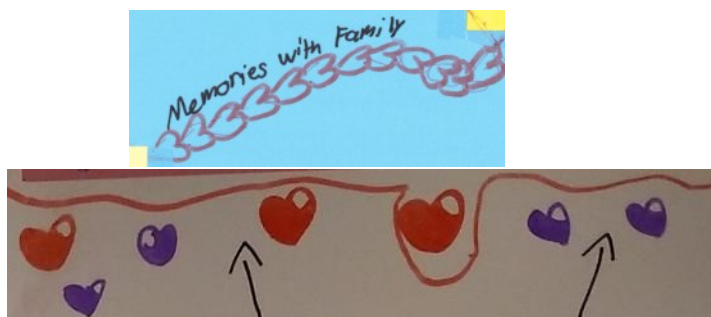


Figure 8. A heart chain connects to a happy story on a board structured after a memory map (left). Hearts encircle the border around the happy family stories section of another board (right).

4.3.2 Designs prompt remembrance of detailed cultural memories despite language barriers

Grandparents and grandchildren suggested that text and drawings representing one element of a story had potential to prompt remembrance of the entire narrative. While all grandchildren used English in their design, grandparents used either only their heritage language, or combined it with English. Though grandchildren may be unable to read their heritage language, families reported that this would not be a barrier to recalling the stories they included on the memory board. Grandparents from four families (F1, F3, F6, F8) explained how drawings could remind them of details and bridge the language gap on memory boards with multiple languages. A GP from F3 says *“I think that they will just get there when it is written in Urdu and I made a little drawing so I think definitely remember the whole story even if they don’t know what is written there”*. Grandchildren from four families (F3, F5, F6, F7) found that short text, such as captions, could help them recall the stories. The GP from F10 already used a similar strategy for ensuring his grandchild did not forget the memories from their time living in Korea. The GP had discovered that showing photos not of the events themselves, but of the people or settings from the story prompted their grandchild to reminiscence. The GP describes how *“showing pictures of her great grandparents recalls the time they went to the hospital, and she [GC] had to stay on her own”*. Families had no photos of the majority of stories they shared. However, grandparents and grandchildren found that drawings and text can serve as an alternative to photos for prompting reminiscence, and drawings in particular can act as a bridge across languages barriers.

4.3.3 Story retrieval designs reveal grandchildren’s desire for greater connection to heritage culture and memories

We observed families thinking about what it would look like when they tried to find stories in the future, especially as their collection grew. We find that the user experience of these envisioned future process is particularly of concern, with families engaging in debate and discussion over the best approach to story retrieval. The GC in F7 decided to extend the hint metaphor and used small drawings under each larger story drawing to support story retrieval as the collection grew, explaining, *“[I] draw a picture under it and then we could just look at the symbols”*. The grandchildren in F9 engaged in a lengthy discussion of how they could index their story collection. They began by adding a single button on the board. When a grandchild raised concern over how the board would know what story the user wanted to hear, they started to add a button for each story. Ultimately, they agreed that the most efficient solution was a “teleportation button” on a sticky note (see Figure 9). The sticky note could be moved around and placed on the story they wanted to experience. Teleporters were a common Magic Thing, suggested by both grandchildren (F4, F6, F9) and grandparents (F3, F5). The GC from F4 described how their teleported worked: *“It takes you to India but you are invisible and no one knows you are there”*.

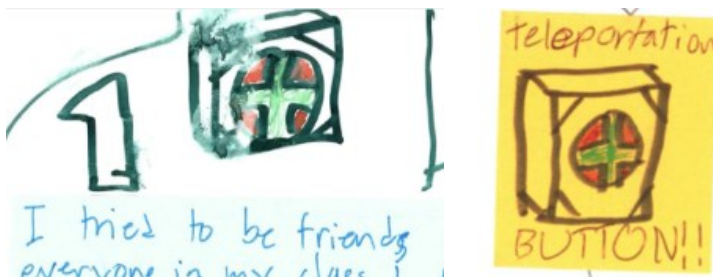


Figure 9. Interactivity matters: A family began adding a magic button to each story (left), before coming up with the idea of a moveable teleportation button that takes you to the story you want to hear (right).

Permanence of the memory board was of concern to families. The GC from F10 wanted their Magic Thing to ensure they never lost anything, saying “*I wish this would be here forever*”. The GC was also concerned about how family would access the memories in the future. They re-traced their drawings in sharpie after deciding the memory board would be placed on the wall, explaining “*when you are looking over the wall normally my family doesn't look closely*”. The grandparent in F1 wanted to be able to share stories over large distances. Families also preserved stories by drawing multiple versions of a story (F5, F6) and making sure stories can be heard again (F2). A GC from F5 added another dimension to memory access, stating that with the Magic Thing they would make the technology free. These design ideas represent an overarching concern that memories are not easily saved or passed on, making this a key aspect for the design of cultural exchange tools.

4.3.4 Hints as emotion-based prompts for reminiscence and for bridging culture and language divides

The idea of a hint to preserve a story allows for a visual representation that reminds someone of the story regardless of language ability or cultural familiarity, and can foster this understanding by intentionally using heritage language or including culturally significant objects. Five families (F1, F3, F4, F5, F9) reported that they can remember the entire story with just the hint from their hint designs as a prompt for remembrance. The GP from F1 states “*Whenever she will get the hint she will remember...Dadi [grandmother] told me*”. We see that it is not just the content of the hint or the design for it that preserves the story, but also the emotional connection between grandparent and grandchild that is formed through the hint design and story sharing process. Culture or language divides can make it challenging for grandchildren to contextualize, recall, or empathize with unfamiliar aspects of a grandparent's story. However, the close relationship with their grandparent can impart new dimensions of meaning around a story in a way that is emotionally impactful for grandchildren.

All of the families incorporated their hint designs directly by placing some or all of them on the board. As the GP from F6 comments on the usefulness of hints as a design element, “*When I look at the pictures, I recognize them, and I remember the stories behind the pictures. Each picture has a few signs, I remember in this way.*”. The hints acted as flashcards they incorporated onto the board to add context and structure. We observe that incorporating a hint-based activity as a pre-story step enriches the family's story sharing and curation process by serving as a collaboratively formed link between generations and bridging language and cultural divisions. Further, it enhances the design process as it leads to small, achievable design artifacts that introduce the different participants to others' design ideas and creates tangible artifacts that become the basis for the larger design task, which can be intimidating when starting from a blank page [47].

4.4 THEME 4: Designs reflect need for flexible support of drawing to match varying capacities and inclinations

Between and within generations, there existed a diversity of interest in drawing as part of story preservation and sense-making, as well as their perceived capabilities. Some grandparents felt uncomfortable with the process of drawing stories, though much of this discomfort was

mitigated by our layered process. Some children enjoyed drawing their stories and took pride in their creations, while others wished to minimize their drawing effort. This variation suggests that design should accommodate for the variety of ways families choose to draw, and that drawing is both a strong tool for families with language and cultural barriers and can be a limitation on interactions when it is forced. Throughout this theme we discuss drawing as the creation of story representations (as visual artifacts for stories that otherwise lack one, like family photos). Drawing as a part of design creation, such as drawing elements of the design itself, were not considered within this theme as that reflects their experience with the research rather than with cultural exchange and sense-making.

4.4.1 Without external prompting, grandparents are uncomfortable with drawing

In five families, grandparents filled the time with stories and conversation with the researchers while the child drew (F2, F3, F4, F5, F6). During these times, the grandparents were not engaged with the grandchildren in the process. One challenge of drawing as a part of a cultural exchange process is the time it takes, which can alienate grandparents who may not be as interested in drawing. In four cases, grandparents asked their grandchildren to draw for them while they directed (F3, F6, F9, F10), like a GP from F2 who asked their GC “*Can you draw back pain?*” In two families, the grandparents did not take part in any drawing or writing (F2, F7).

4.4.2 Grandchild needs their drawings to be good enough to include with story

Unlike their grandparents, the children were often heavily invested in creating artwork they were proud of. In three families, the children re-drew a story hint (without modifying the hint design) until they were satisfied (F1, F5, F6). Grandchildren showed this attention to detail equally for their own memories and their grandparent’s, suggesting a willingness to take on a role of family memory interpreter and preserver. This disparity in the importance placed on drawing can lead to some tension, with grandparents encouraging children to hurry up. In five families, children would also criticize the drawings made by the grandparent or the other child in the session, though the criticism was in a joking and light-hearted manner (F3, F5, F6, F9). One family faced another conflict, as the GP was proud of all the versions the children produced and insisted that they all be included on the board. This idea did not fit with the structure the children had envisioned and they struggled to find space. Eventually, the negotiated a resolution for indicating that a drawing was a re-drawing within the board design, as shown in Figure 10.



Figure 10. After disagreement and negotiation, the re-drawing was added to the board with an arrow as an indicator

4.4.3 Grandchild simplifies drawing content to symbolic representations to minimize effort and time

In contrast to the previous subtheme, grandchildren in three families preferred to keep their drawings simple and largely symbolic (F1, F7, F9). For example, a GC from F9 asked, “*can I draw stick figures? ...[I am] usually bad at drawing*”. Two grandchildren (F7, F10) requested a Magic Thing to help with drawing and incorporated that into the completed designs. This simplification was sometimes prompted by grandparents expressing concern about the amount of time the drawing was taking, sending signals to the children to wrap up such as “*Is it done?*” (F1), “*This is enough*” (F3, F4), “*You’re taking so long*”. (F1, F3), “*It’s getting late already*” (F9). If there is a mismatch between the value children and their grandparents place on the drawing activities, this can lead to disengagement.

5 DISCUSSION

We conclude our report on the findings by providing a discussion of the thematic analysis and grounding it in prior literature. We have divided our discussion in two parts. In 5.1 we contextualize each of our four themes in existing literature and identify how these themes contribute to our understanding of socio-technical theory for multigenerational immigrant family storytelling. In 5.2, we outline four design guidelines drawn from our thematic analysis. These guidelines suggest how to design for the workflow and information practices observed during the sessions. We synthesize the key takeaways emerging from the design guidelines and discuss how these implications contribute to system design.

5.1 Thematic Analysis Discussion and Insights for Socio-Technical Theory

In this section we ground each of our four themes in prior literature. Table 2 at the end of this section summarizes our themes, related findings from existing literature, and how our theme extends our understanding of socio-technical theory. In the next section we build on this discussion to offer several design guidelines drawn from our analysis.

5.1.1 Theme 1: Designs for structuring story transcend story content and cultural tensions

Families with and without language differences value the sharing and discovery of family stories, as has been seen across generations and across traditional storytelling roles like narrator and audience [32]. This process is more challenging for families without physical artifacts, like photographs, to prompt memories [25, 73], as is the case for many immigrant families. When all members of a storytelling session are engaged, stories typically snowball as people build on ideas, recall forgotten details, and branch into related memories [45]. In the designs produced by families in our study, participants highlighted this desire for a snowballing experience by emphasizing the importance of how they tell the story. While filling culture or language gaps, stories frequently snowballed into shared topics of interest. Additionally, designs structured the stories to preserve prompts and culturally significant metadata. However, there was great diversity in the designs for structure, with story ordering, metadata incorporation, and identification of key ideas personalized by each family. Language and culture divisions are often the focus of work with immigrant families [37, 43, 48], as they serve as simple proxies for categorizing information and design needs. However, our study identifies that within this subgroup there is significant diversity of workflows, values and design ideas that must be respected.

5.1.2 Theme 2: Basing designs in familiar metaphors and extending beyond to construct common ground

As mentioned in the prior theme, digital storytelling often relies on photographs, based in album and scrapbooks [e.g., 68]. Families in our study drew on these familiar book-based metaphors in their designs to organize and draw connections across stories. They also made use of other organizational structures, like concept maps and arrows, illustrating how they conceptualize the story collection as a whole. Book-like designs have been used for intergenerational story creation, including mobile storybooks [19] and augmented photo albums [51], and can accommodate the diverse perspectives and audience needs for preserving family memory. Similarly, in our study, the diverse designs made by families complement what is familiar to all generations, indicating they see it fitting with what they are already doing. Additionally, our findings broaden the pool of existing metaphors by identifying how families incorporated features specific to immigrant experiences (e.g. teleporters, translators).

5.1.3 Theme 3: Designs for telling, preserving, retrieving, embellishing, and sharing of stories that have a mix of cultural and language elements

Digital tools have explored mitigating language and generational barriers, such as through research with older adults around their practices of storytelling and history preservation [40, 72], but have not yet explored cultural barriers. Our participants incorporated cultural sharing into storytelling activities, showing process ownership, and had a particular emphasis on protecting from loss of history, stemming from their experiences with immigration. Families have complex processes surrounding storytelling, particularly with pictures [9], and our families’ designs highlight additional complexities. Children added symbols to mitigate language barriers, and grandparents suggested emotions could serve as powerful prompts for story details in the face of language and culture divisions. Connections designed by families to relate prompts and stories are significant to the whole collection of cultural exchange artifacts (and they are themselves a form of artifact) and should be preserved. Over time, these mappings contribute to the evolving network of stories and hints all interconnected across generations of storytelling, a crucial aspect of sharing family memories [53]. This evolving nature of storytelling is rarely reflected in digital tools, which usually expect collections of static stories [64]. Our findings challenge some of these assumptions.

5.1.4 Theme 4: Designs reflect need for flexible support of drawing to match varying capacities and inclinations

In intergenerational PD, children are more engaged in the design process through activities like drawing, while older adults are less likely to participate [78]. While we observed this to some extent in our study, with grandchildren taking the lead on drawing and grandparents taking on storytelling roles, we also observed significant fluidity in roles. Continuing engagement from grandparents and grandchildren, as evidenced by going beyond what was prompted by the researchers, suggests a two-way interest in overcoming reminiscence barriers. In particular, our process reveals the strong leadership roles children adopt in co-construction when given space. Children have been known to excel when co-design involves maker activities such as drawing, but can struggle with navigating group dynamics, such as implementing the instructions of a co-design game [68], though this was not the case in our study. All members of the process defined roles and responsibilities they were comfortable with, reflecting a need to design flexible support. However, grandparents occasionally disengaged with the process suggesting a mismatch with the

grandchild’s level of interest. Beyond the design process, drawing skill may limit expression, or may motivate engagement, especially as a support for language and cultural connections. This suggests a need for sliding scale support for drawing *within* designs to support varying interests of children. Avoiding strict enforcement of structure can also foster curiosity and encourage play, providing important educational and social advantages for children by fostering intrinsic motivation and socio-cultural development [6, 16].

Table 2. Summary of our themes, how existing research validates the theme, and how we extend what is currently known about the socio-technical dimensions of this space.

Theme	Grounding in Existing Research	Novel Insights for Socio-Technical Theory
[1] Designs for structuring story transcend story content and cultural tensions	Generations collaborate to discover and share stories [32], story snowballing is common [45], and generally rely on pictures as prompts [25, 73].	Our participants emphasized the importance of how they tell the story and consider the story collection as a whole through the Magic Thing. They designed the structure of the stories to preserve prompts and culturally significant metadata.
[2] Basing designs in familiar metaphors and extending beyond to construct common ground	Digital storytelling often relies on photographs, based in album and scrapbooks [e.g., 68]	The diverse designs complement what is familiar to all generations, indicating they see it fitting with what they are already doing, and incorporate features specific to immigrant experiences.
[3] Designs for telling, preserving, retrieving, embellishing, and sharing of stories that have a mix of cultural and language elements	Families have complex processes surrounding storytelling, particularly with pictures [9]. Digital tools have explored mitigating language and generational barriers, but not cultural barriers [40, 72].	Our participants incorporated cultural sharing into storytelling activities, showing process ownership, and had a particular emphasis on protecting from loss of history stemming from their experiences with immigration.
[4] Designs reflect need for flexible support of drawing to match varying capacities and inclinations	In intergenerational PD, children are more engaged in the design process through activities like drawing, while older adults are less likely to participate [78]	Beyond the design process, drawing skill may limit expression of thoughts, or may motivate engagement, especially as a support for language and cultural connections. This suggests a need for sliding scale support for drawing within designs.

5.2 Design Guidelines Discussion and Insights for System Design

In this section we suggest four design guidelines for informing the design of storytelling tools for multigenerational immigrant families. We ground these guidelines in prior literature and synthesize key takeaways. For clarity of context, we opt to anchor these takeaways in the relevant parts of the discussion. As a summary, a list of the themes that inform each design guidelines are presented in Figure 11. Relevant themes are tied into each guideline using an identifier and shortened title (Theme #: short descriptor). Table 3 at the end of this section restates our design guidelines, summarizes related findings from existing literature, and highlights how our guidelines extend our understanding of system design requirements.

	Design Guideline (DG) informed by theme
Theme 1: Designs for structuring story transcend story content and cultural tensions	DG1: Snowballing Storytelling
	DG2: Context-Agnostic Story Structure
	DG3: Flexible Generational Roles
Theme 2: Basing designs in familiar metaphors and extending beyond to construct common ground	DG1: Snowballing Storytelling
	DG2: Context-Agnostic Story Structure
	DG3: Flexible Generational Roles
	DG4: Oral, Multimodal Storytelling
Theme 3: Designs for sharing of stories with a mix of cultural and language elements	DG2: Context-Agnostic Story Structure
	DG3: Flexible Generational Roles
	DG4: Oral, Multimodal Storytelling
Theme 4: Designs need flexible drawing support to match varying capacities and inclinations	DG2: Context-Agnostic Story Structure
	DG3: Flexible Generational Roles

Figure 11: Summary of themes informing each design guideline

5.2.1 Design a snowballing storytelling process that supports diversity of cultural and individual perspectives

Intergenerational cultural story sharing is not a linear process. Families loop back, add details, revise versions of events, and map out connections between stories. Hearing a story or seeing a story hint leads to further storytelling, sometimes seemingly unrelated (Theme 1: Transcending structure). Based in the map-like designs created by some families (Theme 2: Familiar metaphors), we suggest the following key takeaway:

Design for the interconnected process by preserving the versions of individual stories and their connections within and across collections of stories.

One interpretation of this would be similar to a branching-structure (Figure 12). In the figure, we illustrate how the process flow of a tech-mediated tool can support family story sharing for cultural exchange. As seen on the figure, when a grandparent or grandchild shares a story (a), they should be able to return to an earlier point to revise or add new information (b). Contributions from other family members should be merged into the storyline (c). Finally, families should be able to branch off into a new story when the in-progress story prompts remembrance of it (d). A shared sense of ownership where children feel connection with shared memories is a fundamental aspect of family history [32, 64], which informs our next key takeaway:

Recognition and representation of the complicated and non-linear process of storytelling creates a flexible space that encourages narrators to build on stories as they are shared, creating more opportunities for continued cultural exchange.

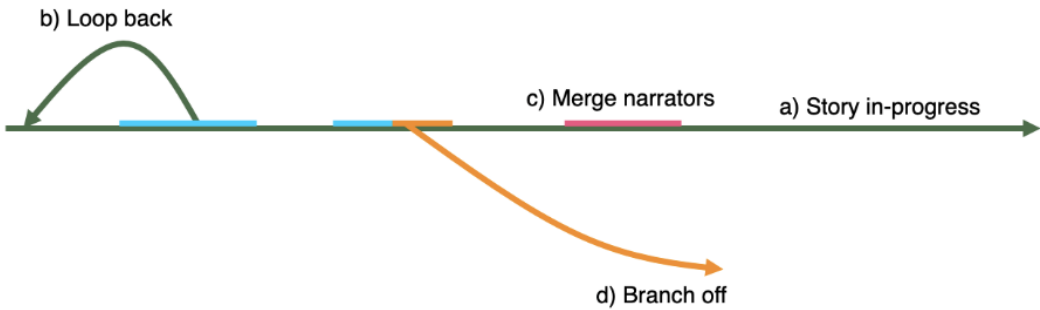


Figure 12. Process flow for tech-mediated collaborative story sharing.

The book-based designs of several of our families, including story titles and author signatures, can help to recognize different contributions across and throughout the collaborative cultural exchange process. The story resulting from a hint artifact can be embellished through, for example, additional illustrations or written versions of a story, creating story artifacts along with hint artifacts that further contribute to the interlinking story structure. Throughout this connected evolution of the shared storytelling, individual versions of a story should be preserved, as should creators and hints that both lead to and stem from a given story. A single hint may lead to multiple stories, directly or indirectly, and these connections should be transparent to families. When preserving family history, older adults reassess their stories from the perspective of their children and grandchildren to fill in perceived cultural or generational gaps [40]. We confirm and extend this finding by identifying that:

Both grandchildren and grandparents rework their personal stories to fill perceived gaps (e.g. explaining cultural artifacts, translations, drawing images) to transform formerly personal stories into shared family history.

Once the initial stories were prompted by our hinting activity, new stories were prompted by the hint cards both while they were being made and later during the design activity (Theme 1: Transcending structure). This suggests that the initial prompts can get families started, but eventually they will not be necessary as their own stories and hints will be the prompts for future storytelling and hint creation. Therefore, we suggest that:

Families should be able to create new hints from existing hints or stories, and creation of new hints should be supported at any point in the process.

This process may vary family to family and should be flexible enough to meet those needs with a focus on meaningful preservation of story connections (Theme 1: Transcending structure). As more stories are shared within a family, these flexible connections between stories represents not only the growing detail of what has been shared, but also the connections between family members. When a grandparent’s story about their time in school prompts a grandchild to share a parallel memory, this link is preserved and the family can see how their experiences are part of a connected whole. In families, individuals may not share stories due to difficulties in anticipating listener needs, which can lead to entrenched inertia and loss of family history [32]. This inertia was exhibited by several grandparents in our study as they struggled to either recall stories or to decide on a story of interest to their grandchild. With older adults in immigrant families, cultural displacement can trigger more intense inertia due to general feelings of loss, confusion about

family roles, and lack of social support [34, 66, 79]. The main contribution of this design guideline for counteracting the inertia identified both in our study and prior work is summarized below:

Our scaffolded process and resulting guideline (i.e. designing for snowballing exchange) has potential to support family members in overcoming the initial challenges associated with engaging in a new, collaborative ritual.

5.2.2 Keep the story structuring process agnostic to story content

Content for hints and for stories varied widely between families: a detailed description of the story, a keyword, or a drawing (Theme 3: Designs for future; Theme 4: Flexible drawing support). Some families had language or cultural barriers which influenced how they chose to represent and curate their stories (Theme 1: Transcending structure). The underlying structure for cultural knowledge in the resulting designs also varied across families, including books, maps, and magic wands (Theme 2: Familiar metaphors). Language learning educators commonly use images in the classrooms as they are effective resources for communicating meaning across barriers, especially with cultural knowledge [4, 12]. Digital tools build on pictures or other family artifacts [73] but have not considered what should be done in the absence of these items. We conclude that:

Families’ proposed metaphor-based designs are all visually vivid links for shared understanding, though the details of how imagery is used varied across families.

To design for this variation, the process for structuring and curating individual stories and the whole collections of cultural knowledge must be flexible (Theme 1: Transcending structure). For instance, older adults recording their memories have been found to divide their stories into “personal” and “family” stories, with family stories containing catered content or metacommentary the older adult perceives as important [40]. The platform should not compel families to use a certain schematic, such as forcing ordering when a family prefers a more loosely organized structure. This flexibility should also encompass the cultural and language diversity within families, such as by supporting translation of a hint caption or other artifact. Flexibility prompts grandparents and grandchildren to have discussions to agree on a shared workflow, providing opportunities for collaboration across the language gap.

Drawing was an area that showed particular need for further support (Theme 4: Flexible drawing support). This is an important aspect of story and cultural representation (as seen in families that illustrated culturally significant objects), but can also exclude some users as there is a pressure to draw it well enough to be preserved. This flexibility must encompass content (e.g., drawings, keywords, written text), organization (e.g., by theme, time, author), and complexity (e.g., from simple hints with just a keyword to a fully drawn scene with multilingual labels), as well as changes to these over time (e.g., a hint made with a small drawing and keyword and later redrawn into a full scene). Additionally, this flexibility does not only apply from family to family, but also within families. When cultural and language divides exist, flexibility is essential for families to share their cultural stories, especially grandparents, in a format that feels natural to them (e.g., grandparents telling stories in “anecdotal form” that did not follow a strict narrative structure). In previous works, ensuring both parties have activities they can comfortably engage in has been seen to naturally make the co-design process more equal and collaborative [68]. In our work, we see the need for support of drawing as a part of interaction with the design. We summarize the main contribution of this guideline below:

Flexibility through choice, as suggested by our guideline, creates a defined space that allows children to exercise their decision making skills, make creative choices, and to develop a personalized process they are motivated to engage with.

5.2.3 Provide space for grandparents and grandchildren as active and flexible participants

In our study, we saw grandparents and grandchildren each find a role to play in the process of cultural exchange, beyond the expected narrator/audience roles (Theme 1: Transcending structure). Grandparents were, as expected, story narrators, but also curators of stories generally, including guiding what should be included in illustrations. Grandchildren tended to take more of a designer role, driving the interaction with and organization of stories after the stories had been told. However, these roles overlapped, and we often saw grandchildren telling stories and grandparents drawing stories into designs, especially once the other party had offered an example to be followed (Theme 4: Flexible drawing support). The existing relationship with their grandparents in this study may have provided children with the appropriate balance of creative freedom and support. This egalitarian exchange has rarely been reported in conversational focused interactions in immigrant families [3, 14], suggesting that:

Our study design may have prompted two-way exchange by giving each party space for leadership.

However, the drawing activities occasionally went on longer than grandparents expected, leading to disengagement. This is not unexpected as older adults are typically less interested in drawing activities [78], but does suggest that incorporating additional flexibility that shortens the drawing process (e.g. pre-made artifacts) could help maintain grandparent interest. This could include drag-and-drop culturally relevant images of people, places, and things to reduce the time required to visually represent a story.

While question prompts (e.g. “Did something funny happen to anyone at school?”) have been seen in several available tools to prompt storytelling and conversation (e.g., StoryCorps [31]), we suggest that these questions be used to prompt the creation of hints, which then in turn prompts storytelling, in order to foster a more personal storytelling process. Families should be encouraged to reflect on these prompts and create hint artifacts (through writing, drawing, or audio) to help them (and others) remember the story. In our study, the hinting activity helped families first to choose which stories to tell and then built on that to make space for them to individualize their process and build ownership of their hint and resulting story (Theme 1: Transcending structure). By using a question to create a hint, rather than moving directly to story, both the prompt (the hint artifact) and the story (resulting from the hint) belong to the family. Additionally:

A hint-first approach allows the storyteller to slowly introduce new cultural concepts and language vocabulary without overwhelming the listener.

These suggestions align with the recommendations of language learning research (e.g. techniques such as spacing, supporting generalization, establishing a shared goal etc.) [1, 38]. Based on this building block approach that was successful in bridging cultural gaps during the sessions, a possible implementation of the hinting ideation phase could be digital flashcards with a prompt on one side and the response on the other. Prompts may include drawing, writing, and audio components. By starting with a small, yet interactive hinting activity such as this, richer exchanges are fostered.

Though individuals in families readily contribute to co-construction of stories in whatever way they best can, preserving origination (i.e., who contributed each aspect: audio, illustration,

amendment, etc.) throughout the collaboration process is important (Theme 1: Transcending structure). Grandchildren preserved origination by acknowledging and documenting the narrator, the artist, and the curator of stories, thus demonstrating the value they placed on individual and collective ownership of cultural memories. We recommend that tech-mediated supports should design for collaboration while recognizing and preserving individual contributions. This supports the much-needed access to stories, especially as a collection of cultural knowledge grows over time (Theme 2: Familiar metaphors). When accessing stories, such as through the versioning framework described in the previous suggestions, families should also be able to filter, sort, and search by story owners, however they choose to define origination (Theme 1: Transcending structure). We suggest that this guideline will foster the following dynamic that we observed with our participant families:

Everyone is an active part of the cultural exchange process, despite known barriers, and everyone can find their own role or roles within that, especially once the hinting activity gets them past the initial work of motivation and choosing a story.

5.2.4 Expect primarily oral storytelling, but mix modalities to foster cohesion between diversity of cultural and language artifacts

Oral storytelling is the oldest modality for passing on family knowledge, and its persistence is due in part to the simple, social sharing it supports [21, 64]. Unsurprisingly, the in-person prompted storytelling observed in our research was primarily spoken. Many designs in our study expected orality to be the main modality (Theme 2: Familiar metaphors), but visual representations often accompanied them, as seen in the magic wand that could read the text of family stories aloud to a grandchild. Listening to recordings of spoken family stories has been found to be important and a strong method of family documentation [66, 75]. As such we identify how different modalities can enrich the storytelling experience:

Designs should expect and encourage oral storytelling, but must not limit the cultural exchange by requiring recorded audio to support other aspects of interaction.

Mixed media artifacts, as we are proposing here, need to connect their various aspects (e.g., audio, drawings, writing, annotations, and metadata) into a cohesive whole, while allowing for the individual creations to be accessible and stand-alone. We highlight examples of mixed media artifacts below:

Designs can propose specific combinations that make recognizable outputs, including read-aloud e-books (audio and writing), animated slideshows or movies (audio and drawings), or collages or map-like combinations of stories (drawings, writing, and annotations).

Mixed media storytelling is a powerful tool for marginalized youth through which they can share their lived experiences [58]. By providing the right tools to engage in this cultural production, the storytelling process itself can become a process for empowerment. Mixed media artifacts also reflect the familiar metaphors used by our families, but many designs also pushed the limits of those metaphors into unexpected formats (Theme 3: Designs for future). We propose that these familiar metaphors should be balanced with the possibility of creating new combinations for novel outputs that can incorporate the value-based sharing we observed during the Magic Thing.

Language supports were common instances of speech-based multimodal interactions in families’ designs and storytelling interactions (Theme 2: Familiar metaphors; Theme 3: Designs

for future). Grandparents employed strategies for teaching heritage language to their grandchildren. Even with a language barrier between generations, families found ways to communicate and collaborate during the design and storytelling activities, such as asking questions about unfamiliar words or concepts and drawing to visually explain when there was a language or culture gap. We propose that developing a tool that provides complete language support in English and in a family’s heritage language may not always be necessary. Rather, we find that:

Knowledge gaps serve a valuable opportunity for spring boarding conversation and learning exchange between generations.

We support this suggestion by drawing on educational literature, which recommends setting goals at an attainable level above an individual’s existing capabilities, and also recommends assigning a facilitator who can guide the individual to the goal [55, 63].

Table 3. Summary of our design guidelines, how existing research validates the guidelines, and how we extend what is currently known about system design implications in the space.

Design Guideline	Grounding in Existing Research	Novel Insights for System Design
[1] Design a snowballing storytelling process that supports diversity of cultural and individual perspectives	Entrenched inertia and loss of family history [32, 64] is exacerbated by unique challenges of immigrant families [34, 66, 79], though a shared sense of connection can help cross these barriers [32, 64].	Our scaffolded process (resulting in this guideline) has potential to support family members in overcoming the initial challenges associated with engaging in a new, collaborative ritual.
[2] Keep the story structuring process agnostic to story content	Images are effective resources for communicating across cultural barriers[4, 12], but digital tools require photos [73] which immigrant families may not have. Little work has explored how to support families in creating their own visual artifacts.	When creating visual artifacts in the absence of photos, content and organization varies across families. Flexibility through choice creates a defined space that allows children to exercise decision making skills, make creative choices, and develop a personalized process they are motivated to engage with.
[3] Provide space for grandparents and grandchildren as active and flexible participants	Active engagement on both sides has rarely been reported in conversational focused interactions in immigrant families [3, 14], as fostering mutual engagement is challenging without a shared goal [1, 38].	Given a shared, goal everyone engages actively in the cultural exchange process, despite known barriers. Everyone can find their own role or roles within that, especially once the hinting activity gets them past the initial work of motivation and choosing a story.
[4] Expect primarily oral storytelling, but mix modalities to foster cohesion between diversity of cultural and language artifacts	Non-textual modalities, like audio recording, are strong methods of family documentation [66, 75] and mixed media storytelling is an empowering tool for immigrant youth [58].	Knowledge gaps serve a valuable opportunity for spring boarding conversation and learning exchange between generations, and this spring boarding can be facilitated through a mix of modalities.

In this case, the goal is the vocabulary necessary for making sense of a story, and the facilitator is the grandchild. This approach serves an additional advantage of empowering children to take on a teaching role. We suggest designing for dynamic person-driven translation that supports the interactive learning dynamics we observed. An example implementation may involve prompting

the grandchild to ask if their grandparent knows the meaning of an English word (e.g. moose). If they do not, the grandchild is prompted to draw a picture to help their grandparent understand. These kinds of adaptive prompts can mimic the facilitative role the researcher took on during the session. By incorporating prompting questions, language and culture gaps can snowball into an enriching learning experience for families. We highlight the key takeaway of this guideline below:

Mixed media artifacts act as a sensemaking bridge by closing generational gaps that arise due to culture and language

6 LIMITATIONS AND FUTURE WORK

Our work was conducted in urban and rural communities throughout Canada, connecting with immigrant families of various heritages. However, half of the families included in our research are of South Asian heritage, and so the demographics of our participants, while relevant to our study goal, may not represent the broader experiences of immigration to Canada. Though we did not detect significant differences between families of different backgrounds, our future work will seek out a larger and more diverse sample of cultural backgrounds, specifically in upcoming iterations of this research in which we aim to validate the proposed design guidelines through the development and long-term deployment of an app with immigrant families. Additionally, Canada has a unique immigration context, resulting in an immigrant population that may differ substantially from other countries. Similar studies in other geographical and socio-economical contexts would be needed to investigate this.

In this paper, we propose design guidelines and potential implementations. These recommendations will need to be tested and validated in future work, such as through an app deployment in families’ homes.

7 CONCLUSION

Intergenerational immigrant families are routinely faced with language and culture barriers in their daily lives. In many cases, these divides can lead to social disconnect between older and younger family members. In this research we conducted PD sessions with immigrant grandparents and grandchildren to investigate their needs for and interest in a tool that supports cultural exchange and reminiscence. By leveraging the Magic Thing approach to provide both older adults and young children with a platform for expressing their needs and ideas, families generated designs they believe could bridge language and cultural gaps while delivering an engaging and meaningful social experience. We identified the collaboration practices of our families, including dynamics common to many families, as well as the unique mediation introduced by language and culture differences.

We suggest four guidelines for designers of reminiscence tools grounded in these sessions. First, a snowballing approach encourages the sharing and preservation of diverse narratives and cultural perspectives. Second, flexibility in the story structuring process prompts grandparents and grandchildren to collaborate over their differences. Third, grandparents and grandchildren are flexible in the roles they take on in the story and design processes and should be respected as active participants. Finally, mixing modalities with oral storytelling provides opportunities for bridging cultural and language gaps. These recommendations will inform development of reminiscence support tools that understand and support the unique storytelling and social exchange challenges present in intergenerational immigrant families.

ACKNOWLEDGMENTS

This work was supported by AGE-WELL NCE Inc., a member of the Government of Canada's Networks of Centres of Excellence.

REFERENCES

- [1] Allen, V.F. 1983. *Techniques in Teaching Vocabulary*. Oxford University Press, 200 Madison Ave., New York, NY 10016 (ISBN 0-19-434130-5, \$4.95).
- [2] Almohamed, A., Vyas, D. and Zhang, J. 2017. Rebuilding social capital: Engaging newly arrived refugees in participatory design. *Proceedings of the 29th Australian Conference on Computer-Human Interaction* (2017), 59–67.
- [3] Ashbourne, L.M. and Baobaid, M. 2014. Parent-Adolescent Storytelling in Canadian-Arabic Immigrant Families (Part 2): A Narrative Analysis of Adolescents' Stories Told to Parents. *The Qualitative Report*. 19, 30 (2014), 1–18.
- [4] Barnes-Karol, G. and Broner, M.A. 2010. Using Images as Springboards to Teach Cultural Perspectives in Light of the Ideals of the MLA Report: Using Images as Springboards to Teach Cultural Perspectives in Light of the Ideals of the MLA Report. *Foreign Language Annals*. 43, 3 (Aug. 2010), 422–445. DOI:<https://doi.org/10.1111/j.1944-9720.2010.01091.x>.
- [5] Birch, H. and Demmans Epp, C. 2015. *Participatory design with music students: Empowering children to develop instructional technology*.
- [6] Bodrova, E. 2013. Play and Self-Regulation: Lessons from Vygotsky. *American Journal of Play*. 6, 1 (2013), 111–123.
- [7] Booker, A. and Goldman, S. 2016. Participatory design research as a practice for systemic repair: Doing hand-in-hand math research with families. *Cognition and Instruction*. 34, 3 (2016), 222–235.
- [8] Braun, V. and Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 3, 2 (Jan. 2006), 77–101. DOI:<https://doi.org/10.1191/1478088706qp063oa>.
- [9] Broekhuijsen, M., van den Hoven, E. and Markopoulos, P. 2017. From PhotoWork to PhotoUse: exploring personal digital photo activities. *Behaviour & Information Technology*. (2017), 1–14. DOI:<https://doi.org/10.1080/0144929X.2017.1288266>.
- [10] Brown, D., Ayo, V. and Grinter, R.E. 2014. Reflection through design: immigrant women's self-reflection on managing health and wellness. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (2014), 1605–1614.
- [11] Burnette, D. 1999. Physical and emotional well-being of custodial grandparents in Latino families. *American Journal of Orthopsychiatry*. 69, (Jul. 1999), 305–318. DOI:<https://doi.org/10.1037/h0080405>.
- [12] Bush, M.D. 2007. Facilitating the Integration of Culture and Vocabulary Learning: The Categorization and Use of Pictures in the Classroom. *Foreign Language Annals*. 40, 4 (Dec. 2007), 727–745. DOI:<https://doi.org/10.1111/j.1944-9720.2007.tb02890.x>.
- [13] Cheng, W., Wu, J. and Bonsignore, E. 2019. Timeless Homes: Exploring Genealogy and Family Histories through Co-Design with Children. *Proceedings of the 18th ACM International Conference on Interaction Design and Children* (2019), 538–543.
- [14] Choi, Y., He, M. and Harachi, T.W. 2008. Intergenerational Cultural Dissonance, Parent–Child Conflict and Bonding, and Youth Problem Behaviors among Vietnamese and Cambodian Immigrant Families. *Journal of Youth and Adolescence*. 37, 1 (2008), 85–96. DOI:<https://doi.org/10.1007/s10964-007-9217-z>.
- [15] Dahya, N. and Jenson, J. 2015. Misrepresentations in school-based digital media production: An ethnographic exploration with Muslim girls. *Diaspora, Indigenous, and Minority Education*. 9, 2 (2015), 108–123.
- [16] Deci, E.L. [Ryan 1981. Curiosity and Self-Directed Learning: The Role of Motivation in Education. (1981).
- [17] Dib, L., Petrelli, D. and Whittaker, S. 2010. Sonic souvenirs: exploring the paradoxes of recorded sound for family remembering. *Proceedings of the 2010 ACM conference on Computer supported cooperative work* (2010), 391–400.
- [18] Dindler, C. and Iversen, O.S. 2007. Fictional inquiry—design collaboration in a shared narrative space. *CoDesign*. 3, 4 (2007), 213–234.
- [19] Druin, A., Bederson, B.B. and Quinn, A. 2009. Designing intergenerational mobile storytelling. *Proceedings of the 8th international conference on interaction design and children* (2009), 325–328.
- [20] Druin, A., Guha, M.L. and Fails, J.A. 2009. Cooperative Inquiry Revisited: Ten Years of Designing with Children for Children. (2009).
- [21] Fiese, B.H., Tomcho, T.J., Douglas, M., Josephs, K., Poltrock, S. and Baker, T. 2002. A review of 50 years of research on naturally occurring family routines and rituals: Cause for celebration? *Journal of Family Psychology*. 16, 4 (2002), 381–390. DOI:<https://doi.org/10.1037/0893-3200.16.4.381>.
- [22] Forghani, A. and Neustaedter, C. 2014. The Routines and Needs of Grandparents and Parents for Grandparent-grandchild Conversations over Distance. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2014), 4177–4186.

- [23] Forghani, A., Neustaedter, C., Vu, M.C., Judge, T.K. and Antle, A.N. 2018. G2G: The Design and Evaluation of a Shared Calendar and Messaging System for Grandparents and Grandchildren. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (2018), 1–12.
- [24] Frauenberger, C., Spiel, K. and Makhaeva, J. 2019. Thinking OutsideTheBox-Designing Smart Things with Autistic Children. *International Journal of Human-Computer Interaction*. 35, 8 (2019), 666–678.
- [25] Frohlich, D., Kuchinsky, A., Pering, C., Don, A. and Ariss, S. 2002. Requirements for photoware. *Proceedings of the 2002 ACM conference on Computer supported cooperative work* (2002), 166–175.
- [26] Hammack, P.L. 2008. Narrative and the Cultural Psychology of Identity. *Personality and Social Psychology Review*. 12, 3 (Aug. 2008), 222–247. DOI:<https://doi.org/10.1177/1088868308316892>.
- [27] Hemmert, F., Hamann, S., Löwe, M., Zeipelt, J. and Joost, G. 2010. Co-designing with children: a comparison of embodied and disembodied sketching techniques in the design of child age communication devices. *Proceedings of the 9th International Conference on Interaction Design and Children* (2010), 202–205.
- [28] Heshmat, Y., Neustaedter, C., McCaffrey, K., Odom, W., Wakkary, R. and Yang, Z. 2020. FamilyStories: Asynchronous Audio Storytelling for Family Members Across Time Zones. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (Honolulu HI USA, Apr. 2020), 1–14.
- [29] Holtorf, C. 2018. Embracing change: how cultural resilience is increased through cultural heritage. *World Archaeology*. 50, 4 (Aug. 2018), 639–650. DOI:<https://doi.org/10.1080/00438243.2018.1510340>.
- [30] Iacucci, G., Kuutti, K. and Ranta, M. 2000. On the move with a magic thing: role playing in concept design of mobile services and devices. *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques* (2000), 193–202.
- [31] Isay, D. 2007. *Listening is an Act of Love: A Celebration of American Life from the StoryCorps Project*. Penguin.
- [32] Jones, J. and Ackerman, M.S. 2018. Co-constructing Family Memory: Understanding the Intergenerational Practices of Passing on Family Stories. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18* (Montreal QC, Canada, 2018), 1–13.
- [33] Jones, M., Robinson, S., Pearson, J., Joshi, M., Raju, D., Mbogo, C.C., Wangari, S., Joshi, A., Cutrell, E. and Harper, R. 2017. Beyond “yesterday’s tomorrow”: future-focused mobile interaction design by and for emergent users. *Personal and Ubiquitous Computing*. 21, 1 (2017), 157–171.
- [34] Jr, J.C.G. and Huneycutt, T.L. 2002. Grandparents Parenting Grandchildren: Extent of Situation, Issues Involved, and Educational Implications. *Educational Gerontology*. 28, 2 (Feb. 2002), 139–161. DOI:<https://doi.org/10.1080/03601270252801391>.
- [35] Kamo, Y. 1998. Asian grandparents. *Handbook on grandparenthood*. (1998), 97–112.
- [36] Kaufman, D., Silva, D., Schell, R. and Hausknecht, S. 2018. Design and Evaluation of an Online Digital Storytelling Course for Seniors. *Proceedings of the Future Technologies Conference* (2018), 1133–1141.
- [37] Kim, S. 2010. *The experience of Korean immigrant grandmothers with their grandchildren*. University of Minnesota.
- [38] Larkin, M. 2002. Using Scaffolded Instruction To Optimize Learning. ERIC Digest. (Dec. 2002).
- [39] Liaqat, A. and Munteanu, C. 2019. Social Learning Frameworks for Analyzing Collaboration with Marginalized Learners. *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing* (Austin TX USA, Nov. 2019), 288–292.
- [40] Lindley, S.E. 2012. Before I forget: From personal memory to family history. *Human-Computer Interaction*. 27, 1–2 (2012), 13–36.
- [41] Manoogian, M.M., Walker, A.J. and Richards, L.N. 2007. Gender, Genocide, and Ethnicity: The Legacies of Older Armenian American Mothers. *Journal of Family Issues*. 28, 4 (Apr. 2007), 567–589. DOI:<https://doi.org/10.1177/0192513X06297605>.
- [42] McDonald, N., Schoenebeck, S. and Forte, A. 2019. Reliability and Inter-rater Reliability in Qualitative Research: Norms and Guidelines for CSCW and HCI Practice. *Proceedings of the ACM on Human-Computer Interaction*. 3, CSCW (Nov. 2019), 1–23. DOI:<https://doi.org/10.1145/3359174>.
- [43] Nauck, B. 2001. Intercultural Contact and Intergenerational Transmission in Immigrant Families. *Journal of Cross-Cultural Psychology*. 32, 2 (Mar. 2001), 159–173. DOI:<https://doi.org/10.1177/0022022101032002004>.
- [44] Nauck, B. 2001. Intercultural Contact and Intergenerational Transmission in Immigrant Families , Intercultural Contact and Intergenerational Transmission in Immigrant Families. *Journal of Cross-Cultural Psychology*. 32, 2 (Mar. 2001), 159–173. DOI:<https://doi.org/10.1177/0022022101032002004>.
- [45] Ochs, E. and Capps, L. 2001. *Living narrative: Creating lives in everyday storytelling*. Harvard University Press.
- [46] Odom, W., Banks, R., Kirk, D., Harper, R., Lindley, S. and Sellen, A. 2012. Technology heirlooms?: considerations for passing down and inheriting digital materials. *Proceedings of the SIGCHI Conference on Human Factors in computing systems* (2012), 337–346.
- [47] Paracha, S., Hall, L., Clawson, K., Mitsche, N. and Jamil, F. 2019. Co-design with Children: Using Participatory Design for Design Thinking and Social and Emotional Learning. *Open Education Studies*. 1, 1 (Jan. 2019), 267–280. DOI:<https://doi.org/10.1515/edu-2019-0021>.

- [48] Park, S.M. and Sarkar, M. 2007. Parents' Attitudes Toward Heritage Language Maintenance for Their Children and Their Efforts to Help Their Children Maintain the Heritage Language: A Case Study of Korean-Canadian Immigrants. *Language, Culture and Curriculum*. 20, 3 (Dec. 2007), 223–235. DOI:<https://doi.org/10.2167/lcc337.0>.
- [49] Petrelli, D. and Light, A. 2014. Family Rituals and the Potential for Interaction Design: A Study of Christmas. *ACM Transactions on Computer-Human Interaction (TOCHI)*. 21, 3 (Jan. 2014), 16. DOI:<https://doi.org/10.1145/2617571>.
- [50] Phoenix, A. and Brannen, J. 2014. Researching family practices in everyday life: Methodological reflections from two studies. *International Journal of Social Research Methodology*. 17, 1 (2014), 11–26.
- [51] Piper, A.M., Weibel, N. and Hollan, J. 2013. Audio-enhanced Paper Photos: Encouraging Social Interaction at Age 105. *Proceedings of the 2013 Conference on Computer Supported Cooperative Work* (New York, NY, USA, 2013), 215–224.
- [52] Raffle, H., Ballagas, R., Revelle, G., Horii, H., Follmer, S., Go, J., Reardon, E., Mori, K., Kaye, J. and Spasojevic, M. 2010. Family story play: reading with young children (and elmo) over a distance. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (2010), 1583–1592.
- [53] Randall, B. 2012. 11 Beyond Healthy Aging: The Practice of Narrative Care in Gerontology. *Adult education and health*. (2012). DOI:<https://doi.org/10.3138/9781442685208-013>.
- [54] Reese, L. 2012. Storytelling in Mexican Homes: Connections Between Oral and Literacy Practices. *Bilingual Research Journal*. 35, 3 (Oct. 2012), 277–293. DOI:<https://doi.org/10.1080/15235882.2012.734006>.
- [55] Rieber, R.W. and Carton, A.S. eds. 1988. *The Collected Works of L. S. Vygotsky*. Springer US.
- [56] Sá, G., Sylla, C., Martins, V., Caruso, A. and Menegazzi, D. 2019. Multiculturalism and Creativity in Storytelling-Visual Development of a Digital Manipulative for Young Children. *Proceedings of the 2019 on Creativity and Cognition*. 369–381.
- [57] Sabie, D., Sabie, S. and Ahmed, S.I. 2020. Memory through Design: Supporting Cultural Identity for Immigrants through a Paper-Based Home Drafting Tool. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, Apr. 2020), 1–16.
- [58] Sawhney, N. 2009. Voices beyond walls: the role of digital storytelling for empowering marginalized youth in refugee camps. *Proceedings of the 8th International Conference on Interaction Design and Children - IDC '09* (Como, Italy, 2009), 302.
- [59] Silverstein, M. and Chen, X. 1999. The impact of acculturation in Mexican American families on the quality of adult grandchild-grandparent relationships. *Journal of Marriage and the Family*. (1999), 188–198.
- [60] Spence, N.D., Wells, S., Graham, K. and George, J. 2016. Racial Discrimination, Cultural Resilience, and Stress. *The Canadian Journal of Psychiatry*. 61, 5 (May 2016), 298–307. DOI:<https://doi.org/10.1177/0706743716638653>.
- [61] Sylla, C., Pires Pereira, Í.S. and Sá, G. 2019. Designing manipulative tools for creative multi and cross-cultural storytelling. *Proceedings of the 2019 on Creativity and Cognition*. 396–406.
- [62] Telzer, E.H. 2010. Expanding the Acculturation Gap-Distress Model: An Integrative Review of Research. *Human Development*. 53, 6 (2010), 313–340. DOI:<https://doi.org/10.1159/000322476>.
- [63] The zone of proximal development as basis for instruction: 1990. */core/books/vygotsky-and-education/zone-of-proximal-development-as-basis-for-instruction/8D42E76783B492648D12FAA7AB108865*. Accessed: 2019-01-07.
- [64] Thiry, E. and Rosson, M.B. 2012. Unearthing the family gems: design requirements for a digital reminiscing system for older adults. *Proceedings of the 2012 ACM annual conference extended abstracts on Human Factors in Computing Systems Extended Abstracts - CHI EA '12* (Austin, Texas, USA, 2012), 1715.
- [65] Tibau, J., Stewart, M., Harrison, S. and Tatar, D. 2019. FamilySong: Designing to enable music for connection and culture in internationally distributed families. *Proceedings of the 2019 on Designing Interactive Systems Conference* (2019), 785–798.
- [66] Treas, J. and Mazumdar, S. 2004. Kinkeeping and Caregiving: Contributions of Older People in Immigrant Families*. *Journal of Comparative Family Studies; Calgary*. 35, 1 (Winter 2004), 105–122.
- [67] Treas, J. and Mazumdar, S. 2002. Older people in America's immigrant families: Dilemmas of dependence, integration, and isolation. *Journal of Aging Studies*. 16, 3 (2002), 243–258. DOI:[https://doi.org/10.1016/S0890-4065\(02\)00048-8](https://doi.org/10.1016/S0890-4065(02)00048-8).
- [68] Vaajakallio, K., Lee, J.-J. and Mattelmäki, T. 2009. "It has to be a group work!": co-design with children. *Proceedings of the 8th International Conference on Interaction Design and Children - IDC '09* (Como, Italy, 2009), 246.
- [69] Vetere, F., Davis, H., Gibbs, M. and Howard, S. 2009. The Magic Box and Collage: Responding to the challenge of distributed intergenerational play. *International Journal of Human-Computer Studies*. 67, 2 (2009), 165–178.
- [70] Vines, J., Blythe, M., Dunphy, P., Vlachokyriakos, V., Teece, I., Monk, A. and Olivier, P. 2012. Cheque mates: participatory design of digital payments with eighty somethings. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (2012), 1189–1198.
- [71] Vines, J., Clarke, R., Light, A. and Wright, P. 2015. The beginnings, middles and endings of participatory research in HCI. *International Journal of Human-Computer Studies*. 74, C (2015), 77–80.
- [72] Volkmann, T., Sengpiel, M. and Jochems, N. 2016. Historytelling: a Website for the Elderly A Human-Centered Design Approach. *Proceedings of the 9th Nordic Conference on Human-Computer Interaction* (2016), 100.

- [73] Wallbaum, T., Esser, M., Heuten, W. and Boll, S. 2016. StoryBox: Design of a System to Support Experience Sharing through Visual Stories. *Proceedings of the 9th Nordic Conference on Human-Computer Interaction* (2016), 97.
- [74] Wang, H.-C., Fussell, S.R. and Cosley, D. 2011. From diversity to creativity: stimulating group brainstorming with cultural differences and conversationally-retrieved pictures. *Proceedings of the ACM 2011 conference on Computer supported cooperative work - CSCW '11* (Hangzhou, China, 2011), 265.
- [75] Wang, Q. 2008. On the cultural constitution of collective memory. *Memory*. 16, 3 (Apr. 2008), 305–317. DOI:<https://doi.org/10.1080/09658210701801467>.
- [76] West, D., Quigley, A. and Kay, J. 2007. MEMENTO: a digital-physical scrapbook for memory sharing. *Personal and Ubiquitous Computing*. 11, 4 (Apr. 2007), 313–328. DOI:<https://doi.org/10.1007/s00779-006-0090-7>.
- [77] Wisniewski, P.J., Kumar, N., Bassem, C., Clinch, S., Dray, S.M., Fitzpatrick, G., Lampe, C., Muller, M. and Peters, A.N. 2018. Intersectionality as a Lens to Promote Equity and Inclusivity within SIGCHI. *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems* (2018), 1–6.
- [78] Xie, B., Druin, A., Fails, J., Massey, S., Golub, E., Franckel, S. and Schneider, K. 2012. Connecting generations: developing co-design methods for older adults and children. *Behaviour & Information Technology*. 31, 4 (Apr. 2012), 413–423. DOI:<https://doi.org/10.1080/01449291003793793>.
- [79] Xie, X. and Xia, Y. 2011. Grandparenting in Chinese Immigrant Families. *Marriage & Family Review*. 47, 6 (Sep. 2011), 383–396. DOI:<https://doi.org/10.1080/01494929.2011.594218>.
- [80] Yip, J.C., Sobel, K., Pitt, C., Lee, K.J., Chen, S., Nasu, K. and Pina, L.R. 2017. Examining adult-child interactions in intergenerational participatory design. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (2017), 5742–5754.

APPENDIX A: LONG DESCRIPTION OF FIGURE 1

A chart of the relationships between themes and subthemes, On the left are four themes, each with several subthemes beneath. Theme 1 is Designs for structuring story transcend story content and cultural tensions and has three subthemes: Diverse concepts of story ownership preserve personal connection to culture, Flexibility in story order fosters collaborative retellings, and Hints actively prompt storytelling and conversation. Theme 2 is Basing designs in familiar metaphors and extending beyond to construct common ground and has four subthemes: Audio-video metaphors overcome language barriers, Text- or map-like metaphors ease digital transition, Interactive nature of reminiscence seen by moving across all stories, and Magic or science-fiction designs reveal divides. Theme 3 is Designs for sharing of stories with a mix of cultural and language elements and has four subthemes: Designs to add context to unfamiliar cultural elements, Designs prompt detailed cultural memories despite language barriers, Story retrieval designs reveal GC’s desire for greater connection to heritage culture, and Hints as emotion-based prompts for reminiscence bridging culture and language divides. Theme 4 is Designs need flexible drawing support to match varying capacities and inclinations and has three subthemes: Without external prompting, GPs are uncomfortable with drawing, GC needs drawings to be good enough to include with story, and GC simplifies drawing content to minimize effort and time.

APPENDIX B: LONG DESCRIPTION OF FIGURE 11

A chart of the themes (in purple boxes) and the resulting design guidelines (in blue boxes). On the left are the four themes: Theme 1: Designs for structuring story transcend story content and cultural tensions, Theme 2: Basing designs in familiar metaphors and extending beyond to construct common ground, Theme 3: Designs for sharing stories with a mix of cultural and language elements, and Theme 4: Designs need flexible drawing support to match varying capacities and inclinations. On the right are the design guidelines associated with each themes. Themes 1 and 2 are connected to DG1: Snowballing Storytelling, and Themes 2 and 3 are connected to DG4: Oral, Multimodal Storytelling. DG2: Context-Agnostic Story Structure and DG3: Flexible Generational Roles are connected to all the themes.

Received: April 2021, Revised: November 2021; Revised March 2022; Accepted: March 2022.