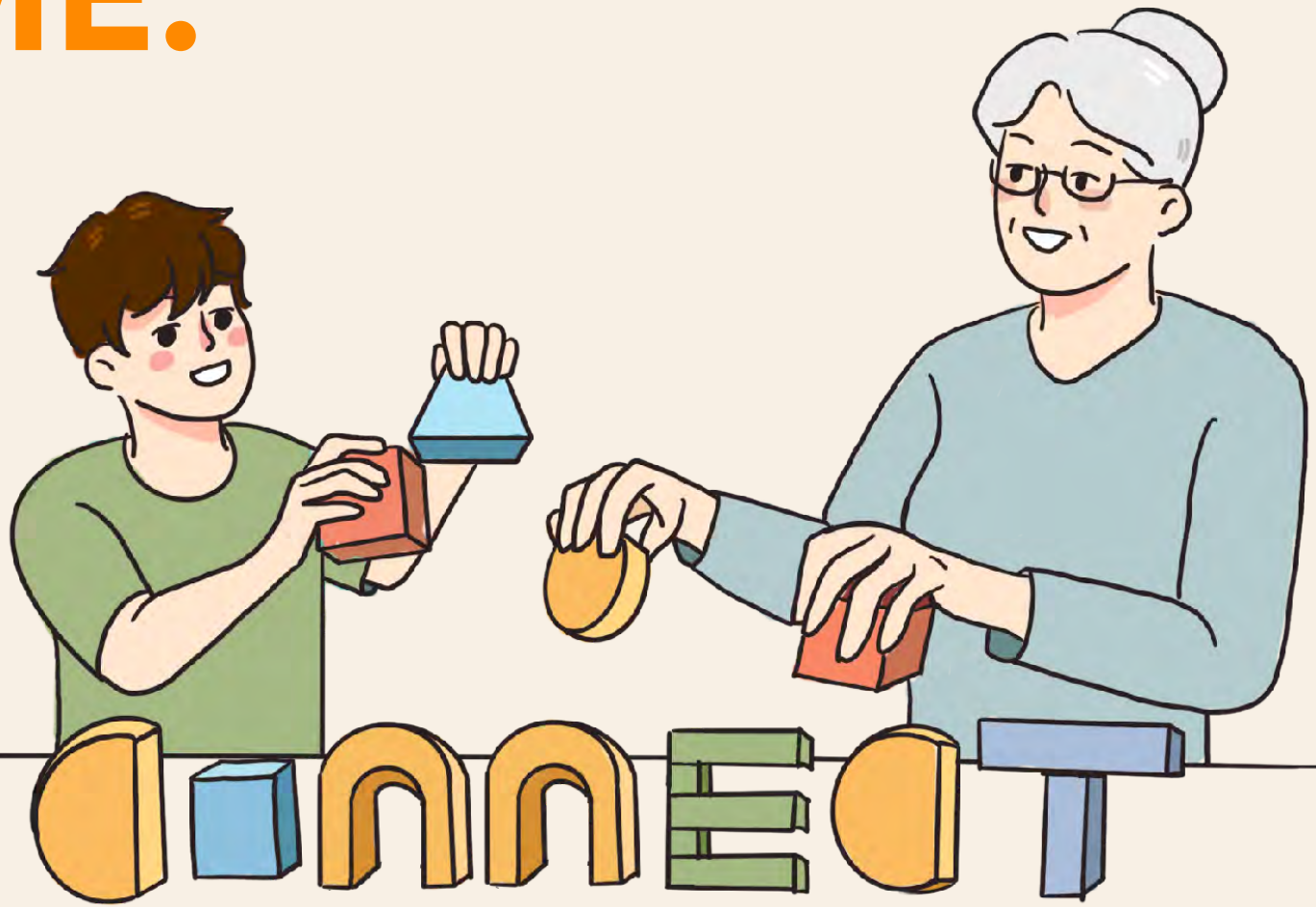
DESIGN FOR TOGETHERNESS AT HOME:

Integrating Technology to Bond Children and Grandparents Through Shared Experiences



Master's Graduation Thesis -
Hongxin Xu

Design for Togetherness at Home: Integrating Technology to Bond Children and Grandparents Through Shared Experiences

Master's Graduation Thesis
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Education
MSc. Design For Interaction
Faculty of Industrial Design Engineering (IDE)
Delft University of Technology

Supervisory Team
Project Chair
Dr. Wilfred van der Vegte
Assistant Professor of Internet of Things, TU Delft

Project Mentor
Mathieu Gielen
Assistant Professor of Design for Children's Play, TU Delft

Author
Hongxin Xu

TU Delft

connect

Abstract

Strong intergenerational relationships can provide emotional support and stability for both grandparents and grandchildren. Technology tools have been proven to be beneficial in connecting grandchildren and grandparents. Prior work mainly examined how to use technology to connect children and their grandparents over a distance. Those collocated grandparents and grandchildren who keep regular physical contact are often neglected in the research.It is essential to understand technology's potential in bonding them in physical meet ups considering the trending of multigenerational families.

This graduation project aims to foster connectedness between children aged 8 to 12 and their collocated grandparents in the Netherlands through physical interactions. Adopting a holistic approach, we explored moments of togetherness, identifying desired qualities of these interactions and defining promising shared experiences for the future.

The research involves three phases of empirical investigations. This research begins by examining how technology could positively impact their bond. Using participatory cards during interviews, this phase captures participants' perspectives, employing mixed methods including sentiment analysis, group clustering, and thematic coding to identify key elements in shared activities that promote or impede intergenerational connectivity. This analysis informs a framework to guide the development of technology aimed at supporting connectivity. Next, the second phase, insights from two design workshops are synthesized into a series of design concepts, which are then visualized through storyboards. The final phase involves evaluating these concepts by presenting the storyboards to both experts and child-grandparent pairs. This step is intended to refine our understanding of how these technological solutions can be leveraged to strengthen family bonds.

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01

General Introduction

1.1 General Background

1.2 Understanding Intergenerational Dynamics

1.2.1 Technology's Role in Family relationships

1.2.2 Design Conceptualization

1.2.3 Solution Evaluation

Summary:

This chapter discussed the general background of this project as the importance of intergenerational connection. Later some problems of intergenerational relations were discussed and mapped out, a choice is made to focus on the aspects related to technology issues.

Chapter 1 General Introduction

1.1 General Background

Strong intergenerational relationships can provide emotional support and stability for both grandparents and grandchildren. For grandparents, this interaction can reduce feelings of loneliness and isolation, while grandchildren can benefit from the caring and guidance that grandparents often provide. Also, the family structure is gradually changing, factors such as economic pressures and the high cost of childcare and housing, have led many families to lean on grandparents for support, reversing the trend of the more isolated nuclear family unit.

In the United States, the share of the population living in multigenerational households has more than doubled, from 7% in 1971 to 18% in 2021 (Mitchell, 2022). A similar trend is observed in the UK, where multigenerational living is also increasing, with roughly 1.8 million multigenerational households in the UK, representing a sizeable increase since the turn of the century (Burgess & Muir, 2019). While no evident data is demonstrating the Netherlands is in the similar situation, some research and research mention that it would be an interesting trend in the future. For example, a special structure of house in the Netherlands called the “Kangaroo house”, typically combines a larger residential house with a smaller one where the parents of the owner live. (Kangaroo House, n.d.) According to news from NOS (NOS, 2023), 42 municipalities of the Netherlands are allowing the construction of pre-informal care homes, which is making separate small houses for senior parents to live in their children’s backyard. In such a context of modern societal dynamics, the relationship between grandparents and grandchildren has become increasingly important.

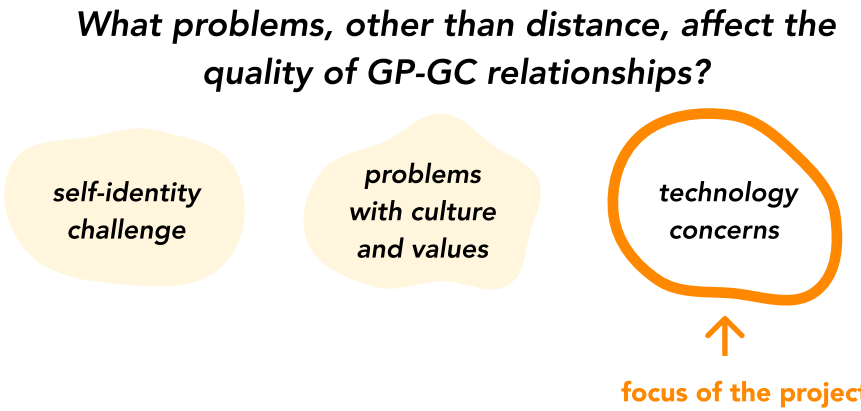
However, although this trend has brought more opportunities for child-grandparent contact, it does not guarantee a bond between grandparents and grandchildren since the quality and depth of interaction also determine the strength of these connections.

1.2 Understanding Intergenerational Dynamics

1.2.2 Overview of Challenges of Intergenerational Bond

Research indicates that geographic closeness is one of the strongest predictors of a close relationship between grandparents and grandchildren (Kalmijn, 2021). However, even when distance is not an issue, other challenges to generational bonding emerge in these collocated settings.

Extensive research has examined the dynamics between grandchildren and grandparents within shared households. Despite theoretical expectations of close relationships, numerous challenges arise, including caregiving tensions, issues with privacy and boundaries, lack of engagement, generational gaps, and discrepancies in culture and values. These issues will be elaborated on in Chapter 1.2.3 to Chapter 1.2.7. Notably, the predominance of studies in multigenerational households in Asia, Eastern Europe, and regions with Asian immigrants, shaped by cultural and traditional preferences, may not encompass the full spectrum of intergenerational challenges. However, these studies serve as a foundational basis, guiding our project's direction in identifying and addressing the challenges of intergenerational bonding.



Among these challenges, technology emerges as a particularly promising area for exploration, offering a new direction through this complex landscape. This potential has been identified as a central theme for investigation in this project.

1.2.3 Caregiving Tensions

When grandparents are involved in providing care to grandchildren, there may be clashes regarding parenting styles and disciplinary measures. This can create confusion and tension among family members, affecting their ability to feel connected and unified.

When it comes to parenting, there are multiple tensions present within multigenerational households. Grandparents who co-reside with their grandchildren often want to provide caregiving, as it brings them satisfaction and positive emotions (Villar et al., 2012). However, grandparents themselves may face identity conflicts by assuming roles as both grandparent and parent (Backhouse & Graham, 2011). Furthermore, conflicts can arise between grandparents and parents when they have divergent views on child discipline. Researchers in Hong Kong (Lo & Lindsay, 2022) found that grandparents may use mild force to discipline children when they misbehave, while parents do not accept physical punishment. Other disagreements have also been reported, such as those involving snacks, meals, screen time, and bedtime. (When Parents and Grandparents Disagree, 2020) Contradictory parenting styles or disciplinary methods can damage grandchildren's and grandparents' relationships (Li et al., 2019).

Sometimes, grandparents' health issues can become a source of tension. Grandchildren may feel resentful if they are expected to take on caregiving responsibilities, or they may not understand the limitations that come with aging.

According to research conducted by Chun and Lee (2006a), providing assistance to grandparents, such as caring for them in the hospital, can promote a positive relationship between grandparents and grandchildren. However, even if the grandchildren are not the primary caretakers when they live together, they may feel stress caring for their grandparents' illness.

1.2.4 Privacy and Boundaries

Younger members might be more connected online, which can conflict with the privacy expectations of older family members who are less accustomed to sharing information or photos on social media.

Grandparents may face the dilemma of “do not over-interfere” and “be there”. Grandparents should avoid being excessively involved or intrusive in the lives of their grandchildren or in the parenting decisions of their children. This means respecting boundaries and understanding that while their experience and advice can be valuable, they should not impose their views or methods to an extent that it becomes overbearing or controlling. On the other hand, "be there" suggests the importance of grandparents being present and available for their grandchildren. This involves offering support, love, and attention, and being an active part of their lives.

One common example is grandparents always concerned about their grandchildren’s safety and health. (Chun & Lee, 2006) So they express these concerns to grandchildren as “Don’t skip meals,” “Don’t be late,” “Don’t wear short skirts,” etc. However, grandchildren thought these concerns were excessive; they wanted more autonomy and could handle their own business. In that case, they wished their grandparents could respect their boundaries. If grandchildren and grandparents cannot reach an agreement, confusion about the perceived boundaries will occur, which will lead to tension. (Chun & Lee, 2006)

The opposite side of boundaries is Overdependence. If grandparents are the default caregivers when parents are busy or unavailable. (Tan et al., 2010)This could lead to an over-reliance on grandparents for childcare, homework help, etc. If grandparents are overly involved in daily responsibilities without clear boundaries, they might experience burnout, negatively affecting their health and well-being.

1.2.5 Deficient Engagement

Grandparents and grandchildren may have conflicting schedules, making it difficult to find a good time to spend together. Additionally, grandchildren may become frustrated if they are expected to spend a lot of time with their grandparents, particularly if they have busy schedules with school, friends, and extracurricular activities.

Öztürk et al. (2017) stated that the most common intergenerational activities were undertaken at home, with watching television together being the most popular. However, due to changes in entertainment preferences (e.g., young people tend to spend more time on social media platforms like Instagram, TikTok, or YouTube for entertainment), there may be fewer shared activities between grandparents and grandchildren.

1.2.6 Generational Gap

Grandparents might not understand the current trends, slang, or pop culture that is important to the grandchildren, leading to a disconnect and sometimes tensions as both sides struggle to relate to each other. Also, grandchildren have access to, and the ability to use, modern information and communication technology, while grandparents don't, which may also cause disconnected feelings between grandparents and grandchildren.

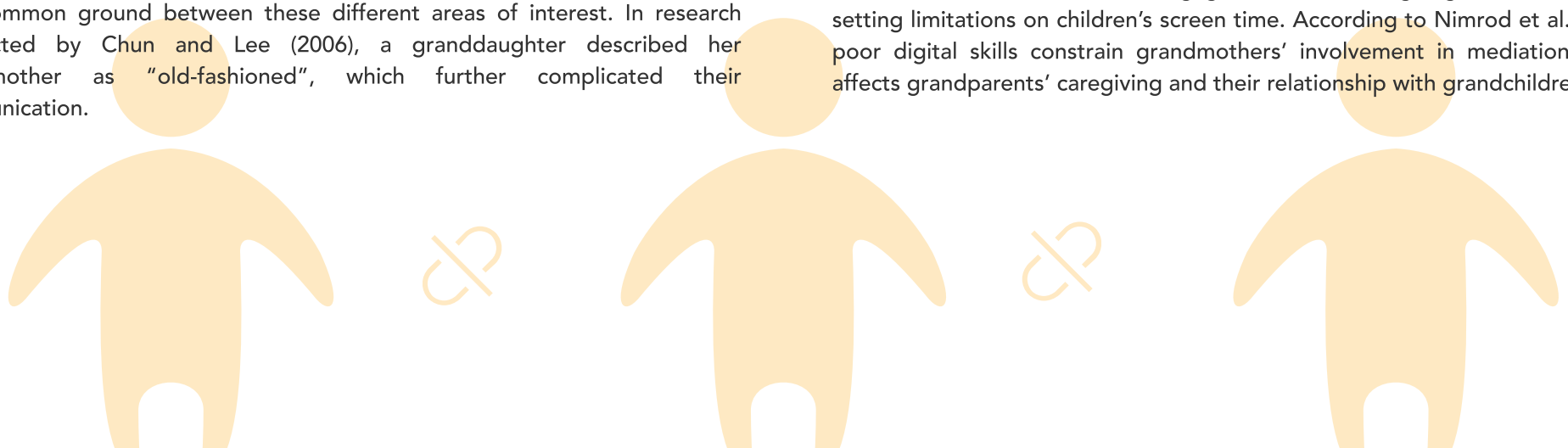
The generational gap is one of the primary reasons for intergenerational disconnect. Previous research has defined the largest generation gap as being between the Baby Boomer generation (classified as being born more or less between 1946 and 1964) and the Millennial generation (classified as being born more or less between 1980 and 2000) (Downs, 2019).

Grandparents and grandchildren prefer divergent communication methods. Grandparents love to talk to their grandchildren, regardless of the method (Hurme, 2010). Meanwhile, new generations, like Millennials, prefer texting and communicating over social media networking sites (Venter, 2017). This split in generations has caused a disconnect between grandparents and grandchildren.

Besides communication channels, content is also a key element in the generational gap. For example, young people often enjoy discussing the latest trends on social media platforms, new apps, video games, and other technology-related topics. On the other hand, grandparents often share stories from their past, family history, and personal experiences. It's hard for them to find common ground between these different areas of interest. In research conducted by Chun and Lee (2006), a granddaughter described her grandmother as "old-fashioned", which further complicated their communication.

Today's communication is heavily reliant on digital platforms. If grandparents are uncomfortable or unfamiliar with these platforms, it can lead to reduced communication. For example, grandchildren might use social media platforms like Instagram or Snapchat to share their life updates. If grandparents are not familiar with these platforms, they might miss out on these updates, leading to a sense of disconnection. Many activities, such as games, entertainment, and even learning, have moved online. If grandparents cannot participate in these activities due to the digital divide, it can lead to a sense of exclusion.

Wright et al. (2012) concluded that the shared interests in the computer program facilitated communication opportunities between grandparents and their grandchildren with autism, which validated that grandparents knowing modern technology is helpful for them in strengthening their relationships with their grandchildren. Sometimes grandchildren act as "teachers" or "instructors" in learning new technology for grandparents. Research suggests that older adults ask their family members, particularly grandchildren, to support them using new technologies. (Portz et al., 2019) However, if grandparents constantly depend on their grandchildren to operate and understand digital devices and platforms, it can lead to feelings of frustration and inadequacy for the grandparents and impatience for the grandchildren. For example, a grandparent might need help with using a smartphone, setting up an email account, or troubleshooting a computer issue, which can become a source of tension if the grandchild becomes impatient or the grandparent feels embarrassed about their lack of knowledge. Another case is that grandparents have to be involved in mediating grandchildren using digital media, mainly setting limitations on children's screen time. According to Nimrod et al. (2020), poor digital skills constrain grandmothers' involvement in mediation, which affects grandparents' caregiving and their relationship with grandchildren.



1.2.7 Cultural and Value Discrepancies

In some families, grandparents might have immigrated from a different country and hold on to cultural traditions that the grandchildren, who are more assimilated, do not connect with or understand. Due to the different societal contexts in which people were raised, it's normal for grandparents and grandchildren to hold different beliefs and opinions. This can potentially lead to conflicts.

The first apparent problem regarding cultural differences is the language barrier, which is common in immigrant families. In an interview conducted by Chun and Lee (2006), grandparents and grandchildren frequently mentioned the language barrier. One grandmother stated, "When she [her granddaughter] speaks English, I feel distance from her." Grandchildren also expressed that they cannot fully communicate with their grandparents.

Multigenerational families are prevalent in East Asia areas and it has been the tradition of this region. When these families expat to Western countries, they are still likely to keep the living pattern. Tradition is highly valued in these families, particularly in terms of filial piety (Liu et al., 2000). Grandparents expect their grandchildren to obey their advice or direction because they have more life experience than the children. However, grandchildren raised in Western culture prefer more equal relationships than hierarchical ones. This can cause conflicts between grandparents and grandchildren.

Conflicts can arise from differences in social norms and values between generations. For instance, younger generations may view tattoos and piercings as commonplace, while older generations may disapprove of body modification. Discrepancies in values, such as career choices, can also cause tension. Grandparents may prioritize job stability, making it difficult for them to comprehend a grandchild's decision to leave a stable job to pursue entrepreneurship, switch careers, or take a gap year. Additionally, if a grandchild identifies as LGBTQ+, their grandparent may have trouble understanding or accepting it due to traditional views on gender and sexuality, which can strain their relationship (Ryan et al., 2010).

A large topic is political beliefs; old people might tend to be more conservative, while young people have more liberal opinions. For instance, they may have differing views on climate change policies, where the grandchild advocates for aggressive environmental protections, while the grandparent might prioritize economic concerns. This could lead to disagreements during discussions about current events or policies. The same situation applies to other policies, Hess et al. (2016) conducted research, and the result shows that compared to the spending preferences of the younger generation, older people are more likely to support increased spending for old age at the expense of educational spending. While this apparently does not fit with young people's benefit.

1.2.8 Conclusions

To conclude, grandparents and grandchildren in a collocation setting might experience problems with caregiving tensions, privacy and boundaries, inefficient engagement, generational gaps, and cultural discrepancies. By looking into this summary, we can capture some factors playing a crucial role (as Figure 1):

Self-Identity Challenges: Dual caregiving roles can cause tensions from differing parenting approaches, complicating the establishment of boundaries and autonomy, leading to stress and potential relationship strain for grandparents.

Problems with Culture and Values: Diverse backgrounds or immigration introduce language barriers and cultural misunderstandings, fueling disagreements on life choices and societal expectations.

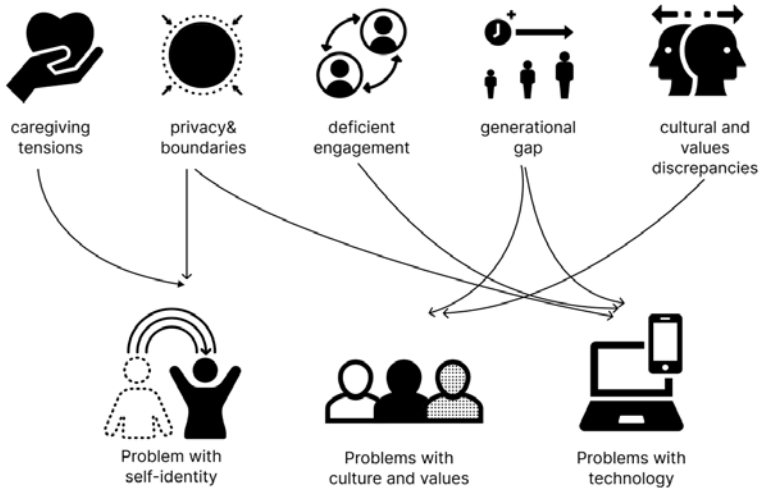


Figure 1. Three categories of intergenerational problems. icons from Noun Project, edited by the author

Technology Concerns: Social media and digital platform use highlight privacy concerns and generational divides in sharing preferences. Differences in communication styles (face-to-face vs. digital) and content interests exacerbate disconnects, often due to grandparents' lesser familiarity with modern digital environments.

The first two categories are more complicated and intertwined: caregiving dynamics and boundary issues reflect complex family roles and expectations, necessitating nuanced, long-term adjustments in family dynamics. Bridging cultural and value gaps requires a deep respect for diversity and evolves slowly, as these are embedded in deeply held beliefs and traditions. While the third one focus on technology, although it's evident that technology have sometimes contributed to communication divides within families, particularly between different generations. However, if properly utilized, it can enhance intergenerational communication and learning.

After evaluating the three key dimensions, we have identified that focusing on issues related to technology use between grandparents and grandchildren in collocated settings holds significant promise. Nonetheless, it remains essential to continually incorporate considerations of identity, and cultural and value discrepancies, in the development of these technological interventions. By doing so, we can ensure that the solutions are not only relevant to the problems related to technology but also address the underlying cultural and value-based causes.

02

Project Overview

2.1 Research Goals

2.2 Project Structure

2.2.1 From Technology Impacts to Shared Experiences

2.2.2 Design Conceptualization

2.2.3 Solution Evaluation

2.3 Chapter Overview

Summary:

This chapter specify the scope of this project and the main research goal. Also, it details the project structure, which encompasses three major phases. Next, a journey map is presented to provide a clearer overview of the project.

Chapter 2 Project Overview

2.1 Research Goals

Technology can shape family interactions and communications in various ways, thus affecting connectedness among family members. Digital technology's role in fostering family relationships, particularly between children and grandparents, is increasingly recognized. Research indicates that both groups perceive significant benefits in using technological devices for connection, primarily through calls and video meetings (Aponte, 2009; Baldassar et al., 2016). Researchers are actively exploring the use of technology to bond children and grandparents, using it as a tool for engagement and creating meaningful experiences (Derboven et al., 2011; Davis et al., 2008; Azadeh Forghani et al., 2018; Wallbaum et al., 2018). However, some of these studies also address the possible disruptive impact of technology on family dynamics (Barrie et al., 2019).

Despite the development of numerous technologies for long-distance engagement between children and grandparents (Derboven et al., 2011; Azadeh Forghani et al., 2018; Wallbaum et al., 2018; Barrie et al., 2019), research on their application in face-to-face interactions is limited. This study aims to understand the perceptions and experiences of both children and grandparents in contexts of physical interactions, emphasizing the importance of comprehending technology's role in family dynamics and its influence on intergenerational connections. Understanding how technology can enhance bonding in face-to-face interactions between these generations remains underexplored. this research aims at understanding children's as well as grandparents' needs in such specific contexts.

Main Research Question

How can technology be designed to strengthen the connectedness between children and their grandparents in the Netherlands during physical meet-ups?

2.2 Project Structure

To address the overarching research question, this master's graduation project consisted of a series of empirical investigations. In detail, the project followed a logical sequence of three main phases that were interconnected and generated generalized knowledge and insights in the field. In short, the three phases refer to 1. Understanding key factors of technology's positive influence on family bonds, 2. Conceptualizating design proposals to support child-grandparent interactions 3. Evaluating design concepts.

2.2.1 From Technology Impacts to Shared Experiences

Technology's roles are explored through a two-step literature review. In first step, shared experiences (activities) is discovered to be positively correlated with enhanced bonds. After that, another review is conducted to map out the existing forms of technology and the experiences they aim to facilitate. At the end, a set of participatory card was invented to inspire interviewees to share their past experiences and attitudes. The results of the interview provide the foundation for the development of a design framework.

2.2.2 Conceptualization of Design Proposals

Using the interview results from last phase as a guide, a series of inspirational concepts for connecting children and grandparents at home are generated. They are visualized through the form of storyboards with generative AI.

2.2.3 Solution Evaluation

In the final phase, these concepts are evaluated firstly by experts in related areas. After expert's selection, four ultimate concepts are presented to real family users (grandparent-grandchild dyads). This step is intended to refine our understanding of how these technological solutions can be leveraged to strengthen family bonds.

Phase in this Project	Research Questions	Research Activities	Methodology	Deliverable
Phase 1.1 Understanding Technology's Role In Family Activity	**Central Research Questions:** *RQ1: How does technology impact the collocated GP-GC relationship?* ↓ *RQ2: What kind of co-use technology is used to facilitate the GP-GC relationship? What kind of shared experience do researchers aim to facilitate?*	Desk Research	Scoping Review	Participatory Tool-Activity Cards
Phase 1.2 Understanding Users' Needs And Values In Shared Experiences	**Central Research Question:** *RQ3: What shared experiences are favored by children and grandparents?* *RQ4: What underlying factors within these activities influence their intergenerational connectedness?*	Semi-Structured Interviews (With Grandparents And Grandchildren) Sentiment Analysis Qualitative Data Analysis (Group Clustering, Thematic Analysis)	Participatory Design Content Analysis	Grandparents/Grandchildren Attitude Tables Theme Clusterings Of Factors That Affect Intergenerational Bonding Design Guidelines For Creating Shared Experiences
Phase 2 Developing Design Proposals	**Central Research Question:** *RQ5: How can technology be integrated into shared experiences to enhance intergenerational bonding?*	Co-Creation Sessions Incorporation Of Ideas Into Design Proposals	Research Through Design	8 Design Proposals (Storyboards)
Phase 3 Concept Evaluation And Testing	**Central Research Question:** *RQ6: How can we evaluate to what extent the newly designed concepts could facilitate bonding between grandparents and grandchildren during face-to-face interactions?*	Design Evaluation Sessions With Experts Design Evaluation Sessions With GP-GC Pairs Qualitative Data Analysis With Thematic Analysis		Validated Evaluation Criteria Cardsets

Table 1. An overview of the project structure

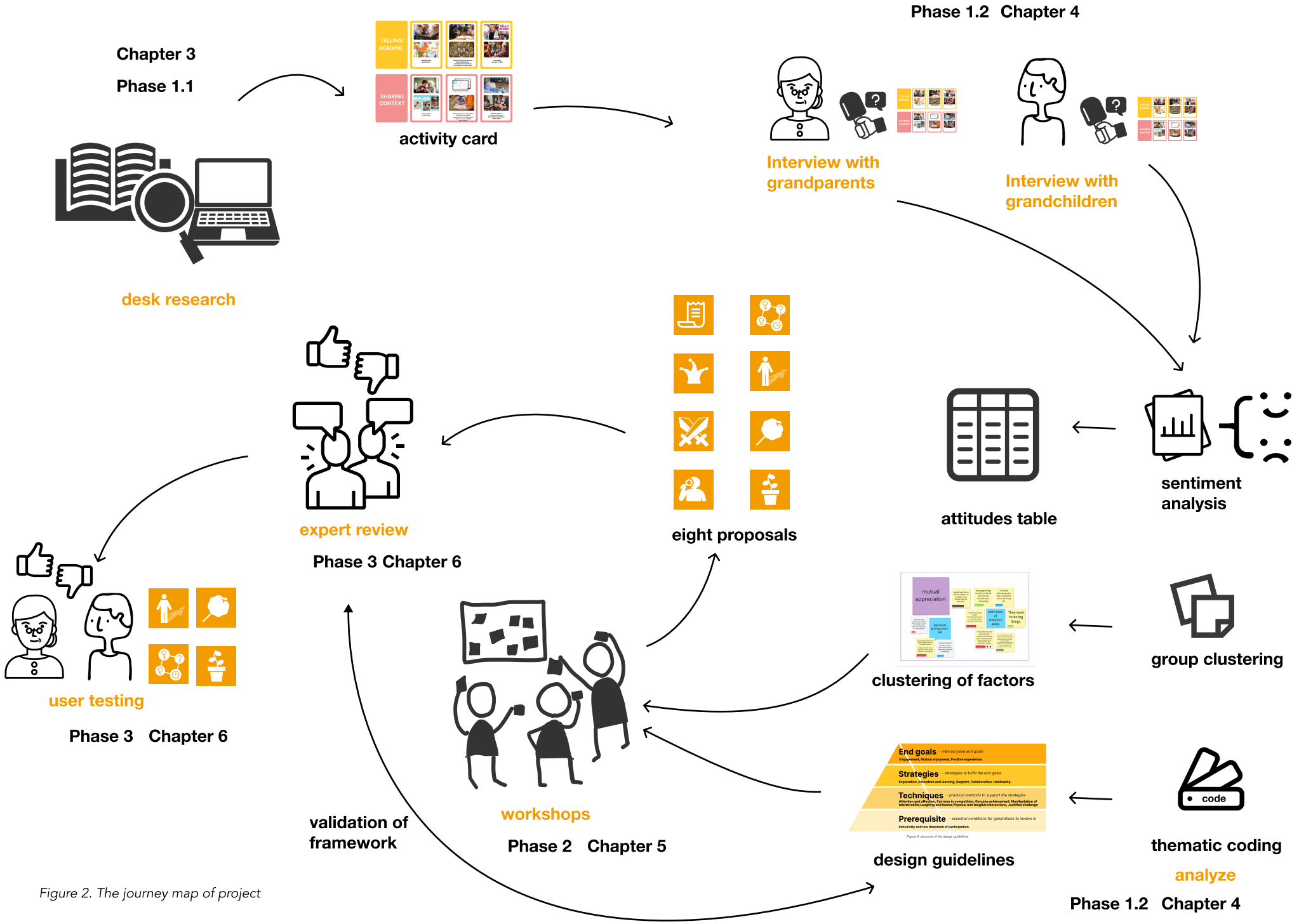


Figure 2. The journey map of project

2.3 Chapter Overview

To obtain a clear grasp of the thesis, a journey map (Figure 2) is provided that visually depicts the alignment between the different phases of investigation carried out in the project and the corresponding chapters in the thesis. This section offers a brief text summary of the upcoming chapters to clarify how the project unfolds.

Chapter 3 explores the relationship between technology and family connectivity through a two-step literature review. The initial segment provides a broad overview, which directs the subsequent research towards a more detailed and focused investigation. Section 3.1 examines the impact of technology on intergenerational dynamics. Section 3.2 delves into the specific applications of technology and the shared experiences they facilitate.

With the end of the literature review, Chapter 4 focuses on refining the design space from the broader concept of shared experiences to specific focal points by conducting interviews with target users. Section 4.1 outlines the development of activity cards employed as prompts during the interviews. Section 4.2 elaborates on the execution of the interviews. This is followed by Section 4.3, presenting a combined analysis methods, including sentiment analysis, group clustering and thematic coding, they respectively produced the attitude table showing preferences of the activity type of both age groups, clusterings of factors affecting intergenerational bonding and a four-layer structured design guides.

Chapter described Phase 2, which aims to incorporate factors that affection intergenerational bonding into designs, and generate a set of design proposals.ection 5.1 and 5.2 details the co-creation activities that served as the primary ideation method. Finally, Section 5.4 introduced the process of using generative AI to further develop ideas into storyboards. Finally, 8 design proposals in the form of storyboards are presented.

Chapter 6 provides a detailed report on the evaluation sessions conducted in Phase 3 of the project. Experts invloved in first to review the design proposals presented in the previous chapter, they (1)provide scores and rankings to concepts (2) give their feedback on each concept (3)validated the design guidelines. Grandchild-grandparent pairs evaluated selected concepts and give their feedbacks. All the feedback on each proposal is organized in a systematic manner to provide comprehensive insights into its (1) positive aspects, (2) points of concern, and (2) design suggestions for further development.

Chapter 7 aims to conduct a comprehensive evaluation of the project process and examine the contribution as well as the limitation of this master's graduation project. Section 7.1 focuses on the discussion of how the deliverables from each of the three investigation phases address their corresponding research questions. Subsequently, Section 7.2 discusses the contributions of the final deliverables in detail, covering both the theoretical and practical implications. Next, Section 7.3 discusses the limitations of this project. Finally, recommendations for future research work will be proposed in Section 7.4.

03

Technology's Role in Family Connectivity

Summary:

This chapter explores the relationship between technology and family connectivity through a two-step literature review. The initial segment provides a broad overview, which directs the subsequent research towards a more detailed and focused investigation.

The organization of the chapter is as follows: Section 3.1 examines the impact of technology on intergenerational dynamics. Section 3.2 delves into the specific applications of technology and the shared experiences they facilitate.

3.1 Technology's impacts on GP-GC relationship

3.1.1 Positive roles

3.1.2 Negative roles

3.2 technology applications to engage children and grandparents in shared activities

Chapter 3 Technology's Role in Family Connectivity

3.1 Technology's impacts on GP-GC relationship

As highlighted in Chapter 2, technology between grandparents and grandchildren are the primary focus of this project. We aim to foster connectedness between grandparents and grandchildren in a specific context of face-to face setting. Before that, it's important to understand technology's role in family dynamics and how it can shape intergenerational connections.

In this section, we center our inquiry around the research question: How does technology affect the relationship between collocated grandparents (GPs) and grandchildren (GCs)?

3.1.1 Positive Roles

Family members utilize devices for communication, activity coordination, and content sharing, enhancing interaction quality (Aponte, 2009). Specifically for the elderly, connecting with family via technology significantly improves life quality and reduces loneliness (Freeman et al., 2020). In familial contexts, co-viewing media andc o-playing video games are linked with heightened relationship satisfaction and closeness (Padilla-Walker et al., 2012; Williams & Merten, 2011; Wang et al., 2018). Moreover, when grandparents face challenges in using digital devices, seeking assistance from younger family members fosters closer bonds. These younger members are often perceived as 'warm experts,' and this intergenerational learning process strengthens family connections (Nimrod et al., 2020).

3.1.2 Negative Roles

Differing communication tool preferences can create friction within families. Young people often favor social networking services for sharing personal content, while older adults generally prefer direct conversation or phone calls (Muñoz et al., 2015). Studies have highlighted frustrations, such as a mother's annoyance at receiving only text messages instead of calls from her son (Barrie et al., 2019), and parents' concerns about children prioritizing social media over family time (Barrie et al., 2019). Family events like dinners often illustrate these tensions, with children absorbed in mobile devices, contrasting with parents' desires for family engagement.

Families engage in 'mediation' to negotiate technology use rules. While parents typically feel responsible for regulating children's technology use, grandparents also actively participate in regulating their grandchildren's media consumption (Nimrod et al., 2020).These negotiations can lead to tensions, especially regarding content safety and time management. Elders' lack of technical skills sometimes prevents them from recognizing online dangers (Barrie et al., 2019), and disagreements about the appropriate level of restriction can cause conflict. Furthermore, inappropriate mediation methods, like taking devices away or cutting off power, can exacerbate tensions.

Grandparents also experience communication challenges with younger family members due to unfamiliar technology language(Nimrod et al., 2020). While some feel outdated by not understanding this 'specific language,'When older adults face difficulties with digital devices, it can result in anxiety and confusion, particularly when family members express frustration or continuously assist them (Nimrod et al., 2020).

Despite growing concerns that technology use may negatively impact family relationships, the specifics of how it influences intergenerational dynamics remain unclear. To address this, Tammisalo and Rotkirch (2022) classified technology use into four categories: (a) individual use of technology tools; (b) techno ference, or the use of technology for personal reasons in the presence of family members; (c) technology-mediated communication among family members; and (d) collaborative/collective technology use within the family. Their research found that only the co-use of technology in families consistently led to positive impacts.

The exploration of technology's role in grandchildren-grandparents relationships reveals that its most beneficial application lies in the collaborative use of information and communication technology (ICT). This co-use aligns closely with the concept of building shared experiences, which are instrumental in fostering strong, positive relationships between grandparents and grandchildren.

QUICK OVERVIEW

stay connected

more communication and interactions about technology

Positive impacts of technology

Preference of technology use
Disrupting family interactions and family gatherings
"Restriction" on technology use
Understanding specific language
Low digital skills

Negative impacts of technology

Figure 3. Technology's impact on GP-GC relationship, illustration from Storyset by Freepik, edited by the author

"only co-use of the technology is clearly associated with positive outcomes"

→

RQ2: What kind of co-use technology is used to facilitate the GP-GC relationship? What kind of shared experience do researchers aim to facilitate?

3.2 Technology Applications to Engage Children and Grandparents in Shared Activities

In exploring the facilitation of grandparent-grandchild (GP-GC) relationships through co-use technology, this section provides an overview of the current design and research landscape. It maps out existing projects that aim to bond children and grandparents, categorizing them by the types of shared experiences they foster and the technologies they utilize.

RQ2: What kind of co-use technology is used to facilitate the GP-GC relationship? What kind of shared experience do researchers aim to facilitate?

3.2.1 Identifying Relevant Studies

To answer this question, another literature review is conducted. It specifically targets the technology domain in fostering grandparents-grandchildren connectedness utilizing Google Scholar and Scopus. Key terms related to the topic were defined as below. Sample search string: "older adult*" AND Youth* AND Technolog*.

children	***software***	***device***
youth*	***intergeneration****	***technology****
grandchild*	***relations***	***computer***
aged	***"social media"***	***application***
senior*	***"cross-generational"***	***intervention***
child*	***connect****	***technolog****
grandparent*	***communication****	***digital***

Inclusion criteria

- Published in the English language
- Contained people aged below 21 and those over 50 years of age
- Peer-reviewed primary research (e.g. journal and conference publications)
- Design or use of technology with the specific intention of fostering connectivity between grandparents and grandchildren

Exclusion criteria

- Programs or interventions where the design or use of technology was not a focus (e.g. summer camps, mixed residences, etc.)
- Literature, scoping, systematic and other reviews.

3.2.2 Results of the Review

For each selected study, critical metrics were extracted from the publications, including the strategy behind the technology (its nature and the mechanisms through which it facilitates connections between grandparents and grandchildren), the types of shared experiences it enables, and the maturity level of the product. Additionally, to augment comprehension, images of the products (if there is one) were incorporated, providing a visual aid to better understand the technological solutions discussed in these studies.

Authors/Pictorial Description	Strategy Of Technology	Practices Of Shared Experience	Maturity Of The Product
 Vanden Abeele & De Schutter. (2010)	Four selected mini-games from Mario party 8 with respect to three design rational: enactive interaction, competition, accerleration, which stimulate intergenerational play.	Digital Multi-player games	existing product on market
Amaro et al. (2016)	A drawing app called NotesHD was provided to grandmother and granddaughter, interactions and communications about building their family tree is the main activity during the engagement session.	Drawing Family history	existing product on market
 Wallbaum et al. (2018)	StoryBox, a tangible device that allows sharing photos, tangible artifacts, and audio recordings of everyday life. It facilitate children to actively sharing their drawings and handwritings and creatings to their grandparents.	Drawing Creating Sharing personal life	experimental prototype
 Forghani et al. (2018)	G2G is a calendar sharing system that providing grandparents and grandchildren with an awareness of each other's lives to support conversations.	Sharing agenda	experimental prototype

Authors/Pictorial Description	Strategy Of Technology	Practices Of Shared Experience	Maturity Of The Product
 Vutborg et al. (2010)	This device is to provide conversation context for grandparents and grandchildren by combing story books (on left) and drawing (blank area). Also photos can be shared to facilitate the conversation.	Storytelling Sharing photos	experimental prototype
 Carlsson et al. (2017)	eBee is a game that integrates quilting and so circuits with the goal of bridging the disparate communities of making and crating through intergenerational play.	Board game	experimental prototype
 Cerezo and Blasco (2019)	The intergenerational experience carried out in an Interactive Space where tangible and gestures interaction are used to participate in pervasive gaming experiences.	Digital Multi-player game	experimental prototype
 Wei et al. (2023)	The VR platform provide participants with various activities such as playing pingpong, chatting, showing emotional expressions	VR game	experimental prototype

Authors/Pictorial Description	Strategy Of Technology	Practices Of Shared Experience	Maturity Of The Product
 Davis et al. (2008)	The Magic Box is cultural probe which is used to transport gifts between grandparents and grandchildren.	Sharing family history Sharing food	experimental prototype
 Derboven et al. (2011)	The game is a “shopping game”, in which the players have to memorize items on a common shopping list and put them in shopping cart.	Brain training/ memory game	experimental prototype
 Gomes et al. (2018)	ViseuInterAgeStories Project promote intergenerational collaborative interaction by gather children and elderly to create collaboratively stories about places of their city.	Drawing Creating stories	experimental prototype
 Lankes et al. (2018)	Co-smonauts is an intergenerational collaborative co-located game installation for a museum context foster the social exchange between old and young	Digital multi- player game	experimental prototype

Authors/Pictorial Description	Strategy Of Technology	Practices Of Shared Experience	Maturity Of The Product
Morganti et al. (2016)	a website designed to support intergenerational reminiscence. The website allows older persons to capture, digitally archive, and share their memories encapsulated in letters, newspaper clippings, postcards, photos and videos to children.	telling personal experiences	experimental prototype
 Qiu et al. (2023)	coroot is a collaborative planting system which allows young people and their grandparents to water each other's vegetables at a distance and to harvest ripe vegetables through collaborative watering	Gardening	experimental prototype
 Zargham et al. (2015)	This is an ambient photo display that allows a small group of users to keep in touch through a kind of visual twitter feed of concurrent photographs from their mobile phones	Sharing photos	experimental prototype
Pedell et al. (2014)	Three Technology Probes were used to facilitate intergenerational fun interactions: collage showing photographs and text messages. Electronic Magic Box letting participants to play a maze game. Storytelling support creation besides e-books of storybook.	Sharing photos Storytelling Game	experimental prototype

Table 2. An overview of existed applications to foster intergenerational connectivity

3.2.3 Conclusions

The form of the game has been widely used to facilitate meaningful interactions between children and grandparents. De Schutter and Vanden Abeele (2010) tested four selected mini games from Mario Party 8 and formulated three design rationales: enactive interaction, competition, and acceleration, which stimulate intergenerational play. Carlsson et al. (2017)designed a game that integrates quilting and circuits to bridge the disparate communities of making and creating through intergenerational play. Cerezo and Ana Cristina Blasco (2019) designed the intergenerational experience carried out in an interactive space where tangible and gesture interaction is used to participate in pervasive gaming experiences. Lankes et al. (2018) developed Cosmonauts, which is an intergenerational collaborative co-located game installation for a museum context to foster the social exchange between old and young. The potential of using VR games to engage children and grandparents is also explored, Wei et al. (2023) described a VR platform that could provide participants with various activities such as playing ping-pong games.

Besides games, another occurring topic is sharing and exchanging. Wallbaum et al. (2018) introduced StoryBox, a tangible device that allows the sharing of photos, tangible artifacts, and audio recordings of everyday life. It facilitates children to actively share their drawings handwritings and creatings with their grandparents. G2G (Azadeh Forghani et al., 2018) is a calendar-sharing system that provides grandparents and grandchildren with an awareness of each other's lives to support conversations. Davis et al. (2008) tested the magic box that could "transport" gifts between grandparents and grandchildren. Zargham et al. (2015) presented an ambient photo display that allows a small group of users to keep in touch through a kind of visual Twitter feed of concurrent photographs from their mobile phones.

Telling stories, including family stories is also a popular form to connect children and grandparents. Amaro et al. (2016) discovered that when a drawing app NotesHD was provided to grandmother and granddaughter, interactions and communications about building their family tree were the main activity during the engagement session. Vutborg et al. (2010) proposed a design that uses drawing and photo sharing to facilitate fun conversations between children and grandparents during storytelling activities.

Morganti et al. (2016) provided a website designed to support intergenerational reminiscence. The website allows older persons to capture, digitally archive, and share their memories encapsulated in letters, newspaper clippings, postcards, photos, and videos with children. Besides these activities, some other designs tried to involve children and grandparents in other ways such as drawing (Cristina Azevedo Gomes et al., 2018), gardening (Qiu et al., 2023), and building blocks (Evropi Stefanidi et al., 2023).

These studies offer important insights into activities that facilitate bonding between children and grandparents, particularly through the use of new technologies. However, they primarily address challenges related to geographical distance and overlook the dynamics of children and grandparents who are in close proximity and engage in physical interactions. Moreover, while technology often seeks to augment traditional shared activities such as storytelling, its success depends on the users' intrinsic interest in these activities. If children and grandparents do not inherently enjoy storytelling, then technologically augmenting this activity may not effectively strengthen their bond. It is essential to consider whether the activity itself- regardless of technological enhancement- resonates with children and grandparents.Understanding user preferences for shared experiences and the underlying motivations enables the identification of opportunities for meaningful technology integration in intergenerational interactions.

Our research focused on understanding how design can facilitate bonding between children and grandparents in face-to-face settings through meaningful shared experiences. We aim to answer the following research questions in next phase:

RQ3: What shared experiences are favored by children and grandparents?

04

Interview and Analysis

4.1 Development of the Activity Cards

4.2 Users' Interview with Children and Grandparents

4.3 Mixed Analysis Methods

- 4.2.1 Sentiment analysis
- 4.2.2 Group Clustering
- 4.3.3 Thematic analysis

4.3 mixed analysis methods

- 4.3.1 Attitudes towards activities
- 4.3.1 Factors
- 4.3.2 Design guidelines

4.5 Conclusions

Summary:

This chapter focuses on refining the design space from the broader concept of shared experiences to specific focal points by conducting interviews with target users.

The chapter is organized as follows: Section 4.1 outlines the development of activity cards employed as prompts during the interviews. Section 4.2 elaborates on the execution of the interviews. This is followed by Section 4.3, which introduces a mixed-methods analysis approach. The chapter concludes with the presentation of the interview results and key findings.

Chapter 4 Interview and Analysis

4.1 Development of the Activity Cards

Getting insights from 3.2.3, we know that assessing the inherent appeal of activities for both children and grandparents is crucial. By grasping user preferences and motivations for shared experiences, we can pinpoint where technology can enrich intergenerational engagement meaningfully. In this section, a framework categorizing activity types based on existing literature on how technology facilitates connections between children and grandparents is defined.

RQ3: What shared experiences are favored by children and grandparents?

Our categorization process, drawing inspiration from Pedell et al.'s in-situ observations, focuses on understanding key elements of shared grandparent-grandchild experiences [33]. Five primary goals emerged from Pedell et al.'s structure of intergenerational fun: play, gift, show and tell, look and read, and communication. Recognizing the variability in these categories, from specific (e.g., show and tell) to broad (e.g., play), we ensured a comparable level of abstraction in our thematic analysis. This approach led to the identification of four key themes: Game, Telling/Reading, Making/Creating, and Sharing Context.

Game: Emphasizes playful, cognitive interactions suitable for all ages, enhancing teamwork and competition.

Telling/Reading: Focuses on narrative activities, fostering emotional connections and family history awareness.

Making/Creating: Involves joint creative investments, from crafts to cooking, producing tangible results of collaboration.

Sharing Context: Pertains to sharing everyday life aspects, strengthening presence awareness and connectedness.

Theme	Activities
Game	• Board games/Cardgames • Digitalmulti-player game • Mixed reality game • Brain training game
Telling/Reading	• Reading books • Telling family stories/ personal experience • Storytelling
Making/Creating	• Drawing/Handcraft • Building projects • Cooking • Gardening
Sharing context	• Sharing photos • Sharing agenda • Sharing personal environments/spaces

Table 3. Activity types and themes

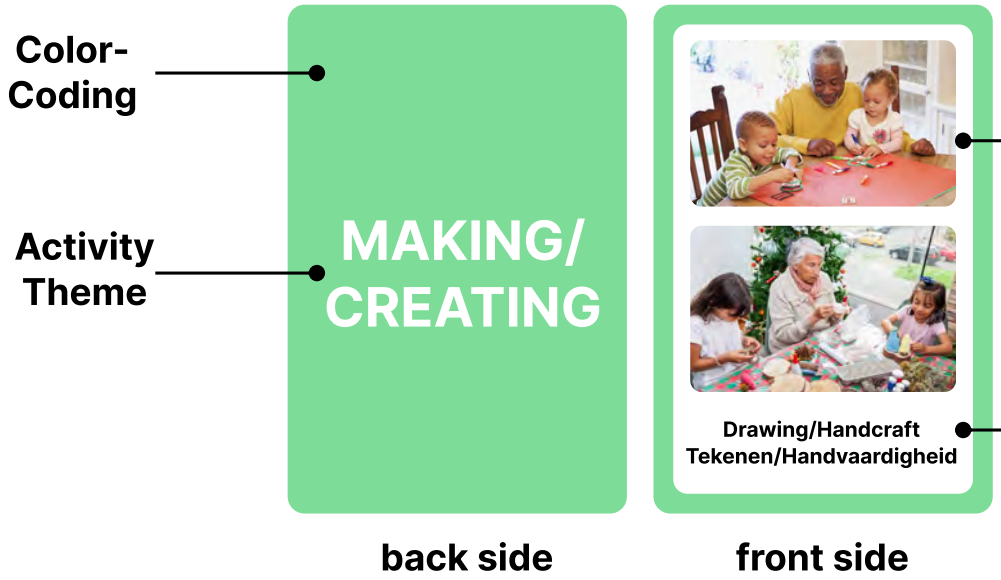
Four overarching themes were identified, under which a total of 14 distinct activities were selected and categorized to align with these themes (Table 3). These shared activities were also collected from the literature, and we found that most studies apply technology in home settings. The gap we defined is how to connect children with their grandparents in physical meet ups. Although in reality, it involves outdoor activities, we decided to focus on home-based activities to maintain a clear research direction and foundation.

To answer RQ3, conducting interviews are key process, through which we can gain direct insights from both groups. Chapter 4.2 will detail this segment. From previous design experience, using tools or props in the interview can significantly help in facilitating the process, especially with children and elderly groups. Providing some visual stimuli would be a good way to make the interview more engaging and less formal, thereby encouraging openness and ease of conversation. Besides, it can ensure that each interview covers a consistent set of topics, making the data more uniform and comparable across different interviews.

To aid interviews, each card was designed with specific features for ease of use (Figure 4). In the end, a set of 14 activity cards (Figure 5) were designed and printed out as interview prompts.

Cards are color-coded to represent four activity categories, allowing for quick identification.

The theme shows which the category that activity belongs to.



Cards feature real-life photos of grandparents and grandchildren, focusing discussions on their activities and providing context for interviewees to share experiences.

Each card includes activity names in both English and Dutch, to make sure that participants can have a good understanding of the activity.

Figure 4. example of the design of activity card

Figure 5. overview of the activity card set used in interview

4.2 Users' Interview with Children and Grandparents

To move from theory to practice, it is imperative to gain a more nuanced understanding of the actual needs, preferences, and challenges experienced by these target groups. This understanding is crucial in identifying potential areas for improvement and innovation within the design space. Consequently, conducting interviews emerges as a necessary step in this process. We aim to answer these two questions with the interview process:

RQ3: What shared experiences are favored by children and grandparents?

RQ4: What underlying factors within these activities influence their intergenerational connectedness?

4.2.1 Designing Interview Questions

We have two main goals in this step 1. Knowing their preference and emotions for the activities. 2. Finding underlying factors that improve/hinder the shared experience. We developed questions from four aspects: activity reflection, emotional reflection, suggestions and improvements.

Here is the questions taking example from the children's side, grandparent will be asking the same question.

1 Activity Reflection

Can you describe the scenarios that you do this activity with your grandparents?

2 Emotional Reflection

How did doing the activity make you feel? What is your favorite part about doing this activity with your grandparents? Why? (e.g. we can communicate, i can learn something, just accompany or being there)

3 Suggestions

If you have a superpower or magic, how would you like to use it in the activity to make you like doing it more with your grandparents?

4 Connectedness

How close do you feel when you are doing this activity with your grandparents? why?

Figure 6. emocard used in the interviews

In conjunction with the primary questions posed for each activity card, our approach includes a set of questions designed to gather basic information, focusing primarily on the duration and frequency of interactions between grandparents and grandchildren. Additionally, supplementary questions are integrated to explore potential activities that may not be represented in the cards. This comprehensive approach ensures a thorough exploration of the grandparent-grandchild relationship dynamic. The complete list of questions, encompassing both the main and supplementary queries, is available for detailed review in Appendix A of this report.

To enhance the depth of understanding in our interviews, emotion cards (Desmet, 2003) were introduced to assist interviewees in articulating their feelings towards various activities. This addition was prompted by insights gathered from a pilot test, where we discovered participants to describe their emotions in limited terms, predominantly as "happy" or "excited."

The introduction of emotion cards serves as a reference, particularly designed to facilitate a more nuanced expression of feelings and emotions among interviewees, especially children. These cards (Figure 6) provide a range of emotional descriptors, offering participants a broader vocabulary to accurately convey their experiences.

4.2.2 Recruiting Participants

Due to the time and language constraints, we decided to split the interview process into the grandparents group and the children group. Given the rarity of cohabiting grandparents and grandchildren in the Netherlands, we focused on participants living nearby with frequent visits. Interviews were conducted individually for recruiting and scheduling ease. The choice to define the children's age group from 8 to 12 is underpinned by several reasons:

Communication Skills: By ages 8 to 12, most children have developed a level of communication skills that allows them to articulate their experiences, feelings, and ideas more clearly, providing richer data during interviews.

Cognitive Development: Children within this age possess the cognitive abilities to follow complex instructions, engage in structured games, and understand the nuances of shared activities, which qualifies them as suitable candidates for this study.

Children from 8 to 12 also can represent the group that this study aims at as they are in "middle childhood". This stage is a transitional period, by focusing on children in middle childhood, the project aims to post long-lasting effect for intergenerational connections.

4.2.3 Interviewing Children and Grandparents

We recruited 5 grandparents (all grandmothers aged 55-78, median age 68) through local association networks, and 5 children (ages 9-11, three girls and two boys) from local primary school. The study focus on children aged 8-12 and grandparents maintaining frequent contact. Each participant, fitting the criteria of regular visits with their grandchild or grandparent living in the Netherlands, was interviewed individually for 40-50 minutes.

The Interviews started with an Introduction to the research context, providing participants a brief summary followed by initial questions. These questions explored the regularity and nature of interactions between children and grandparents, such as the frequency and duration of their meetings, and the common spaces where they spend time together.

Upon gathering initial information, participants were introduced to a set of activity cards depicting shared activities between children and grandparents. These were presented randomly to reduce bias and maintain participant engagement. For each card, four questions were posed: first, participants recounted scenarios where they engaged in the depicted activity. Then, using emocard as a reference, they reflected on their emotions during these activities. Follow-up questions explored the reasons behind these feelings and their favorite aspects of the activity. Then, using emocard as a

reference, they reflected on their emotions during these activities. Follow-up questions explored the reasons behind these feelings and their favorite aspects of the activity. After this question, the interviewer encouraged participants to envision changes to the activity for greater enjoyment, asking them to use their imagination as if they had superpowers or magical abilities. This was designed to uncover their hidden desires and needs within the shared experiences. Following these reflections, supplementary questions explored activities not represented on the cards and inquired about any difficulties encountered during these activities. This interview session was approved by the Human Research Ethical Committee of TUDelft.

4.3 Mixed Analysis Methods

Our research seeks to discern participants' preferences for shared activity types and identify the factors that influence intergenerational connectedness. Additionally, we aim to determine how technology can be effectively incorporated into these shared experiences between generations. Sentiment analysis, employing the Text mining add-on of the Orange data mining software package1, provides a quantitative measure to assess emotional appreciation of activity types. It alone could not capture the nuanced reasons behind these emotions. Group clustering and qualitative coding, on the other hand, offered complementary insights. The former research seeks to discern participants' preferences for shared activity types and identify the factors that influence intergenerational allows for the exploration of themes in participants' narratives, highlighting factors that influence intergenerational connectedness. The latter, through Atlas.ti software affords a more granular examination of the data, revealing intricate patterns and relationships between codes related to elements that contribute to successful bonding. By understanding these elements, we can better determine how to integrate technology into shared experiences in a way that resonates with both children and grandparents, enhancing their connection. Each of the 10 interviews was audio-recorded, with subsequent transcription of the recordings. In the first round of analysis, the author extracted all relevant quotes pertaining to a specific activity from the established framework and then organized them under the corresponding activity types. This"complete" version of text was used in group clustering and qualitative coding.However, for sentiment analysis, we selectively retained quotes specifically expressing feelings and emotions about the activities to mitigate bias from leading questions. Quotes reflecting positive emotions based on hypothetical enhancements to activities were excluded to ensure authenticity in sentiment representation.

4.3.2 Sentiment Analysis

Sentiment analysis was used to quantify the text data of participants' attitudes from interviews towards shared activities on a negative-positive spectrum ranging from -100 to +100, using the Multilingual Sentiment lexicon (Cerezo & Ana Cristina Blasco, 2019) of the Sentiment Analysis widget in the Orange data mining software. The input is the selective data of text from interviews, the preprocessing and model training for sentiment analysis were automated within the software and give out the outcome in value form. In the outcomes, positive values indicate stronger positive emotions, while negative values suggest stronger negative emotions.

4.3.2 Group Clustering

Group clustering involved a thematic analysis conducted by three TUD IDE design students (including the author). Each quote was placed at the center of a Post-it note with an activity-type tag at the bottom. The text was divided into thirds, with each student creating Post-its for one section. After an initial round of independent clustering, students exchanged sections to review and add potentially overlooked insightful quotes.

The clustering process is It's a bit more open variety of thematic clustering, where quotes that describe similar or related topics are brought together, and overarching, more global or abstract meanings are formulated.

[1]https://orangedatamining.com/

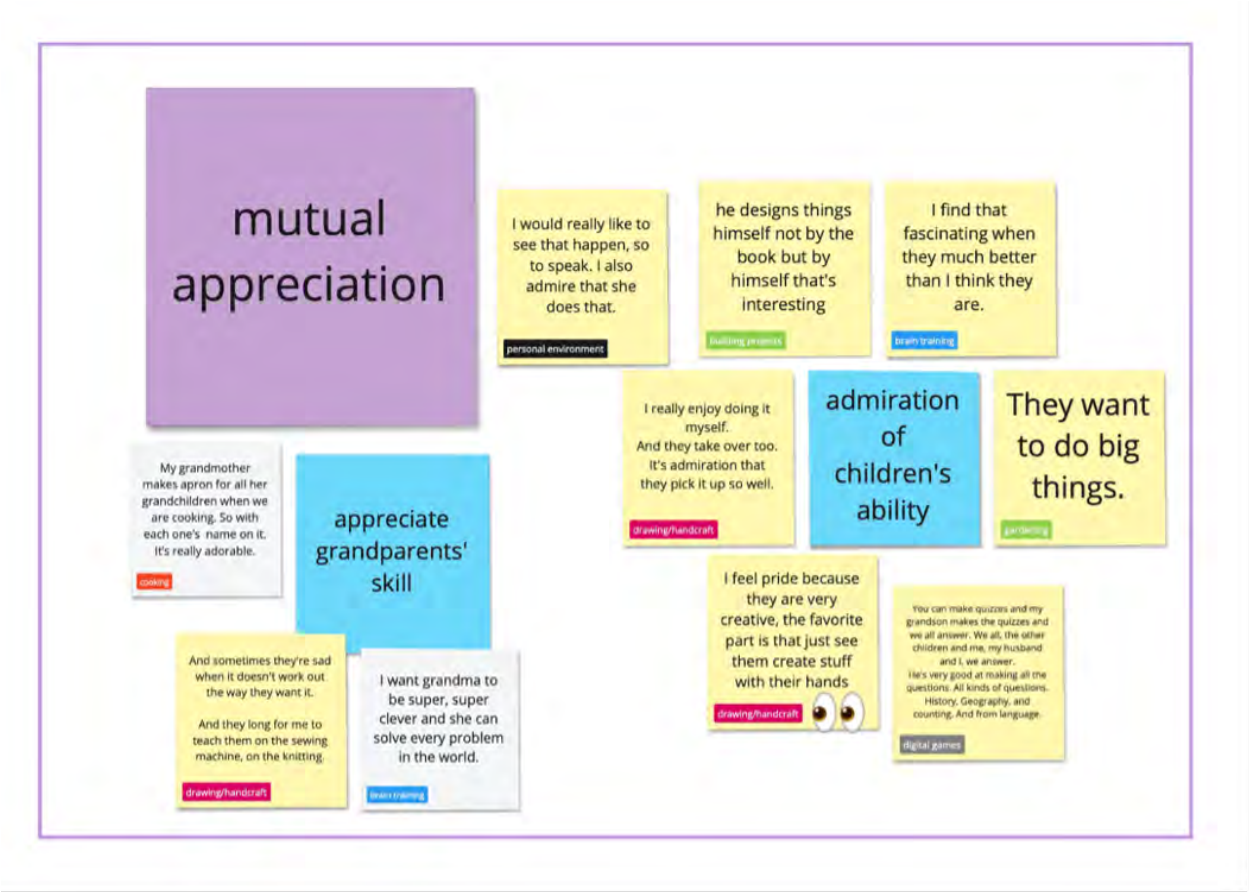


Figure 7: example of group clustering result

In Figure 7, yellow stickers show grandparents' quotes and white show grandchildren's quotes. Blue stickers were used to initially group related quotes, which were then further aggregated into meta-themes represented by a larger purple sticker. These meta-themes, being more abstract, capture overarching concepts, such as the positive impact of mutual appreciation during shared activities, which facilitates connection between grandparents and grandchildren. Full results of group clustering can be found in appendix A.

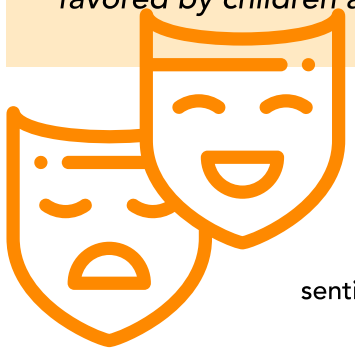
4.3.2 Thematic Analysis

We took an inductive approach (Tammisalo & Rotkirch, 2022) to develop codes from the interview data using Atlas.ti software. Table 4 shows the code schemes. The author initially analyzed the texts from interviews, assigning codes, which were then reviewed by two TUD IDE designers. A total of 362 codes (including the reoccurring ones) were defined and grouped into 22 code themes). Throughout this process, the relationships between codes were defined and refined, arriving at a structured framework that serves as a guideline for designing shared experiences for children and grandparents.

Code themes	Codes	Quotes
Attention and affection	Grandparental affection	*Grandparent P2: "Kids are Very happy and very clever, and the other one, a little less, but in her way, in his way, just as lovely."*
	Attention from grandparents	*Grandchild P3 :"Sometimes I don't really understand it and I can't start and my grandma starts doing her own stuff."*
	Recognition from children	*Grandparent P2: "I'm proud that they try it(sewing). It's my thing and they want it to be their thing."*
	Shared emotional experience	*Grandchild P3 :"I can tell when something really nice happens at school I tell them when I do reading or cooking."*

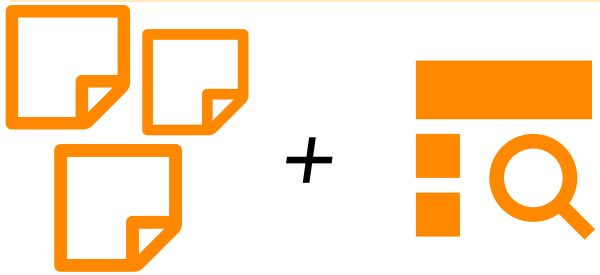
Table 4: Example of coding schemes

RQ3: What shared experiences are favored by children and grandparents?



sentiment analysis is applied to answer RQ3.

RQ4: What underlying factors within these activities influence their intergenerational connectedness?



group clustering plus thematic analysis are applied to answer RQ4.

QUICK OVERVIEW

4.4 Findings From the Analysis

4.4.1. Attitudes Towards Activity Types (Sentiment Analysis)

The dataset encompasses sentiment values from 10 participants across 13 activities, including a total of 130 data points. Due to the participants' lack of experience with VR/AR games and the associated difficulty in imagining this activity, VR/AR games were excluded from the analysis owing to insufficient data. All of the value has been rounded to two decimals and the activity followed the order of high to small.

The mean sentiment value, calculated as the arithmetic average of all sentiment scores for each activity, serves as an indicator of the general sentiment towards that activity. Children's preferences greatly vary from grandparents' preferences. For instance, grandparents like telling stories, including family stories better (Table. 5), while children like games and cooking with grandparents (Table 6).

Rank	Activity	Sentiment Score –Grandparents
1	Storytelling	7.64
2	Family stories	6.73
3	Drawing/handcraft	6.52
4	Gardening	4.99
5	Brain training games	4.47
6	Personal environment	4.38
7	Agenda	4.08
8	Cooking	3.76
9	Sharing photos	3.66
10	Board/ Card games	2.96
11	Reading	2.86
12	Digital games	2.81
13	Building projects	0.67

Table 5: Sentiment value of grandparents' group

Rank	Activity	Sentiment Score –Grandchildren
1	Cooking	6.81
2	Brain training games	6.58
3	Board/Card games	6.19
4	Gardening	5.42
5	Drawing/handcraft	5.25
6	Building projects	5.22
7	Family stories	5.10
8	Agenda	4.28
9	Digital games	2.89
10	Reading	2.71
11	Sharing photos	2.33
12	Personal environment	2.17
13	Storytelling	1.25

Table 6: Sentiment value of childrens' group

The mean sentiment value for each activity, combining scores from both grandparents and grandchildren, is reflected in Sentiment-avg (Average sentiment). It serves as an indicator of overall sentiment across generations. (Table. 7). Activities like 'Family stories' and 'Drawing/handcraft' rank high in average sentiment, indicating their popularity among both groups. Conversely, 'Reading' and 'Digital games' show lower averages, possibly reflecting less engagement or appeal.

We also determined the variance in absolute difference between sentiment in children and grandparents for each activity (sentiment difference, Table 8) Notable divergences in children's attitudes towards storytelling and building projects with grandparents suggest a potential attitude gap. Conversely, sentiments regarding digital games and reading are consistent across both groups.

Rank	Activity	Sentiment Score – Average
1	Family stories	5.92
2	Drawing/handcraft	5.89
3	Brain training games	5.52
4	Cooking	5.28
5	Gardening	5.20
6	Board games	4.57
7	Storytelling	4.45
8	Agenda	4.18
9	Personal environment	3.27
10	Sharing photos	3.00
11	Building projects	2.94
12	Digital games	2.85
13	Reading	2.79

Table 7: Average sentiment value of each activity

Rank	Activity	Sentiment Score – Difference
1	Storytelling	6.39
2	Building projects	4.54
3	Board/Card games	3.24
4	Cooking	3.05
5	Personal environment	2.21
6	Brain training games	2.11
7	Family stories	1.64
8	Sharing photos	1.32
9	Drawing/handcraft	1.27
10	Gardening	0.43
11	Agenda	0.20
12	Reading	0.14
13	Digital games	0.08

Table 8: Value of sentiment difference of each activity

RQ3: What shared experiences are favored by children and grandparents?

The sentiment value tables show to group's attitude towards each activity, children's preferences greatly vary from grandparents' preferences. Children like cooking most, followed by physical games(board/card games and brain training games, grandparents like storytelling, no matter stories from books or sharing their family stories.

The sentiment analysis in our study indicates that there is no singular 'best' solution or a specific type of activity that universally enhances intergenerational connections. Given this complexity, it becomes imperative to correlate these findings with qualitative methods.

4.4.2 Why Do These Shared Activities Make Them Connected/Not Connected?

The results were based on the text (quotes from the interviews), unlike sentiment analysis using very specific filtered data (focusing solely on emotional responses), this result was based on the complete data version containing all relevant quotes pertaining to a specific activity. Full list will be shown in appendix X

Positive Factors

The listed positive factors are presented in order of their frequency of being mentioned by participants (number of post-its), reflecting their prominence in the shared experiences. Key positive factors in shared activities include a balance of interest, where grandparents often prioritize children's preferences while ensuring mutual enjoyment. Educational value is a significant consideration, with a focus on personal growth for children, who show keen interest in learning practical skills like cooking. Role definition within activities, allowing for individual contributions, is crucial. Emotional connection often transcends the activity itself, fostering mutual appreciation of skills and talents, leading to collaboration and assistance. Activities should be inclusive, catering to all ages, with an appropriate level of difficulty to maintain engagement without causing frustration. The overarching goal for both children and grandparents is to have engaging and enjoyable experiences.

"Grandparents often prioritize children's interests in shared activities, stating, ***'We do things that they like.'*** When necessary, they subtly guide activity selection to ensure both of them like the activity, as one grandparent put it, ***'Last time they wanted to go to swim, but I didn't like it, so I suggested we go to an amusing park.'***

A Balance of Interests

Grandparents view shared activities like reading, cooking, and gardening as vital for their grandchildren's character development, they also teach emotion management and resilience through games. Grandparents alway say: ***"Reading is very important for children"*** Conversely, children value learning practical skills through these activities, such as cooking, that extend beyond formal school education.

Educational Value

Joy and fulfillment are experienced by grandparents when they actively contribute and feel valued. **It's important that they can find their roles in the activity and contribute in their own ways.** Moreover, grandparents emphasize the importance of consistent attention from their grandchildren during these interactions.

Self-worth(Contribution)

In their shared experiences, both grandparents and grandchildren underscore the significance of ***"doing things together"***, highlighting the value of active collaboration in their interactions. Grandchildren show a distinct preference for activities that involve ***"action" or physical movement.***

Action and Collaboration

Both grandparents and grandchildren favor age-inclusive games, emphasizing the value of family-wide participation. These games must balance challenge and accessibility, fostering an environment of ***'fair competition' as perceived by the grandchildren***. One noted, ***"He is cheating, but it's also nice I like it"***, highlighting the importance of equitable play that equally distributes winning and losing, ensuring engagement and fairness.

Inclusive & Challenges

Negative Factors

The identified obstacles in grandparent-child connections are sequenced by the number of participant mentions (as indicated by the number of post-its), illustrating their negative impact on the quality of shared experiences. The primary obstacle in child-grandparent connections is incapability, often stemming from complex activity rules or procedures. Grandparents' lack of confidence, slower reaction times, and limited technology skills can lead to frustration, diminishing their participation. Children noted dissatisfaction with grandparents' passive involvement, they prefer more active and collaborative involvement from grandparents instead of just watching. The notion of 'fun' is crucial; children tend to disengage from activities they find boring. Additionally, generational differences in what is considered 'fun' pose challenges. Grandparents' attempts to suggest enjoyable activities sometimes miss the mark with children's entertainment preferences, leading to a disconnect. For instance, while grandparents find joy in collecting leaves to create art, children may perceive this activity as dull, leading to a lack of enjoyment and a diminished sense of connection during the experience. The participant said: "But sometimes it was not always fun, grandfather thinks it's fun to get the leaves and things like that but I don't think so." Time constraints also emerged as a factor impacting shared experiences, some activities take too long so there is not enough time for their shared involvement.

Children generally show a strong aversion to activities they perceive as boring, which consequently diminishes their motivation to participate in these activities with their grandparents.

A notable challenge arises from the ***differing perceptions of what constitutes "fun" between the two generations***. There are instances where grandparents, with the intention of proposing enjoyable activities, suggest ideas that do not align with the children's understanding of entertainment. The child said: ***"But sometimes it was not always fun, grandfather thinks it's fun to get the leaves and things like that but I don't think so.***"This discrepancy can lead to a disconnect, where the grandparents' well-intentioned proposals fail to resonate with the interests and preferences of the grandchildren.

Boring

Incapability, manifesting in various forms, significantly hinders the participation of both grandparents and grandchildren in shared activities. One such barrier arises from complex rules or procedures of games that prove too challenging for the participants. Additionally, factors such as ***grandparents' lack of confidence,*** lower reaction pace, and limited technology skills can lead to frustration, further discouraging their involvement.

Incapability

Concentration is crucial for successful grandparent-grandchild shared activities. Dissatisfaction arises among grandchildren when grandparents appear distracted, diminishing the interaction's quality. One grandkid said:" ***I don't like When I don't really understand it and I can't start and my grandma starts doing her own stuff."*** Grandchildren prefer their grandparents' active and engaged participation, they want grandparents being fully present and responsive during these activities.

Lack of Concentration

In child development, recognizing the dynamic nature of interests—shaped by e***volving personality, gender identity, and age—is key.*** This variability poses challenges in creating activities that cater to individual preferences and ensure engagement and effectiveness.

Dynamic of Interests

Children's desires for more frequent engagement face constraints like time availability, dependency on external conditions like weather, and the need to balance screen time with the rise of technology use. These factors are essential in planning and managing shared activities effectively.

Time/Frequency

4.4.2 Guidelines for Designing Shared Experiences that Effectively Connect Children and Grandparents

This analysis uses the same data of all relevant quotes pertaining to a specific activity but analyses it through thematic analysis, with a specific focus on elements that contribute to successful bonding.

During the coding process, themes were consistently labeled as nouns to maintain focus and facilitate grouping. Smaller code groups were merged into broader themes for clarity and coherence. For example, codes like 'emotional guidance,' 'encouragement,' 'patience understanding,' and 'supportive presence' were merged into a larger theme labeled 'Support.' Additionally, relationships between themes were carefully identified. For instance, the 'manifestation of talent/skills' theme was linked to 'genuine achievement,' illustrating how showcasing abilities contributes to positive experiences.

Themes were categorized into four layers according to the graph (Figure 8):

The framework's hierarchy is structured from the most fundamental to the most advanced levels of shared experience design (from bottom to top). The foundational layer sets prerequisites determining participant involvement. The technique layer outlines specific, actionable approaches. At the strategy level, the focus shifts to broader, more conceptual guidance for interaction design. Culminating at the top is the end goal layer, which articulates the desired outcome of the activity.

Figure 8. structure of the design guidelines

In order to offer more comprehensive insights and facilitate comprehension of the outcome derived from thematic coding, this section presents more codes and how they are categorized (Table 9 to Table 12).

Code themes	Codes	Quotes
Low threshold of participation	available resources	*"we don't have that much LEGO at our place for them." (GP2)*
	ease of doing	*"Yeah games for older kids it's hard. I can't really understand when they explain but then it's really hard to do it."(GP4)*
	limitatons of grandparents	*"he likes drawing, but I'm not a drawing. I'm not so good at it."(GP3)*

Table 9: Example of theme"low threshold of participation"

Code themes	Codes	Quotes
engagement	no boredom	*"But sometimes it was not always fun, grandfather thinks it's fun to get the leaves and things like that but I don't think so." (GC5)*
	immersive engagement	*"I like it when we are really getting into the games and we like it when we play it for a long time." (GC2)*
	visual engagement	*"when we are telling family stories, we use computers, the photo list, the digital ones." (GP5)*
	timeless appeal	*"they're all games from my children so it's games their parents used to play so I feel joy because i still see them enjoy a really old game that's like 25 years old." (GP3)*

Table 10: Example of theme"engagement"

Code themes	Codes	Quotes
support	balanced help to children	*"A little help to my granddaughter, but not too much." (GP5)*
	patience and understanding	*"And cooking, yes it's beautiful, when the cook is burnt, or It's too hard, but they'(grandkids)re preparing, that's the lovely thing." (GP2)*
	emotional guidance	*"We also really have to learn to cope with their crush" (GP3)*
	supportive presence	*"I am just sitting next to them to help them if they don't know how to go but they can do it all by themselves." (GP3)*

Table 11: Example of theme"support"

Code themes	Codes	Quotes
fairness in competition	perceived fairness of children	*"My granddaughter said why does grandma always win, it's not fair" (GP2)*
	mediating for fairness	*"I always seek for a balance between her and her brother, so I help her a little but not to much" (GP5)*
	feeling of competition	*"My favorite part is counting who wins" (GC1)*
	fairness	*"That is very frustrating for her if her brother always wins." (GP5)*

Table 12: Example of theme"fairness in competition"

prerequisite of the activities

This layer presents essential conditions for generations to involve in, it highlights the **inclusivity** and **low threshold of participation** as prerequisites for designing shared experiences for children and grandparents. While our focus was on children aged 8-12, it's common for others, such as siblings or parents, to participate. Hence, activities must accommodate a wide age range. Additionally, a low participation threshold is crucial; activities should be easily understandable for both children and grandparents and not require excessive resources. The 'difficulty' factor, frequently mentioned in interviews, underscores the need for activities to be accessible and manageable for all involved.

Examples of pictures showing related interaction qualities are introduced:

inclusivity

Figure 9: images showing inclusivity of the activities, from Shutterstocks and iStock

low threshold of participation

Figure 10: images showing low threshold participating of the activities, from Shutterstocks and iStock

Prerequisite *- essential conditions for generations to involve in*

inclusivity and low threshold of participation.

how to achieve: (technique level)

This layer provides corresponding approaches that could effectively facilitate interaction and thus support the strategies for achieving the end goal.

Attention and affection: children and grandparents both seek attention from the other side and want recognition, affection is a key component of emotional bonding.

Fairness in competition: When activities involve competition, perceived fairness is crucial. This ensures that both children and grandparents feel engaged and valued.

Manifestation of talents/skills: showing talent or skills provides a natural path towards collaboration or education.

Genuine achievement: activities that enable a sense of accomplishment, fostering pride and a shared sense of success, support the aforementioned strategies.

Laughing and humor: Incorporating elements of shared humor in activities can create a light-hearted atmosphere, encouraging joyful feelings.

Physical and tangible interactions: activities involving physical or tangible elements can strengthen the sense of physical togetherness and connection.

Justified challenge: Introducing appropriate challenges can increase engagement, especially when they are challenging enough to be engaging but not so difficult as to cause frustration.

Attention and affection

Figure 11: images showing attention and affection of the activities, from Alamy and iStock

Manifestation of talents/skills

Figure 12: images showing manifestation of talents/skills of the activities, from Alamy and Dreamstime

Fairness in competition

Figure 13: images showing fairness in competition of the activities, from Alamy, Adobe Stock and Dreamstime

Techniques *- practical methods to support the strategies*

Attention and affection, Fairness in competition, Genuine achievement, Manifestation of talents/skills,Laughing and humor,Physical and tangible interactions, Justified challenge

Genuine achievements

Figure 14: images showing genuine achievements of the activities, from iStock and Buffer

Physical and tangible interactions

Figure 15: images showing physical and tangible interactions of the activities, from Freeimages

Laughing and humor

Figure 16: images showing laughing and humor of the activities, from Shutterstock, iStock and Unsplash

Justified challenge

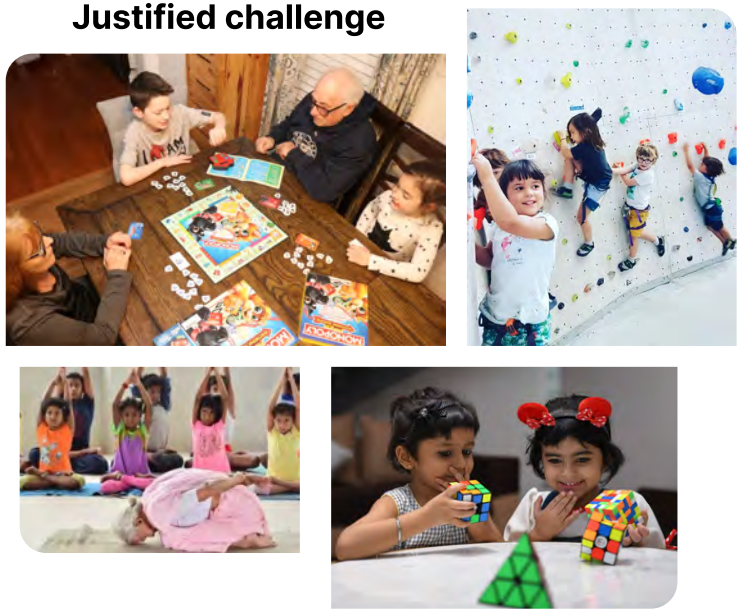


Figure 17: images showing justified Challenge of the activities, from iStock and getty images

Techniques *- practical methods to support the strategies*

Attention and affection, Fairness in competition, Genuine achievement, Manifestation of talents/skills,Laughing and humor,Physical and tangible interactions, Justified challenge

what to achieve (strategy level)

This layer provides strategies that, according to children and grandparents, could be employed in order to fulfill the intended end goal of fostering connectedness

Exploration: it can provide freedom of exploration area for children so they can fulfill their curiosity and willingness to discover.

Education and learning: providing mutual learning, skill sharing between children and grandparents.

Support: grandparents could support children as unintrusive guiding, emotional support, they also respect the autonomy of children so they make themselves available to give any level of support that children request.

Collaboration: children and grandparents can both invest and contribute in their own ways.

Habituality: children and grandparents love the interaction and it could be developed into a habit or ritual between them.

Exploration

Figure 18: images showing exploration of the activities, from Alamy and Shutterstock

Education and learning

Figure 19: images showing education and learning of the activities, from gettyimage

Support

Figure 20: images showing support of the activities, from iStock and Pexels

collaboration

Figure 21: images showing collaboration of the activities, from Shutterstock, gettyimage and alamy

Habituality

Figure 22: images showing habituality of the activities, from Alamy

Strategies *- strategies to fulfill the end goals*

Exploration, Education and learning, Support, Collaboration, Habituality.

end goal

This end goal is the overarching aim of the activities: bonding children and grandparents through shared experiences.

Engagement: Engaging activities capture the interest of both children and grandparents, maintaining their involvement and interaction throughout.

Mutual enjoyment: Activities that are enjoyable for both parties, for similar or different reasons. Mutual enjoyment is key to sustaining interest and fostering a positive relationship, ensuring that both children and grandparents look forward to these shared moments.

Positive experience: Activities that are designed to leave both children and grandparents with pleasant memories and a desire to engage in future interactions.

Engagement

Figure 23: images showing engagement of the activities, from Alamy and gettyimage

Mutual enjoyment

Figure 24: images showing inclusivity of the activities, from Shutterstock

Positive experience

Figure 25: images showing inclusivity of the activities, from Dreamstime

End goals *- main purpose and goals*

Engagement, Mutual enjoyment, Positive experience.

Design Vison

My design vision is to use technology to create engaging, mutually enjoyable, and positive shared experiences that support grandparents and grandchildren in strengthening their bonds during physical meet-ups. This experience can be achieved through techniques such as attention and affection, fairness in competition, manifestation of talents/skills, laughing and humor, physical and tangible interactions, and justified challenges, or strategies such as exploration, education and learning, collaboration, and habituality.

4.5 Conclusions

In this chapter, we observed conducted interview with target groups, by using activity cards as participatory tool, we investigated their attitudes toward various shared experiences. We found tension fields in these attitudes, with children preferring games and cooking while grandparents prefer telling stories. It provides a perspective that rises above the form of the activities but instead uncovers the underlying factors that contribute to children and grandparents feeling connected. This brings us to the second finding of key obstacles and enablers of shared experiences to child-grandparent connection. Finally, through the thematic coding process, the hierarchical system of potential prerequisites, strategies, and techniques toward achieving the end goal was mapped. This structured guidelines can serve as design inspiration as well as evaluation criteria in the later process.

05

Towards Design Proposals

5.1 Designers' Workshop

5.1.1 Workshop Material - Role Cards

5.1.2 Creative Session 1

5.2 Inverse Brainstorming

5.3 Conclusions

5.4 Presentation of Design Proposals

Summary:

This chapter described Phase 2, which aims to incorporate factors that affection intergenerational bonding into designs, and generate a set of design proposals.

The chapter is structured as follows: Section 5.1 and 5.2 details the co-creation activities that served as the primary ideation method. Finally, Section 5.4 introduced the process of using generative AI to further develop ideas into storyboards. Finally, 8 design proposals in the form of storyboards are presented.

Chapter 5 Towards design proposals

This chapter mainly outline the procedure of phase 2 of how might we apply the findings in last chapter, the factors that affection intergenerational bonding into designs. Our goal is to create successful bonding experience for grandparents and grandchildren.It's important to clarify that technology need not be the focal point of the design. Technology itself is not necessarily to be center of the design, in this project, technology can be interpreted as any type of devices or tool, regardless of technology complexity. The aim of mentioning technology here is that our research base is co-use of technology. This expression makes the research question more connected to main research question.

RQ5: How can technology be integrated into shared experiences to enhance intergenerational bonding?

In order to stimulate creativity, two different creative sessions with different participants were organized. The first session is a designers' workshop about finding design opportunities directly from obstacles and enablers of shared experiences, and the second session is focused on creating crazy, unconventional ideas for connectivity in the form of inverse brainstorming. All creative sessions took place between 5 to 14 December 2023. The following paragraphs will explain in detail how the two creative sessions are composed, which steps are exactly taken, and what results are delivered.

5.1 Designers' Workshop

5.1.1 Workshop Material - Role Cards

The analysis has yielded significant insights; however, for the purposes of a creative facilitation workshop, there remains a need for a more defined problem statement to guide designers. Utilizing the raw themes—positive and negative factors—extracted from group clustering is an impractical approach due to its complexity and the extensive time required to elucidate each finding.

To address this, a synthesized narrative has been constructed, framing the insights from the perspective of the roles that grandparents and grandchildren assume. This narrative offers a clear summary of the group clustering data, aiding designers in understanding the core issues. It enables quick grasp of the main points, focusing on the most significant challenges in intergenerational interactions.

Five grandparent roles—competitor, educator, helper/supporter, collaborator, observer—and three grandchild roles—initiator, explorer, evolver—have been defined and represented as role cards. These cards feature a title, explanation, simple visulas and quotes, providing designers with a clear understanding of each concept. Examples of these role cards are shown as below . Full role cards can be found in appendix B.

Grandparent as a competitor

When grandparents and grandchildren are gaming, they compete with each other and want to win the game.

The problem is that grandparents and grandchildren ***can not always land on the same level.*** When grandchildren are young, grandparents intentionally let kids win to make them happy, they kids grow older, they want grandparents to ***"fight for victory"*** but not ***"give it to them"***. Later, grandchildren pursue difficult games but grandparents ***"don't know how to play"*** so ***"it's less interesting for me"***

"I will let him win, that's what grandmas always do, you don't want to see the kid sad..."

"Now I have to fight (for victory)."

"Sometimes the game is too difficult, they want to force me to do it."

VS

Grandparent as a competitor

Grandchildren are attracted by novel ideas and activities. They mentioned that: It's pretty normal to share pictures so it's not special for me. But they like it when there is ***"fun and cool stuff"***.

They like to explore unique experiences. One grandma said every grandchild loves the idea of a special trip: "I told them by every birthday you have us together we go out for a special day." a boy said with grandparents ***he can do new things which he can't do with parents.***

" I like it when there are funny photos or cool photos."

"we're just going to stay up a tiny bit later when i am at home and we do fun stuff."

5.1.2 Creative Session 1

The first session took place in the afternoon of 5 December 2025 and lasted 2 hours as scheduled. As previously mentioned, this creative session was designed to ideate on how to connect grandparents and grandchildren through solving obstacles or enhancing enablers of their shared experiences, four MSc design students at TU Delft (including myself) participated in the first creative session and the participants were recruited based on their study background in design. The study backgrounds and current occupations of the participants are shown in Table 13.

Participant	Study Background	Current occupations
P1	MSc. Design for Interaction	MSc Student
P2	MSc. Strategic Product Design	Recent Graduate
P3	MSc. Integrated Product Design	Recent Graduate
P4	MSc. Design for Interaction	Graduate Student (me)

Table 13: Participants of Creative Session 1

The session process was set up based the model of creative diamond 2.0 proposed by Heijne and Van der Meer (2019) (Figure 26).

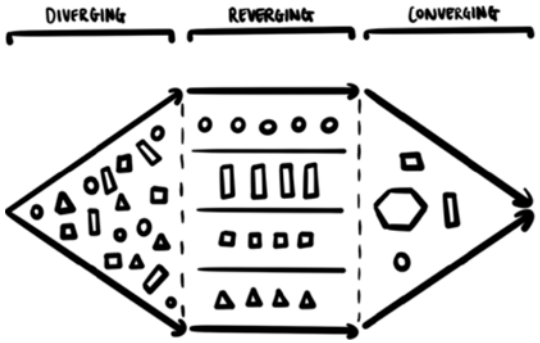


Figure 26: The Model of Creative Diamond 2.0 (Heijne & Van der Meer, 2019)

Setting Up

Prior to the creative exercise, participants were carefully briefed about the graduation project and were allowed to ask any questions to clear up any doubts. After the briefing, each participant was given the 8 role cards to help them quickly capture the core issues, the full stack of group clustering result is also provided in case they want to have a further and detailed check.

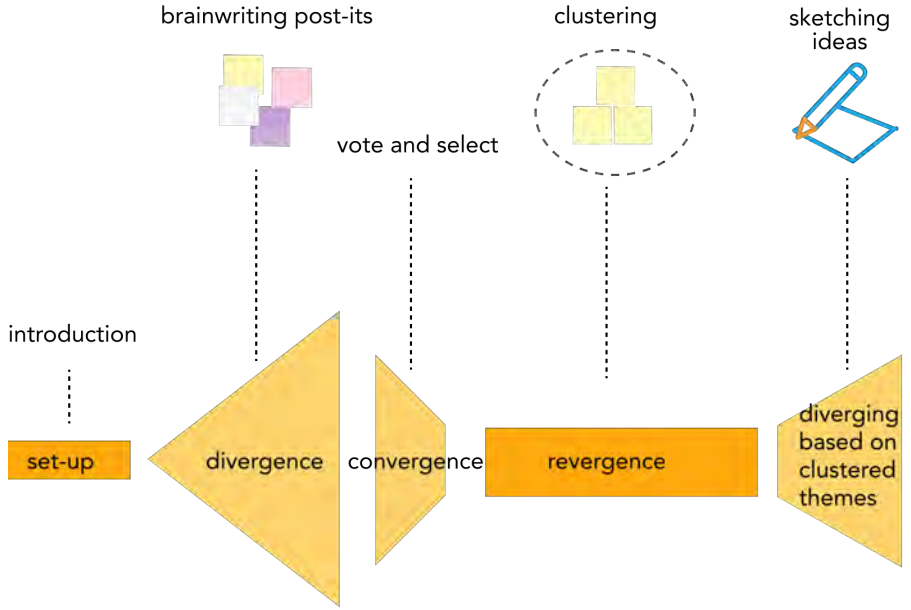


Figure 27: An overview of the creative session process

Diverging

In the first part, designers tried to explore new directions, altering the general question of "how to connect grandparents and grandchildren through shared experience?" into more inspiring, guiding ones such as "How might we transform familiar elements into new and unique experiences, thereby creating fresh opportunities?" For each role card, designers took 3-5 mins to brainwrite with Post-Its (Heijne & Van der Meer, 2019).

After brainwriting for each role card, participants take turns to explain their thoughts and what could be new and inspiring direction for the idea generation phase. During these process, some rough and vague ideas already popped up. While one person was presenting ideas/questions, the others were encouraged to jot down new ideas once they were inspired by the newly shared thoughts.

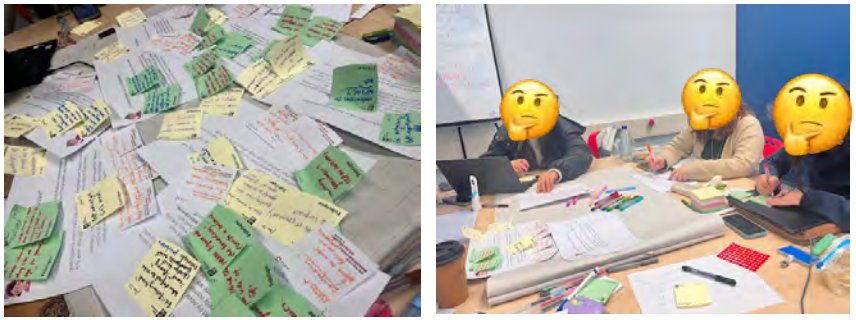


Figure 28: Photo taken during the first creative session

Reverging

According to Heijne and Van der Meer (2019), "revergence" refers to an extra sub-step after diverging ideas, which introduces activities as a kind of mental pause to look at all the options and produce a systematic overview (Figure 9). In this session, the technique chosen to reverge ideas is Spontaneous Clustering (Heijne & Van der Meer, 2019), which asks participants to cluster all the emerged ideas into five to seven groups of comparable options.

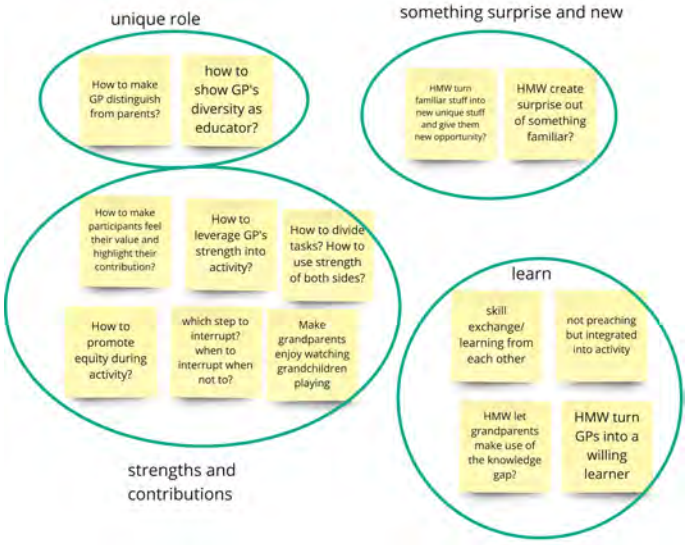


Figure 29: Photo taken during the first creative session

Idea Sketching

In the last stage, four themes emerged from Spontaneous Clustering (Figure 29). Designers are required to brainstorm with the direction of each theme provided. There are in total four rounds of idea sketching, each round lasted about 8-10 mins. At the end, participants take turns to introduce their sketches to others.

5.2 Inverse Brainstorming

Following a standard design workshop that yielded conventional ideas, an additional workshop was conducted employing the technique of inverse brainstorming. This technique allows designers to come up with unusual ideas by inverting the current situation. This session took place in the afternoon of 14 December 2023 and lasted around 1.5 hours, three MSc design students at TU Delft (including myself) participated in this session. It is worth noting that the other two participants besides me were completely different from the previous session. The study backgrounds and current occupations of the participants are displayed in Table 14.

Participant	Study Background	Current occupations
P1	MSc. Design for Interaction	Recent Graduate
P2	MSc. Strategic Product Design	Recent Graduate
P3	MSc. Design for Interaction	Graduate Student (me)

Table 14: Participants of inverse brainstorm

Following the structure of brainstorming (provided by Co-design with kids toolkit from TU Delft), questions such as "What are the typical interactions in current shared activities?" and "What do these activities typically look like?" were asked, and from these responses, a list of 'normal words' was documented.

The next phase involved generating the inverse of each listed word, thereby creating an 'inverse word list.' This list then served as a creative springboard, guiding participants to conceive innovative ideas. The purpose of using these inverse words was to stimulate unconventional thinking, with the ultimate goal of developing activities that enhance the connection between grandparents and grandchildren. This approach ensured a departure from standard ideas, fostering a more creative and out-of-the-box ideation process.

normal words		Inversed words
expertise	⟷	noval/beginner
things already known	⟷	things out of perception
talk	⟷	silent
safe environment	⟷	dangerous environment
multiple people	⟷	single/ one pair of people
shared task	⟷	different goal
listen to each other	⟷	ignore each other
showing strengths	⟷	showing weakness
funny moments	⟷	serious moments
engaging atmosphere	⟷	distracting atmosphere
familiar environment	⟷	new environment
grandchildren know what to do	⟷	guess what to do
require attention	⟷	avoid attention
be winner	⟷	be loser
help each other	⟷	make “trouble” to each other
facilitate learning	⟷	interrupt learning
useful knowledge	⟷	useless knowledge
meaningful	⟷	meaningless
normal	⟷	untraditional
compulsory	⟷	optional
in control	⟷	out of control
relaxing	⟷	nervous
definite outcome	⟷	open-end
unequal role	⟷	equal role

Table 15: Normal words and inversed words

5.3 Conclusions

Based on the results of two creative sessions (designers' workshop and inverse brainstorm) we collected a series of ideas. To enhance visualization and comprehension of these ideas, we employed generative AI, specifically Dall-E 3 by OpenAI, as a principal tool for crafting visuals. This approach aids designers in more effectively communicating their concepts, while the resulting images serve to further stimulate and refine their creative process.

At the end, each idea is accompanied with one pictured created by Dalle-3 as visual support. Example of the prompts to generate those pictures are:

1. generate image: a grandparent - who has a shadow of a bear, a grandkid - who has a shadow of a cat.
2. generate image: mini-crime box, and one kid act as detective, using magnifier to find clues and grandparent act as judge.
3. generate image: a cute and friendly physical "rumor machine".

Figure 30 provides an overview of the initial ideas. These ideas are synthesised and iterated, finally informing eight various ideations, this part will be addressed in next chapter.

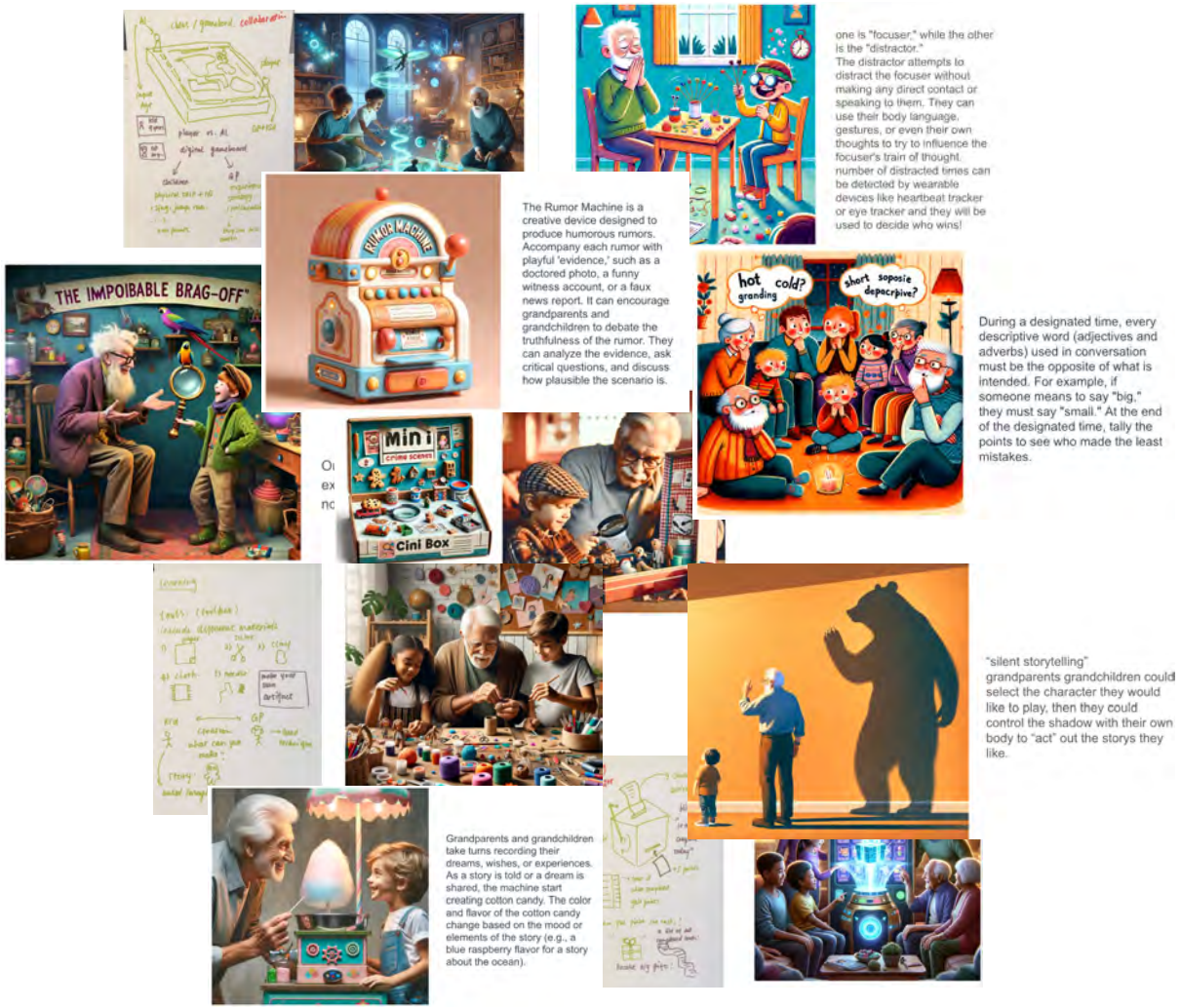


Figure 30. Overview of the initial ideas

Conclusions of idea generation phase.

The first co-design workshop follows the classic procedure, it requires more effort to prepare the materials, explanations and controlling over the whole process. The ideas generated are more mature because it serves for an explicit target (theme in figure 29). The second workshop- inverse brainstorm offered a more relaxed and enjoyable atmosphere, demanding less preparatory work, and contributes more unconventional and innovative ideas. However, these ideas were less refined and needed further development. Drawing from this experience, I recommend incorporating additional techniques for inverse brainstorming to enhance idea generation. The current method relies on inversed words, which sometimes may not be sufficient for ideation. Employing strategies such as word combinations and associations, or crafting unusual one-sentence stories from inverse words, could generate more compelling and creative concepts.

As the initial step of using generative AI in crafting visuals, it's a noval exploration for me. We can experience the benefits as mentioned: it can boost designer's speed of creating ideas. it significantly accelerates the ideation process for designers. Where designers previously invested considerable time in sketching and conveying messages, Dall-E 3 now generates intricate images within seconds. Moreover, its ability to interpret natural language means designers don't have to type long lines of words to decribe the scenario on their minds. Conversely, the prompt that I used is quite simple, it also allowed more variety and imagination in this process, bring new inspirations to designers through the stimulation of images. However, there are still some deficits of Dalle-3, for example, there are stereotypes as gender/ethinic bias, although the gender and outlook of the characters is not specified, it always give out while male figures. Additionally, it struggles with creating images containing text, with apparent spelling errors.

5.4 Presentation of Design Proposals

Exploring design opportunities identified through role cards and factors influencing intergenerational bonding, and drawing from the preferred interaction quality framework outlined in the design guidelines, we developed a series of visually represented concepts.

In this step, since we aim to create better experience for generations. We want to turn each design proposal into a scenario-based storyboard. In this way, 1. It tells the story that how grandparents and grandchildren could use the product in the context. 2. It depicts the whole journey of grandparents and grandchildren bonding, allowing for a deeper consideration of user behaviors and potential reactions, thus enriching the details of the concept. 3. It provides more effective communication for the evaluation, as providing detailed imagery that immerses participants in the story.

To this end, we explored how could generative AI could be used to create storyboards. Unlike single image, a major problem in creating storyboard is the control of character as well as environment consistency. After searching and experimenting, we chose Dalle-3 as the main tool to generate image and we discovered a method for maintaining this consistency by specifying character appearances (repeat the words in brackets) in every prompt. An example is as follows:

"in a cozy living room, grandfather (a 65-year-old man with white hair, dressed in brown) is getting printed report with an image and waving the file to his granddaughter (10 years old, with long gold straight hair and blue eyes, wearing a pink sweater and jeans) and inviting her to explore the report together. flat illustration"

Ultimately, we produced 8 scenarios for each concept, resulting in a total of 64 images, with some images subsequently refined by the authors to more effectively articulate the concepts.

The following pages illustrate the concept through storyboards and text description. It's tight back to design guidelines through a visual representing the desired interaction qualities they covered.

QUICK OVERVIEW

Figure 31: Storyboard of concept 1

01

The Activity Generator

Traditionally, grandparents will do things that grandchildren likes to do. This machine reverses the roles by assigning unexpected, mutually enjoyable tasks to both grandchildren and grandparents. Its core mechanism is an interactive, point-accumulation system where users complete tasks to earn points. Accumulated points unlock a grand prize for grandchildren as an incentive for shared activities. The system is also designed to balance the interests and preferences of both age groups, thus promotes sustained engagement and cooperation.

01

The Activity Generator

Figure 32: Storyboard of concept 2

02

Home Scavenger

In this future-oriented, speculative scenario, household objects are equipped with smart functions, akin to Amazon Alexa, enabling them to interact and talk with people. Within this context, starting with a cup glows and emits light, capturing the attention of a child. This glowing cup presents the child with a puzzle, initiating a treasure hunt. The puzzle involves finding the next object, guided by clues. As the child follows these clues and solves the puzzle, they are led to a teapot. The teapot then prompts the child with a question related to their grandparent's souvenirs. This question necessitates the child's interaction with their grandfather, naturally facilitates a conversation about his travel experiences. The completion of the scavenger hunt culminates in a reward for the child. This system is designed to refresh daily, ensuring that each visit to the grandparents' home offers new puzzles and stories.

02

Home Scavenger

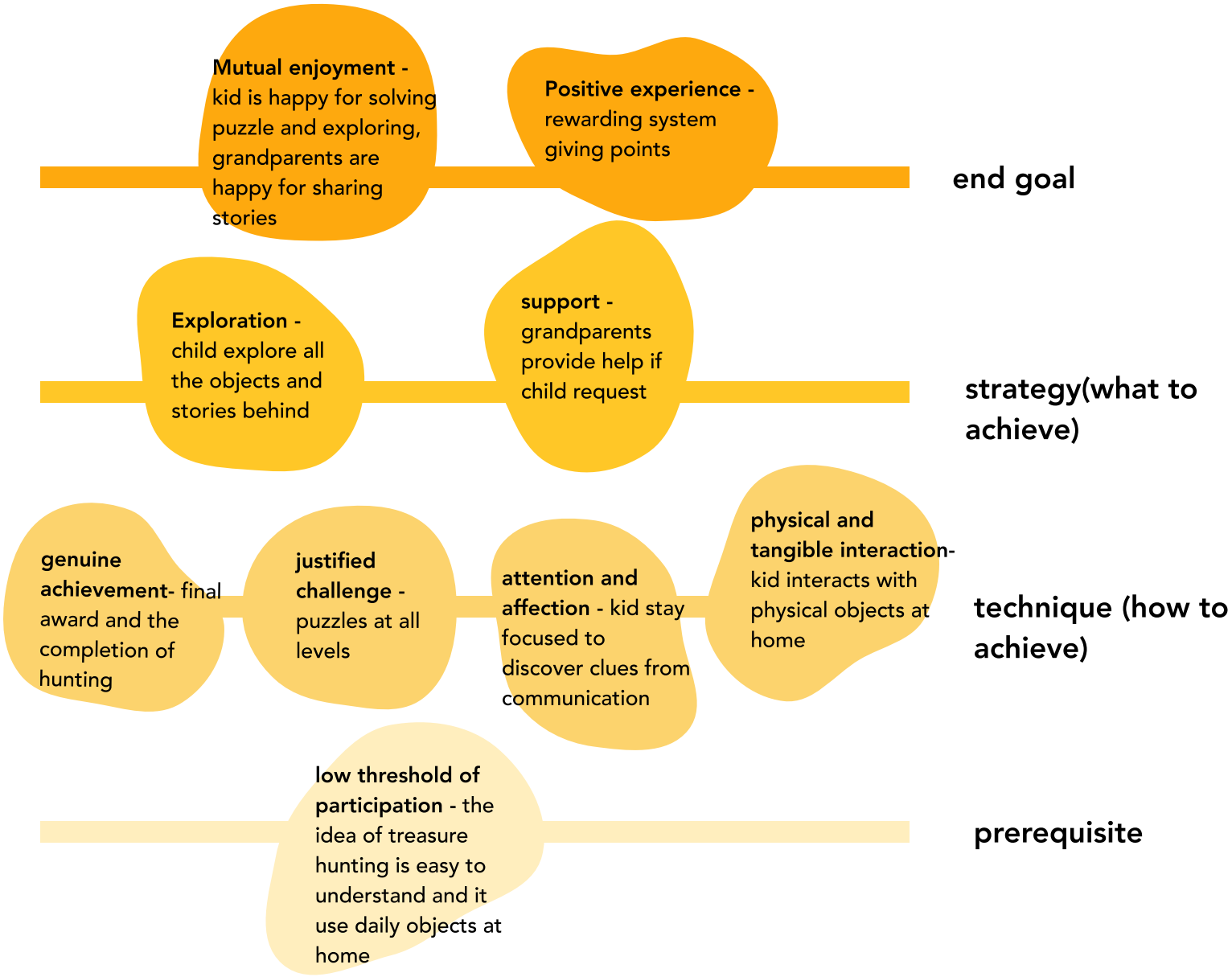


Figure 33: Storyboard of concept 3

03

The Rumor Machine

The 'Rumor Machine' is a concept designed to generate humorous rumors, each accompanied by playful 'evidence' such as altered photos, comical witness accounts, or mock news reports. This machine is intended to spark lively debates between grandparents and grandchildren, challenging them to assess the veracity of each rumor. Through analyzing the evidence, posing critical questions, and discussing the plausibility of the scenarios, this interactive experience not only entertains but also educates. It blends elements of humor with educational aspects, promoting critical thinking about media literacy and bonding through shared laughter.

03

The Rumor Machine

Figure 34: Storyboard of concept 4

04

"Silent" Storytelling

In this interactive storytelling system, participants select characters to act as, using their body movements to control shadows and bring stories to life. The system responds to narrative cues, such as setting changes or character introductions, by altering visual elements like the background or adding new character shadows. For instance, a grandfather playing a bear and a grandson playing a wolf can navigate through an evolving story, with the system adding elements like a jungle scene or a dancing fox shadow based on their narrative inputs. This system elevates traditional storytelling, intertwining physical activity and imaginative play.

04

"Silent" Storytelling

Mutual enjoyment - kid is happy for being active and all the movements, grandparents like storytelling

engagement - kid and grandparent interact through engaging visuals

Positive experience - system doing all variations and interactions

end goal

Exploration - users can use their creativity to create all characters and control them to do all movement or gestures

Collaboration - grandparents and children co-created the story

strategy(what to achieve)

justified challenge - they use their creations to solve the problem (e.g cross river)

attention and affection - kid and grandparent focus on the shadow world

physical and tangible interaction- using body movements to control shadows

technique (how to achieve)

low threshold of participation - it's nature to play with shadows and using body movement doesn't require knowledge

inclusivity - people of all age can enjoy the light and shadow

prerequisite

41

Figure 35: Storyboard of concept 5

05

Fun Battling

The fun battling game has three modes. The first one is bragging, grandparents and grandchildren have to compete with most exaggerated, unbelievable, and nonsensical bragging. Next one is focus and distract, one play as focuser and one act as distractor, distracted times will be recorded and compared through system. The final one id opposite words, during a designated time, every descriptive word (adjectives and adverbs) used in conversation must be the opposite of what is intended. This game incorporate the "unconventional game" with competition.

05

Fun Battling

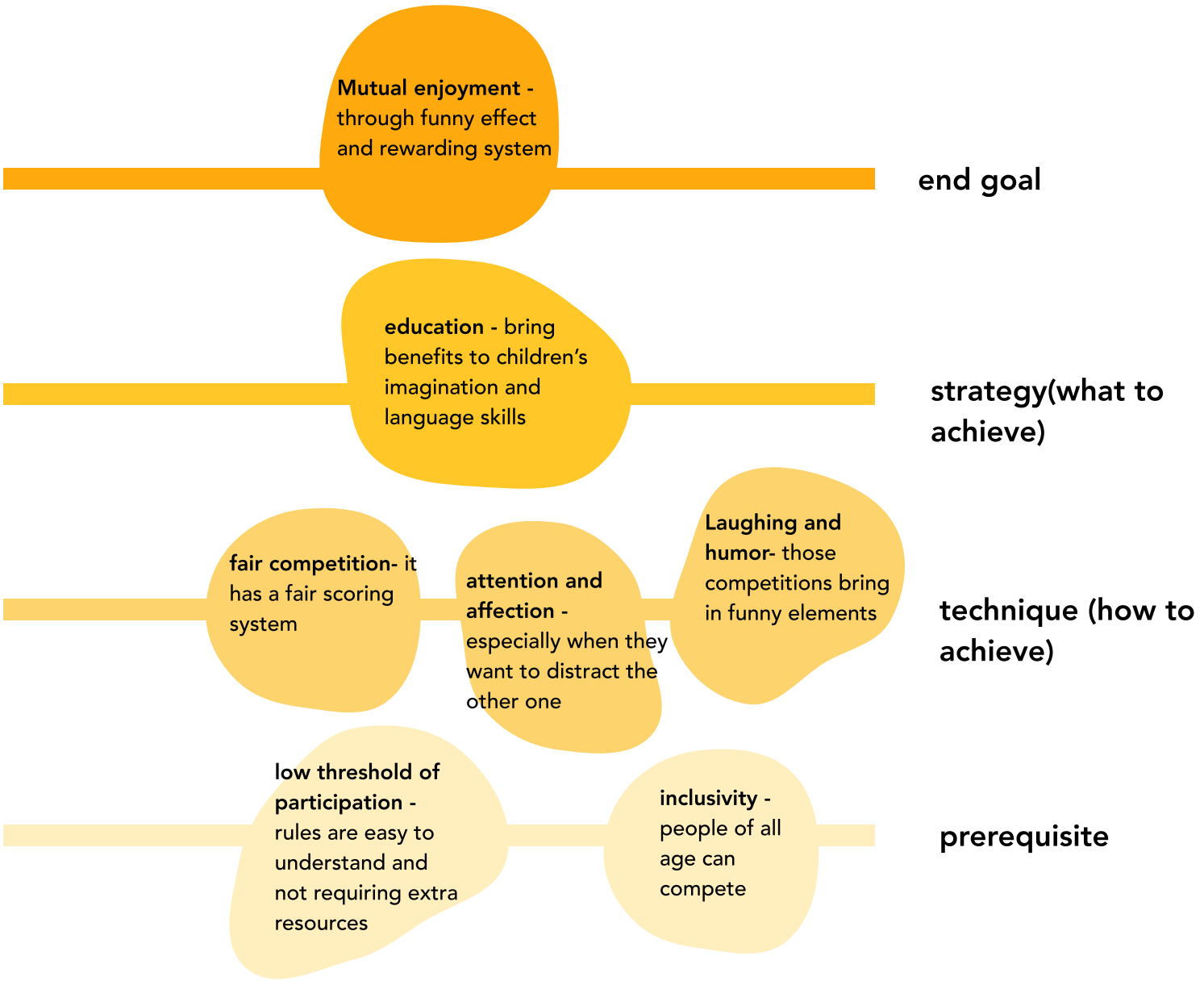


Figure 36: Storyboard of concept 6

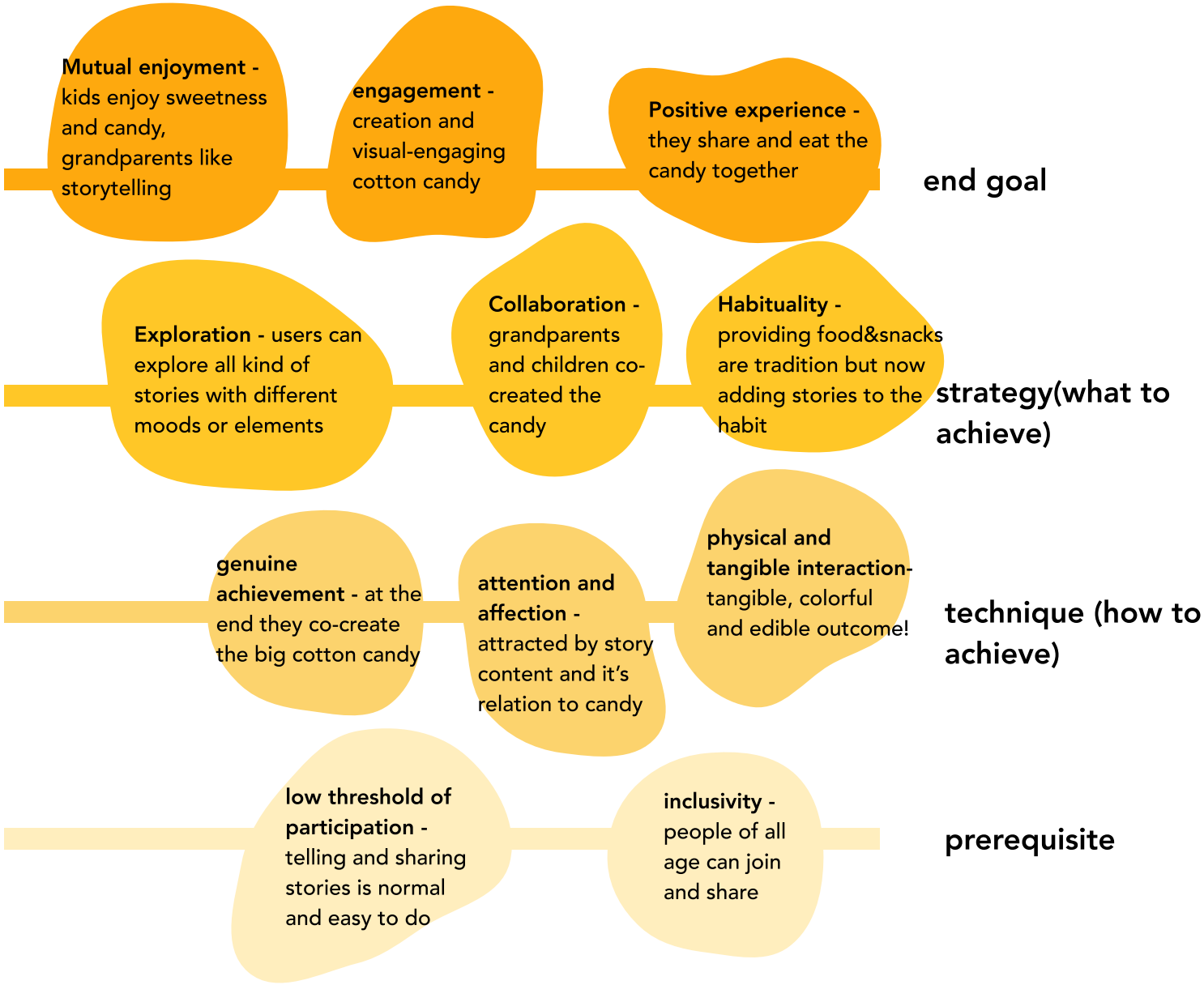
06

"Dreaming" Cotton Candy Machine

Grandparents and grandchildren take turns recording their dreams, wishes, or personal experiences. As the story or dream is shared, the machine initiates the creation of cotton candy. The color and flavor of the cotton candy are dynamically tailored to reflect the mood or key elements of the narrative. For instance, a story about the ocean might produce cotton candy with a blue color and a blueberry flavor. The more stories and experiences are shared, the larger the cotton candy grows. Upon completion, grandparents and grandchildren can take the cotton candy out from the machine and eat it together. This system not only encourages the sharing of stories and dreams but also creates a tangible, delightful outcome.

06

“Dreaming” Cotton Candy Machine



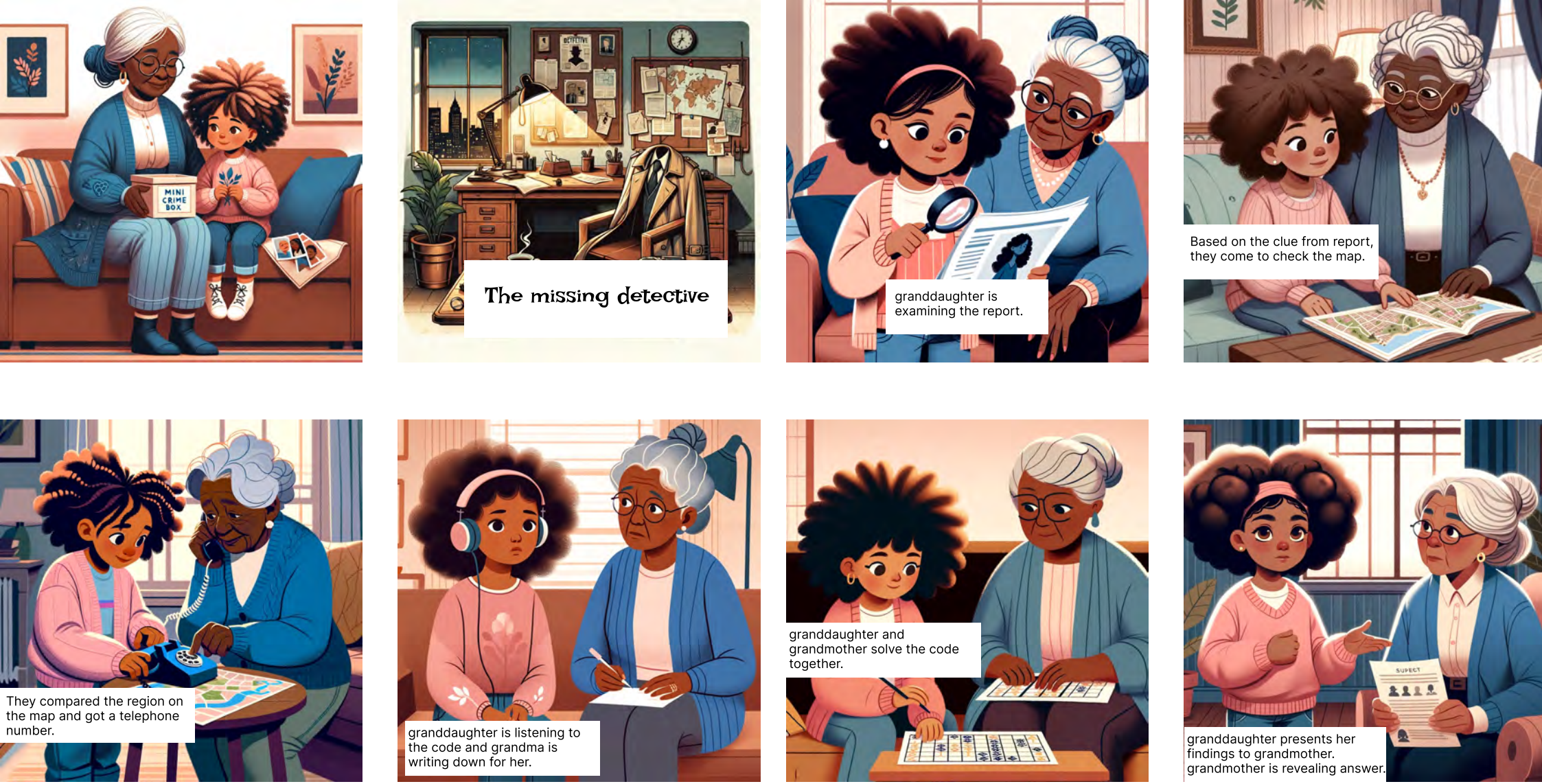


Figure 37: Storyboard of concept 7

07

Mini Detective

This concept introduces an interactive mystery-solving platform tailored for grandchildren and grandparents, promoting collaboration, critical thinking, and role-playing. The system presents a series of cases with accompanying 'evidence' and 'clues' for the duos to analyze and solve together. Grandparents can contribute by guiding their grandchildren through the investigative process, leveraging their wisdom and experience, or they can assume the role of judges, evaluating the solutions and reasoning presented by the grandchildren. AI could also be embedded into the system to provide various/changing mysteries to provide a continuous appeal to the users.

07

Mini Detective

Positive experience - by role-playing and solving mystery

end goal

Support - grandparents can provide help to solve the mystery

strategy(what to achieve)

genuine achievement - at the end solved the mystery

justified challenge - make the puzzle adjustable through ai generation

technique (how to achieve)

low threshold of participation - mechanism similar to escape room and other detective games and easy to understand

prerequisite

Figure 38: Storyboard of concept 8

08

Co-plant

This system intertwines the care of a real plant by grandparents with the digital game of their grandchildren. When grandparents tend to the plant, such as by watering it, the system acknowledges this nurturing act and sends a notification to the grandchildren. This notification is accompanied by a 'energy points,' which can be used by the grandchildren to care and interact with the digital plant pet on his phone. It allows for the expression of affection through diverse contributions. It also facilitate more communications about real plant or digital plant when the kid is visiting the grandmother.

08

Co-plant

Mutual enjoyment - kids enjoy achievement of digital plant pet, grandparents like caring plants and teaching children

engagement - both parties are involved in this activity

Positive experience - generation of energy points

end goal

Education - grandparents can teach children knowledge about plants

Collaboration - grandparents and children have diverse contributions

Habituality - make checking and exchanging information of the plants a routine

strategy(what to achieve)

Manifestation of talents/skills - skills for taking care of the plants

genuine achievement - both physically and digitally

attention and affection - grandkid express affection and thankfulness to grandparent's contribution

physical and tangible interaction- watering the plant and see plant grow

technique (how to achieve)

low threshold of participation - watering plants do not require much effort and understanding

inclusivity - people of all age group can take care of plants

prerequisite

conclusions of the concepts

The concepts broadly address the design qualities across various layers. For the first layer of inclusivity and low threshold. Most concepts are accessible and straightforward, lacking complex rules, making them easy to engage with. Concepts like the cotton candy machine and shadow play resonate with childhood memories, enhancing their universal appeal. However, for the home scavenger and mini detective, it's hard to involve more people in the activities because of the mechanism. It requires more consideration of content scalability and the potential for broader family involvement.

In the technique layer, while all qualities are represented, some, such as fairness in competition and the incorporation of laughter and humor, appear less frequently. This disparity is understandable, given that competition and humor are inherently more specific and subjective elements that may not align universally across all concepts. The effectiveness of humor, in particular, can vary significantly based on content and individual personality traits.

The strategy layer sees comprehensive coverage of its qualities, though support and habituality emerge less prominently. There's an indication that grandparents may prefer active collaboration over passive support, reflecting a desire for meaningful and diverse contribution. This preference, however, is situational, as grandparents' availability and energy levels can influence their participation. Habituality presents a challenge, necessitating continuous innovation to maintain engagement and prevent boredom.

The end goal, representing the ultimate objective of fostering enjoyable and meaningful interactions, varies significantly among individuals. User satisfaction and enjoyment are subjective, making it challenging to conclusively determine the presence of this quality in one concept over another. So here I only provide some estimations with my expertise and experiences.

reflection of storyboard creation

The images in this storyboard were generated using ChatGPT's Dalle-3. A notable issue encountered was the inconsistency in the characters' appearances across different images. This is attributable to the current limitations of Dalle-3 in maintaining character consistency; even direct prompts such as “I want the same character” have proven ineffective. To mitigate this issue, detailed descriptions of the characters’ facial features and clothing were provided, aiming to achieve maximum similarity between character representations. Even though, if looked carefully, there are still some inconsistent part such as hair styles, glasses and cloth styles.

Advantages of this strategy include:

Efficiency: The process allows for quick storyboard creation, with the possibility of generating a complete set within 1-2 hours.

Visual Quality: Dall-E 3 produces high-quality images that enhance the storyboard's visual appeal.

Challenges:

Bias: The AI tends to generate stereotypical images based on generalized prompts, often defaulting to white, male figures for "grandparents" and "grandkids," reinforcing gender and racial stereotypes. With the introduction of character consistency controls, the responsibility of mitigating this bias shifts to the designer, who must thoughtfully consider the gender and racial balance of the characters. However, since the database is already biased, even we asked for different races of people to increase the diversity, the quality of the image is dropping (in concept 8 the grandmother looks different in each scenario, as the coherent level is inferior to other storyboard.) Another consideration is that to make people notice the character role effectively, we specified the role”grandmother” and AI give her old-fashioned clothes, also her body looks not fit. Exposing those images to real users might inadvertently perpetuate stereotypes, potentially causing discomfort among them.

Risk of Overemphasis on Details: The high quality and intricacy of the generated images pose a risk of diverting attention away from the core narrative. Testers may become preoccupied with the elaborate details of the images, potentially overlooking the underlying story they are meant to convey. Also its details might hinders people’s imagination compared to a rough sketch.

06

Proposal Evaluation

6.1 Expert Evaluation

6.1.1 Evaluation Session

6.1.2 Feedback From Experts

6.1.3 Conclusions

6.2 User Evaluation

6.2.1 Participant Recruiting

6.2.2 Evaluation Session

6.2.3 Feedback From Users

6.1.3 Conclusions

Summary:

This chapter provides a detailed report on the evaluation sessions conducted in Phase 3 of the project. Experts invloved in first to review the design proposals presented in the previous chapter, they (1)provide scores and rankings to concepts (2) give their feedback on each concept (3)validated the design guidelines. Grandchild-grandparent pairs evaluated selected concepts and give their feedbacks. All the feedback on each proposal is organized in a systematic manner to provide comprehensive insights into its (1) positive aspects, (2) points of concern, and (2) design suggestions for further development.

The chapter is structured as follow: each section offers detailed description of the evaluation process. Followed by feedback they provide and the conclusions.

Chapter 6 Proposal Evaluation

Following the generation of the eight design proposals presented in the previous chapter, the project entered Phase 3, the project progressed to Phase 3, focusing on evaluation sessions to gather feedback from participants and target users. Initially, experts assessed and scored each concept, enabling the selection of the 'best concepts' for subsequent family evaluations. Post-expert review, the scoring highlighted standout proposals, which were then showcased to grandchildren and grandparents together to elicit their feedback. As previewed in the first chapter, Phase 3 aims to address a central research question, which is presented below:

RQ6: How can we evaluate to what extent the newly designed concepts could facilitate bonding between grandparents and grandchildren during face-to-face interactions?

The research question itself implies that for an effective evaluation of new designs, the outcome of Phase 3 must be comprehensive enough to cover a wide range of design ideas, ranging from educational to exploratory. We propose to validate the design criteria derived from the thematic analysis of Phase 1 interviews through expert review. Additionally, since our design proposals are tailored for children and grandparents, their input is crucial. That's why we arranged two sessions of evaluation. In this chapter, Section 6.1 outlines the evaluation procedures and presents expert feedback systematically, while Section 6.2 describes the family review setup and their responses to the design concepts.

6.1 Expert Evaluation

6.1.1 Evaluation Sessions

All the evaluation sessions were executed between the 31st Jan to 9th Feb 2024, the meetings were all conducted in person individually in IDE faculty. As a result, 5 experts were recruited to evaluate all these ideas.The diversity of the recruited experts ensured that the proposals were evaluated from various perspectives. The information on the recruited experts is presented in Table 15.

expert of the evaluation	Participants's expertises/experiences	Current occupations
E1	Culture in design, design for family relations	Professor in culture design
E2	design for children education	Phd candidate
E3	technology ethics, game design in museum for children and (grand)parents	Phd candidate
E4	design for children's healthcare, AI technology	PostDoc
E5	Interaction Design for Children, Co-design with kids	Lecturer

Table 15: Participants of expert review

Prior to the session, all participants were provided with information about this master's graduation project and were briefed on the previous research process. The project aim of integrating technology to bond children and grandparents through shared experiences is underlined. In the session, we started by introducing the design guidelines framework, supported by printed visuals(in chapter 4.4.2). Experts were reminded to consider this framework during their subsequent evaluations. We then presented and explained the eight design proposals, each accompanied by an A3 printed storyboard and a brief textual description. Following the presentations, experts completed a survey featuring a 7-point Likert scale ranging from 'unsatisfied' to

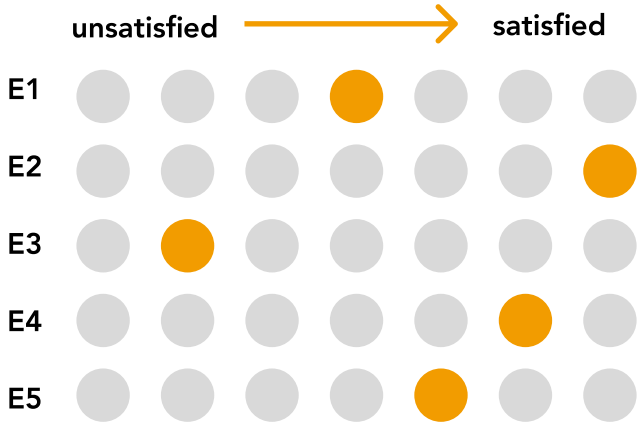
'satisfied.' They scored each proposal, provided reasons for their scores, and offered additional suggestions for each concept. The end part is framework validation, experts answer to what extend does these four layers affect or influence their evaluation, this is also in the form of 7-point Likert Scale. Upon the completion of the evaluation sessions, the feedback provided by the experts was systematically documented which will be presented in the following section. It is also important to mention that, with participants' consent, all sessions were audio-recorded and later transcribed to capture and analyze the experts' insights and feedback.

6.1.2 Feedback from Experts

This section delivers a detailed presentation of the expert feedback gathered from the evaluation sessions. Upon the conclusion of these sessions, we collected the surveys, examined all feedback session transcripts, and extracted key insights. Initially, we present the scores assigned to each design proposal. Subsequently, we categorize the feedback for each proposal into three areas: (1) positive aspects, (2) points of concern, and (3) suggestions for further development. Finally, we provide an overarching review of the feedback on all design proposals and the evaluation process itself, including the validation of the design framework, which concludes this section.

01 The Activity Generator

A machine generate activities cater to both grandparents and children's interests.



Positive Aspects

In general, participants acknowledged it's effectiveness in fostering intergenerational bonds through the creation of shared memories, especially its alignment with daily activities that yield tangible outcomes. The to-do list is highlighted as a visual representation of compromise and balance between grandparents and grandchildren. Moreover, the incorporation of gamification transforms potential reluctance into collaborative engagement, illustrating that framing tasks as part of a game enhances willingness and cooperation in shared activities.

E4:"it's closer to daily activities, and it can be related to practical activities like making dinner or improving home environment， thus having immediate tangible outcomes for them."

E5:"collaboration happened in a gamification way because I can imagine that if grandparents ask children to do something they might not willing to, but this make the process like a game"

Concerns

Expert feedback raises concerns about sustainability, noting that the machine's primary functions—printing and awarding points—can be replaced by other simpler and more sustainable alternatives like laptop screen. There is also a critique that the system overly burdens grandparents with preparation tasks. Furthermore, experts emphasize the necessity for the activities on printed list themselves to be engaging for children and grandparents otherwise it could not support this idea.

E1:"And also maybe the grandmother is too much the entertainer here. Not really balanced exchange of fun because she has to do a lot.There's a list, a to-do list, and then she has to prepare everything."

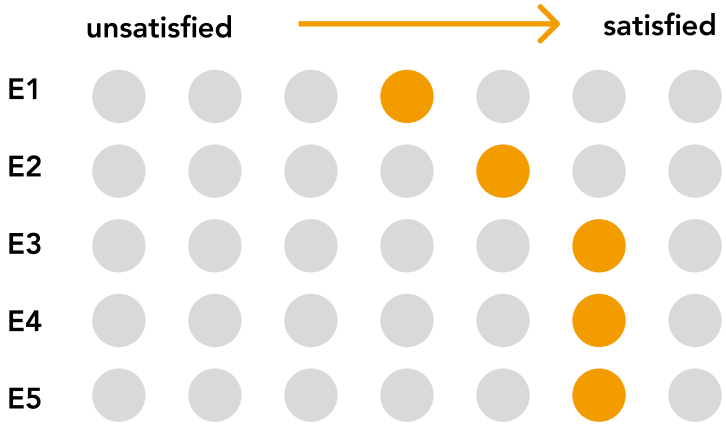
E3:"The activity generator could also output these other experiences, but it's about the experiences themselves that, that I think is what your design should be about."

Suggestions For Further Development

- before the list is made out, let the grandparents and kids know each other's interest and co-create this to-do list to compromise their interests. (E4)
- find a alternative word for "tasks" or "to-do lists", make it less harsh. (E5)

02 Home Scavenger

A treasure hunting system that hints children to explore stories behind objects at grandparents' home.



Positive Aspects

Experts highlight the value of enabling children to explore rooms through artifacts, with grandparents sharing the stories behind these items, fostering a deeper understanding between generations. This approach personalizes the interaction, grounding it in family histories and personal stories, making it more meaningful than conventional gaming. Such activities not only strengthen bonds but also provide a unique opportunity for children to learn about their grandparents' lives, which might otherwise remain undiscovered.

E5:"I really like here that this boring place of grandparents where you have to go and you don't have anything to play with, there's no toys, but you make it more interesting. The attributes are there, that a story from grandparents come alive."

E4: "I find it more meaningful than just doing a game. Of course, it can be an interesting activity, but I think it's the kind of activities that the grandkids can do only with their grandparents. Otherwise, they may not even have a chance to learn the stories about their grandparents."

Concerns

Experts express technical concerns regarding the system's construction and question its necessity, pointing out that simpler methods like text prompts, which could facilitate the process without imposing technical challenges on grandparents. Additionally, the feedback suggests a lack of knowledge exchange; while the system enables grandchildren to learn about their grandparents, it lacks mechanisms for grandparents to similarly gain insights into their grandchildren's lives. This imbalance highlights the need for a more two-sided approach to foster mutual understanding and strengthen intergenerational bonds.

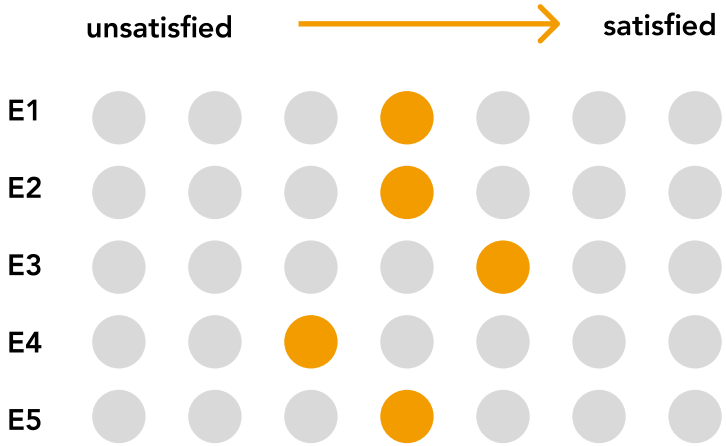
E2:"what I feel is missing a bit is that the kid gets to know the grandparent. But I'm wondering how the grandparent can get to know the kid. So, I feel like maybe it's a bit one-sided."

Suggestions For Further Development

- Think of a reasonable solution for grandparents to select the objects and create the narrative considering of their technology abilities. (E2)
- Hint grandchildren to share about their lives to grandparents (E3)
- Highlight the bond as the final outcome instead of gaming certificate. (E5)

03 The Rumor Machine

A machine printed funny fake reported to facilitate debated and discussion between generations.



Positive Aspects

Experts acknowledge that discussing rumors can serve as an entertaining activity, with its appeal largely dependent on the level of strangeness. Additionally, they recognize a potential educational dimension, suggesting that the engagement with rumors could also offer learning opportunities, provided the content is thoughtfully created.

E3:"I think, um, that could be interesting if you have something that generates weird rumors and you could talk about this."

Concerns

Experts express reservations about the practicality of introducing a large machine into the home environment, suggesting that a laptop could effectively implement the concept with less pollution and resources needed. The engagement level with the concept is noted to depend on the humor and uniqueness of the rumors. Additionally, there is a critique regarding the innovation aspect, with comparisons made to existing "black stories" card games, indicating a need for further differentiation the concept need to be.

E1:"large machine, i'm not sure i would like to buy a large machine in the house, you can just use a laptop to achieve this concept."

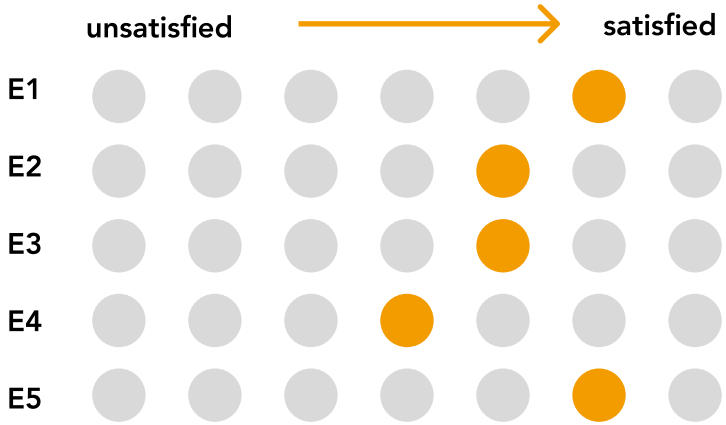
E3:" in general, it all depends on how funny and how strange the rumors are, they need to be entertaining of course to talk about."

Suggestions For Further Development

- Integrate the rumors with personal stories or life events that grandparents and grandchildren have experienced together, highlighting moments where their lives overlap. The rumors should be crafted or chosen to reflect these shared experiences, or alternatively, allow them to collaboratively create their own rumors based on these intersections. (E5)

04 "Silent" Storytelling

A shadow play system allows users to control the animal shadows with body movement and react to narrative stories



Positive Aspects

Experts envision the concept as a good combination for storytelling and interactive play, appreciating its capacity to engage both generations together. They like the innovative reinterpretation of traditional elements. The integration of grandparents' storytelling with activities that encourage children's physical activity is particularly valued. Furthermore, the open-ended nature of the concept, allowing for diverse narrative directions, is highlighted as a strength.

E5:"I like here that the concept is really combining the grandparents' storytelling with the need to be more active as a kid. And I also think it's nice that it's very open-ended, that you could go any direction the story brings you."

E1: "I can imagine that it evokes storytelling and playing a lot and grandparents and kids can be really together because i see a lot of playing elements here."

Concerns

Experts question the practicality of technology requirements, noting the need for a large empty wall space in the home. They also express concerns about the longevity of engagement, speculating that the frequency of participation in these activities might diminish over time.

E2:" I wonder how good this will function.I also wonder like if they have like enough big wall. It's a bit constrained to what the grandparents and the child have at home."

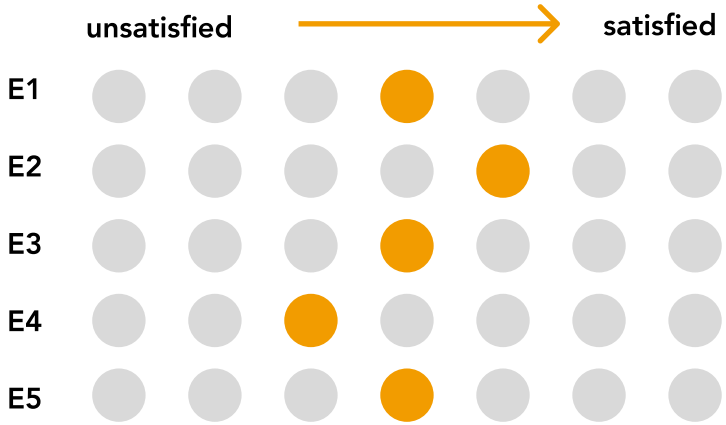
E4:" I'm considering how long both of them can be engaged with these activities. Probably Grandparents and kids might like these ideas but it might happened less frequently."

Suggestions For Further Development

- Consider implementing triggers or prompts to initiate activities, especially if relying solely on participants' imagination may be challenging. Providing subtle hints could effectively guide users, enhancing engagement and creativity in the process.(E5)

05 Fun battling

Unconventional game triggers humorous competition between grandchildren and grandparents.



Positive Aspects

Expert evaluations highlight the impact of integrating gamification elements into technology, emphasizing its ability to enhance user engagement and foster the creation of shared memories. Also, this concept is more practical and experts already see how it can be developed into a video game or application.

E2:"I imagine it to be a little bit like a video game they are playing on the TV or somewhere. So, it's very technology wise it's very tangible.I like the gamification element, and it's again creating memories together and playing with each other."

Concerns

The effectiveness of these activities hinges on the pre-existing relationship and prior experience in similar engagements, requiring a sense of humor and mutual appreciation for competitive interactions between grandparents and grandchildren. Concerns are raised regarding the technology's role, which appears constrained to merely tallying points, suggesting a need for broader functionality to enrich the system's impact.

E4:" Unless they have already certain kind of relationship or previous experience of doing these kind of activities. Because it might need some humor from both sides. And grandparents and grandkids both need to like these kind of competitions. Maybe the people who might like it are a small group."

E1:" What is the technology's role here? Now it seems that the system only count the point so it's a bit limited."

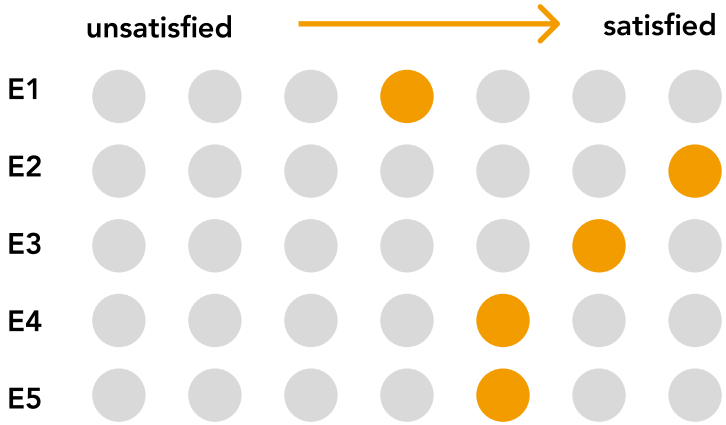
E2:" I think the implementation of this game might be a problem."

Suggestions For Further Development

- Making the game more personally related to user themselves but not restricted to game elements. (E4)

06 "Dreaming" Cotton Candy Machine

A machine change people's dreams and stories into different flavor and color of cotton candies.



Positive Aspects

The concept is recognized for its potential to enhance children's language development and facilitate deeper mutual understanding. The strong emphasis on food as a connecting element is particularly appreciated, with the integration of a generative AI system adding a creative twist that generates novel and engaging experiences around food. Experts also value the traditional association of kids visiting grandparents place and they are provided with food, snacks, and cookies, the concept catches this point and introduces interactive activities centered on this theme.

E2:"It is again like that both of them can share stories and get to know each other. And they create something together. I feel it has lots of elements that people can look back to the childhood. I started to think how me and my grandma always used to make cotton candy and talk about it, so the element of food is very strong for me to connect."

E5:"I like here that if you're going to your grandparents, you can always get food and snacks and cookies. It's kind of a big part of the tradition, but there's now kind of an interaction related to it."

E3:"I really like the idea that you then put a generative AI system on top of that. Then you get all kinds of crazy cotton candy."

Concerns

Experts express concerns over the health implications of consuming too much sugar, noting that grandparents may be hesitant to encourage unhealthy eating habits in children. Additionally, the concept demands significant effort, input, and storytelling skills from both grandparents and grandchildren.

E3:"The cotton candy machine is not very healthy, although which obviously something that kids would like, but you don't want them to eat cotton candy all the time."

E1:"It does not fits the idea of a sustainable world, a healthy world. if this is a future idea, I don't think grandmothers like to contribute to the bad health of children."

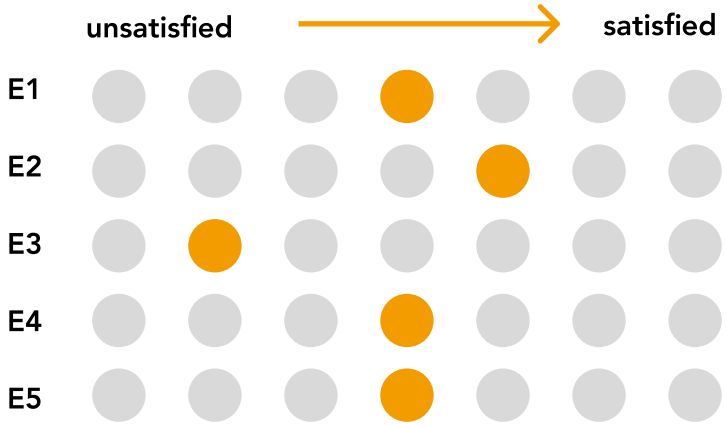
E4:"Compared to others, I think it needs more effort from both sides."

Suggestions For Further Development

- We can make the cotton candy machine produce healthier cotton candy (e.g. sugar-free cotton candies) (E4)
- make the variations clearer to users, let them easy understand how they can modify the content of story and as well as change the color and flavor of the cotton candy. (E5)

07 Mini Detective

Puzzle solving game for child to play as detective and grandparents play as judge.



Positive Aspects

Experts like the gamification element, and it's grounded with escape room games so it's practical and easy to understand.

E2:"I like the game elements in it, that you have like a little game and then there are like riddles you have to solve. Then you have to call a phone number or look up a website or everything."

Concerns

Experts observe a potential imbalance in the interactive dynamics, where the grandmother predominantly assumes the role of an assistant to the child. This setup might limit the engagement level, as it lacks a balanced interaction between the participants. Drawing parallels to existing games, such as a well-known Sherlock Holmes detective board game, suggests a familiarity with the concept but also showing the concept lacks a certain novelty.

E1:"Here I feel like the grandmother is only the assistant of the child. There is not a balanced interaction here."

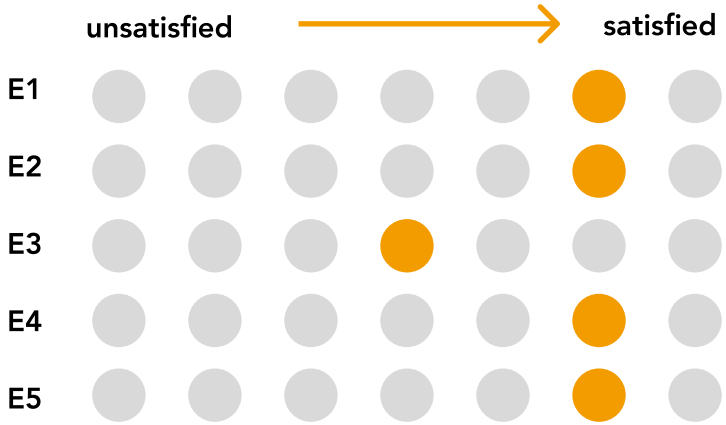
E5:"I see a little less of the personal input from both players. it's very related to kind of these escape rooms or I think the role playing or what it makes it special needs to be enlarged."

Suggestions For Further Development

- Create a relevant content related to users' personal life (more personal links) (E5)
- Making the elements of technology more obvious and necessary. (E3)

08 Co-plant

A planting system connect grandparents and grandchildren through real plant and digital plant.



Positive Aspects

Experts highlight the concept's sustainability and educational potential, emphasizing the mutual learning opportunities in plant care. The co-creative aspect of jointly nurturing a plant no matter digitally and physically symbolizes the growth of the grandparent-grandchild relationship. This dual presence allows for the observation of parallel growth in the plant, fostering more personal and relevant narratives between the two generations. It integrates remote and face-to-face interactions, as well as asynchronous and synchronous communication, enriching the bonding experience.

E1:"This is imaginable how it would work and that you can learn also from each other how to treat plants. It fits in the idea of a sustainable world as well as older people want to teach younger people."

E4:" I like that they co-share the plant digitally and physically, and they can see the growth of digital version and the physical version together."

E5:"it's really the combination of being remote and being together and asynchronous and synchronous interactions. And also that the grandparents feel that they have some kind of contribution."

Concerns

Experts question the depth of connected moments given the division of responsibilities—grandparents caring for the physical plant and grandchildren engaging with its digital counterpart. They suggest enhancing the system to allow children to independently grow the plant in the game, with grandparents providing supplementary support for enhanced growth or aesthetics. The integration of technology in this specific context lacks perceived innovation, indicating a need for further originality in its technological execution.

E2:"But it's still like she (grandmother) takes care of the plant at home and he (grandson) takes on the screen. So, I'm wondering how many connected moments are happening."

E4:"Now grandchildren seems a bit relying on grandparent's actions."

E3:"I think this basically exists already, but not in this form, but the technology implementation is not very innovative."

Suggestions For Further Development

- Make the kid could also care of the plant pet in his own ways and grandparents' effort as booster. (E4)
- invent more possible ways to interact with physical plant, a plant maybe needs water once a week, do something more to make there's even more to share. (E5)

6.1.3 Conclusions

Conclusions of concepts

Overall, experts could see the potential of these concepts in providing new shared experiences to bond children and grandparents. Although they evaluated those proposals based on their backgrounds and expertises, the result of the score showed similar preferences. It is shown in Table 16. The 'Home Scavenger' concept emerged as the most favored with 29 points, closely followed by 'Co-Plant' with 28 points. 'Dreaming Cotton Candy Machine' and 'Silent Storytelling' also received high marks, scoring 27 and 26 points respectively. Given the narrow margin between the third and fourth concepts, the decision was made to advance all four concepts to the next phase of family testing instead selecting only the top three as the initial plan.

Back to the content, experts showed great interests in concepts that allow users to create new memories. Implantation of technology is also a primary consideration, A recurring question, "What is the role of technology here?", indicates their expectation that technology should not only be present but also function effectively and contribute meaningfully to the overall experience. Experts also assess the long-term viability of each concept, using a forward-looking technique to evaluate its endurance and scalability. By imagining regular and extended use by grandparents and grandchildren, they question the concept's sustained functionality, its ability to adapt and grow, and its influence on fostering enduring positive changes in intergenerational relationships.

Rank	Concept Name	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Sum
1	Home Scavenger	6	5	6	6	6	29
2	Co-plant	6	6	4	6	6	28
3	Cotton Candy Machine	4	7	6	5	5	27
4	Silent Storytelling	6	5	5	4	6	26
5	Activity Generator	4	7	2	6	5	24
6	Rumor Machine	4	5	5	3	4	21
7	Fun Battling	4	5	4	3	4	20
8	Mini Detective	4	5	2	4	4	19

Table 16: Results of expert scoring concepts

Conclusions of validating design guidelines

In the initial phase of evaluation, experts were familiarized with a four-layer guideline, theoretically posited as a potential evaluative tool. The concluding section of the survey aimed to discern the extent to which these identified qualities impacted their evaluative judgments. Given the presence of 17 distinct qualities, assessing each individually was deemed impractical. Instead, validation proceeded on a layer-by-layer basis, utilizing a 7-point scale to range influences from weak (1) to strong (7). The outcomes are detailed as follows:

framework layer	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
Prerequisite	4	7	7	7	2
Techniques	4	5	6	4	7
Strategy	7	7	5	6	5
End goal	6	7	7	6	6

Table 17: Results of evaluation guidelines

Despite individual variations in assessing the framework of design criteria, experts generally agreed that the framework and its four-layer structure are coherent and meaningful. Through this evaluation, the framework has been affirmed as an effective tool for designing shared experiences aimed at strengthening bonds between children and grandparents. Experts suggested that the framework could evolve into a tangible set of evaluation cards by incorporating visuals for each quality alongside brief textual descriptions. Figure 39 offers a practical example of such a criteria card.

Figure 39: example of criteria card

Additionally, in the final phase, we not only validated our conceptual framework but also transformed it into a set of design tool cards. These cards serve dual purposes: they inspire the generation of new ideas and function as assessment criteria for evaluating the generated ideas. Full card set can be found in appendix C.

Reflection of expert evaluation session

The expert evaluation contributed significantly valuable insights, enhancing the concepts' overall value. Through multiple rounds of evaluation, we refined our narrative based on expert feedback, establishing a clear and accessible description of each concept's essence. Experts, drawing on their diverse backgrounds, enriched the concepts in various ways. Some emphasized the importance of product sustainability, while others highlighted cultural transmission as critical, offering valuable directions for future development of the design concepts.

It's worth noting that even though experts are told to use the framework to evaluate the ideas, they have their own judgement based on their diverse experience and expertise. A commonality among experts was the value placed on the "novelty" and creativity of the concepts. Certain experts expressed a preference for concepts that facilitate the creation of new memories, as opposed to those with a retrospective focus. Additionally, a notable emphasis was placed on the importance of "creative play" and "open-ended play," indicating a preference for designs that allow for flexibility and imagination in the interaction between generations.

An area for improvement involves inviting a broader group of experts to participate in a collective review workshop if time is allowed. This collaborative setting would enable experts to enrich the evaluation process through mutual facilitation. Within the workshop, there would be opportunities to refine concepts further and collaboratively enhance presentations, ensuring that the final ideas presented to users are more polished and mature.

6.2 User Evaluation

In the concluding session of expert reviews, we identified four design proposals for further exploration: Home Scavenger, Co-Plant, Cotton Candy Machine, and Silent Storytelling. This phase involved presenting these concepts to real users to collect their perceptions and understand how they believe these concepts could enhance their relationships during gatherings.

6.2.1 Participant Recruiting

Through the TU Delft networks, we recruited three pairs of grandparents and grandchildren for our evaluation. The participant groups consisted of two grandmother-granddaughter pairs and one grandfather-grandson pair. The evaluation process was conducted in the form of interviews, carried out at the participants' homes for their convenience. Each pair, meeting the criteria of grandchildren aged between 8 to 12 who regularly visit their grandparents residing in the Netherlands, participated in interviews lasting approximately 30-40 minutes.

6.2.2 Evaluation Session

All the evaluation sessions were executed between the 11th Feb to 14th Feb 2024. We familiarized each pair of participants with our research context by sharing a short summary and asking them an introductory question of what's their favorite shared activity when they are physically being with each other. This question was designed to immerse them in the research context and establish a connection between our concepts and their experiences. We informed them that they would be presented with four storyboards, each illustrating a design concept aimed at strengthening the bond between children and grandparents. We clarified that these storyboards represented conceptual, rather than fully realized, products, introducing them as alternative means of fostering connections. Furthermore, we expressed our interest in understanding how they envisioned these design proposals influencing their relationships.

We then animated each of our storyboards manually, by narrating a sequence of scenario presented in PowerPoint. While this format created a similar experience to viewing a video, it enabled us to pause and respond to questions from participants, who we invited to interrupt. It also allowed us to iteratively adapt our narration over the course of the 3 interviews, based on participants' contributions.

Following the presentation of each concept, we facilitated a discussion round, encouraging both the child and grandparent in each dyad to share their views on the concept, including aspects they liked or disliked, and how they envisioned the concept enhancing their real-life interactions if implemented. To ensure balanced participation, we alternated who shared first in each of the four discussion rounds, aiming to gather unbiased feedback from both grandparents and grandchildren.

After all the concept were discussed, we concluded with participants selecting their preferred concept and explain the reason behind. Lastly, we asked them if they had any additional contributions to prompt participants to confirm, or reconsider, their initial responses to the individual proposals. These final questions also provided us with opportunities to identify new lines of enquiry and to interrogate responses more deeply.

Considering that all participants' native language is Dutch, we accommodated language preferences by providing an additional screen displaying the storyboards in Dutch, minimizing potential misunderstandings. For the two grandmother-granddaughter pairs with proficient English skills, the interviews were conducted in English by the author. Conversely, the interview with the grandfather-grandson pair was conducted in Dutch by another Master's student from IDE faculty, ensuring clarity and comfort for the participants due to their language proficiency.

Upon the completion of the evaluation sessions, the feedback provided by the users was systematically documented which will be presented in the following section. It is also important to mention that, with participants' consent, all sessions were audio-recorded and later transcribed to capture and analyze the users' insights and feedback. This evaluation session was approved by the Human Research Ethical Committee of TUDelft.

6.2.3 Feedback From Users

We categorize the feedback for each proposal into three areas: (1) positive aspects (users liked) (2) negative aspects (users disliked) and (3) suggestions for further development. Finally, we provide an overarching review of the feedback on all four design proposals and the evaluation process itself.

01 Home Scavenger

A treasure hunting system that hints children to explore stories behind objects at grandparents' home.

Positive Aspects

Participants found the concept effective in fostering connections between children and grandparents through storytelling and communication. Children appreciated the interactive aspect, enjoying the exploration of stories via puzzles. Notably, one boy highlighted his appreciation for the system's ability to refresh puzzles, ensuring continuous engagement with new activities. A girl mentioned the concept's dual benefit of allowing children to expend energy and simultaneously learn communication skills. Grandparents expressed pleasure in how the activities naturally facilitated talkings and chatting and they can know more about children during talking.

Grandchild P1:"It's positive in the way that you like the child gets to exert its energy somewhere. It can use up the energy and learn things and also learns how to communicate."

Grandparent P1:"Once you started talking and chatting together, you have the good nose to understand what the child wants to do."

Grandparent P3:"It's the similar when you let them see photographs of your trip. But it's perhaps a little bit more concrete than just a conversation."

Negative Aspects

Grandparents voiced concerns regarding the reliance on technology for communication within this concept, with one expressing concern that it could diminish the value of direct interaction. Additionally, there is worry that the technology might impede children's imaginative development by providing stories or contexts for objects that children would typically created themselves, potentially harming their creative growth.

Children is considering about the process of the activity, since all the puzzle is linked if one puzzle is too difficult, user might feel frustrated and don't know how to skip or move.

Grandchild P1:"if the puzzle is to difficult, they might not find how to move on or stop it."

Grandparent P2:"it's new experience together but it's a shame that you have to rely on those technologies to communicate with your kids. And actually kids already play with objects and talk to you about it. It's also harming children's imagination (the system is doing all the imaginative work for children so they don't train themselves/have to do that themselves)"

Suggestions For Further Development

In response to user feedback, introducing a consistent assistant voice could be a beneficial enhancement. This feature would offer additional hints to children facing challenging puzzles, or provide the option to skip the step, thereby mitigating frustration and enhancing the user experience.

02 Co-plant

A planting system connect grandparents and grandchildren through real plant and digital plant.

Positive Aspects

Parcipants are especially interested in learning knowledge about caring the plants. Also communicating with each other when it's time to water the plant create the bond between grandparents and the kids. They liked the analogy of making the plant as pet, by taking care of it, system gives both sides award and it brings a lot of fun. Moreover, the inclusion of a digital plant component was viewed favorably for its ability to extend interactions and communications about plant care beyond those associated with a traditional plant, due to its continuous engagement potential.

Grandchild P1:"child can learn about plants and learn to communicate and the grandmother has time to water the plant and she knows what she's doing is going to her grandchild. And it's just like this bond, it creates this bond."

Grandchild P3:"It's really nice because you learn about the plant."

Grandparent P1:"It also gives a sort of feeling like we did with the tamagotchi. You have to care for it and you get a reward. And the reward gives both people fun. "

Grandparent P3:"There is some kind of system with rewarding, I think. Perhaps it's motivating the child or the grandma to go on with this project.
Because normally you talk about the plants once, or perhaps twice, but not every time. And this is more a project which is taking a longer time."

Negative Aspects

A major concern to this concept is related to the digital part, causing the increase of screen time of the children. And grandparents' contribution to the plant somehow translated into more screen time the child gets. Grandparent also think the digital system(screen) is distractive when they want to talk to the children. Also it lose attraction to someone who doesn't like plants. The warnings of not relying on technology to communicate is also mentioned with this concept.

Grandchild P1:"A negative part is the more the grandma does it, the more screen time the child gets. And screen time is not the best thing necessarily."

Grandchild P2:"I don't like plants. I don't care about them."

Grandparent P1:"We (grandparent and the kid) can chat and talk more freely than with the total organization of the screen. So My son often phones in his car and then we put off the screen and we only do it with auditive. So the screen is an extra complication for communication."

Grandparent P3:"you cannot rely on the plant to talk to each other. "

Suggestions For Further Development

Given the cautious approach towards screen use expressed by both grandparents and grandchildren, it appears beneficial to design the system on the children's side to extend beyond mere screen interaction. To achieve a more balanced experience, incorporating both digital and real plants for each user could enhance the tangible, real-world aspect of the interaction, ensuring both parties engage in a meaningful, hands-on experience. It can also be related to other daily behaviors of people such as drinking water(boiling water) so it can facilitate a more frequent communication.

03 "Dreaming" Cotton Candy Machine

A machine change people's dreams and stories into different flavor and color of cotton candies.

Positive Aspects

Participants are intrigued by the idea of linking stories to different flavor of cotton candy, because the approach is personal and helps grandparents and grandchildren know more about each other. Also, both children and grandparents can contribute to the growth and variations of the cotton candy. Children is interested to see how can the cotton candy grows and mostly importantly they like to taste the cotton candy! Grandparent values the story parts more.

Grandchild P1:"And it's really nice that they get to share experiences and at the end, relive the mood and see all the flavours and colours mixed together, the mood and the stories. It just sets this atmosphere. I think it will improve the relationship with the stories. You get to share more about your life, to know them more personally."

Grandchild P3:"it's really funny how the cotton candy begins to grow. And there are colors coming in. You are tasting the flavor of the stories."

Grandparent P1:"I like the idea that both can influence the final candy. "

Grandparent P3:"I think it's nice to see what you tell, what is going on with the color and the taste. But of course, it's about real stories, I think."

Negative Aspects

An obvious deficit of this concept is eating too much sugar is unhealthy, both grandparents and grandchildren realized this issue. Also they question about the role of this machine, it's a cool tool to facilitate sharing stories between children and grandparents. Again, it might pose threat that people only want to talk to get the big candy. At the same time, this concept requires some storytelling skills so the effect of the candy is largely depends on the age and skills of children.

Grandchild P1:"I think it's a really cool idea. But one, cotton candy is made out of pure sugar."

Grandparent P1:"some children are very keen on fairytales and fantasy and creativity and other grandchildren will be more on the practical side, realistic side. So that is a problem. It's depending on the child. It is depending on the age, I think, of their mental age also."

Grandparent P2:"Sharing stories is very meaningful. Face to face talking is valuable. You need the machine in the middle? Machine should not be facilitating interactions of stories in this way. If you don't have the candy then you don't want to talk to your grandparents? that's a shame "

Suggestions For Further Development

Addressing health concerns, incorporating sugar-free materials for candy production emerges as a vital consideration. Additionally, enhancing user autonomy and control by providing clear guidelines on how different story elements influence the cotton candy's color, flavor, or shape could significantly improve satisfaction with the product's customizable aspects. An alternative suggestion involves diversifying the machine's functionality beyond edible creations, such as producing balloons in various shapes (e.g., animals)(similar to ballon clown on the street). This modification not only mitigate health concerns but also serves as a tangible memento. Every time users see the ballon, it will bring them back to the afternoon that they creating memories together.

04 "Silent" Storytelling

A shadow play system allows users to control the animal shadows with body movement and react to narrative stories

Positive Aspects

Participants like how the concept bring grandparents and grandchildren together, also freedom of creation is frequently mentioned during the evaluation process.Its gamified form encouraged engagement from both generations. Despite its virtual nature, it can still help grandparents and grandchildren know more about each other, like one child noted that character creation is like to expressing one's personality. Other benefits is that it can function like a good conversation starter.

Grandchild P1:"you just you create this character. In the system, you can choose a character. And you just like create your own personality in it. And I believe that isn't like truly yourself. So essentially, you're just meeting that persona, that like character. But if it's like used properly, it can really improve the relationship and how you think of each other."

Grandchild P2:"I like it because you can create anything you want with the system."

Grandchild P3:"You can be your own creature and it's really nice that system can turn your words into something, it's like doing magic things"

Grandparent P1:"You can make more stories, the intention to make a fancy story with some movements and so on, some fun that will make people happy and active. And then I think after some while you lose the interest in the game itself, but then you are talking together and you don't need it anymore.And you are doing everything what you like because then the contact is there."

Grandparent P2:"I like it because it provide a game (you are playing together) and the technology is a kind of supporter role. The focus is not on technology anymore but just on playing."

Negative Aspects

The effectiveness of the storytelling process is significantly influenced by children's creative and linguistic abilities. Children with limited creativity or language skills may find the experience less enjoyable.

Grandparent P1:"It's also depends on children's age and ability of imagination, so it might be more dependent on grandparents to create the story."

Suggestions For Further Development

Adapt the feature of the system according to children's intelligence or personality. For example, for children like exploration, it can be a open-end game and children can create everything inside. For children who want to challenge themselves, it can be provide more puzzles. It can also grow with children's age and other preferences.

Which Concept Do You Like Most?

Home Scavenger — P1

Co-Plant — P1

Dreaming Cotton Candy Machine — P3, P3

Silent Storytelling — P2, P2

Chosen By Grandparents

Chosen By Grandchildren

P1 "Grandparents don't have to do much for the kids and they can just leave it to kids to explore, just don't break things."

P2 "you can create everything you want with the system."

P3 "You can taste the story actually, you taste all the flavors because you make it together, it's directly making the change through telling stories to each other."

P1 "This is relatable and I could imagine how I and my granddaughter can use it."

P2 "Technology is supporting the play and it's not the focus of the interactions."

P3 "We get stories of both sides."

6.2.4 Conclusions

Overall, the four design concepts received mostly positive feedback from participants across both age groups. The concepts that resonated strongly with personal life experiences, particularly those that evoked past memories, such as the cotton candy machine and silent storytelling, were especially favored.

Critiques highlighted concerns about potential over-reliance on technology for interaction, emphasizing the need for a balance between the engaging aspects of the product and the fundamental goal of communication/interactions between generations. This suggests that while technology can enhance interactions, it should not overshadow the natural, direct engagement between generations, serving instead as a supporter of bonding rather than the focal point or main goal.

Additionally, the feedback revealed interesting perspectives based on age/personality differences. For instance, a younger child evaluated the concepts from a self-centric viewpoint, expressing his disinterest in plant care, whereas an older grandchild considered their grandparent's preferences when choosing his/her favorite concept. This variation could stem from age-related maturity or individual personality differences.

While further validation with a larger sample size is necessary, the preliminary insights suggest a strategy beyond merely selecting a single concept for product development. Tailoring the concepts to detailed user personas—potentially expanding even into service design (subscription service for grandparents since they might have several grandchildren with different personalities)—could better match specific user needs, allowing for a more personalized approach to enhancing intergenerational connections.

07

General Discussion

7.1 Deliverables Answering to Research Questions

7.2 Contributions

7.2.2 In Theory

7.2.3 In Practice

7.3 Limitations

7.3 Future Work

Summary:

After showing all the work done throughout this master's graduation project, the chapter 7 aims to conduct a comprehensive evaluation of the project process and examine the contribution as well as the limitation of this master's graduation project.

The chapter is structured as follows: In Section 7.1, the focus will be on the discussion of how the deliverables from each of the three investigation phases address their corresponding research questions. Subsequently, Section 7.2 discusses the contributions of the final deliverables in detail, covering both the theoretical and practical implications. Next, Section 7.3 discusses the limitations of this project. Finally, recommendations for future research work will be proposed in Section 7.4.

Chapter 7 General Discussion

7.1 Deliverables Answering to Research Questions

This section aims to provide an in-depth discussion of how the deliverables of the three investigation phases align answer their corresponding research questions. This discussion will be conducted on a phase-by-phase basis.

The initial research question was thoroughly explored in the investigation's first phase, as documented in Chapter 3. Notably, Section 3.1 presents a visually-oriented summary of the response to RQ1, designed to facilitate quick comprehension of the key findings.

RQ1: How does technology impact the collocated GP-GC relationship?

Building on the investigation of RQ1, we conclusively discovered that the positive impact on intergenerational relationships is predominantly facilitated through the co-use of technology. This insight impacted the project's direction, informing the development of RQ2 for further exploration.

RQ2: What kind of co-use technology is used to facilitate the GP-GC relationship? What kind of shared experience do researchers aim to facilitate?

To answer RQ2, a subsequent literature review was carried out, with findings detailed in Chapter 3.2.2. The outcomes of this review informed the development of a set of participatory tool cards, containing 14 shared experiences across four broad categories, further enriching the project's insights and methodologies.

After establishing a comprehensive overview of shared experiences, identifying the project's design space became essential. Interviews were conducted to pinpoint opportunities for the project. RQ3 was addressed by analyzing participants' attitudes towards each activity, converting emotions and preferences into quantifiable data points. This approach facilitated a comparison of preferences across age groups. Chapter 4.4.1 features tables that illustrate the activity rankings from the perspectives of both grandparents and grandchildren, providing a data-driven foundation for design decisions.

RQ3: What shared experiences are favored by children and grandparents?

RQ4: What underlying factors within these activities influence their intergenerational connectedness?

Addressing RQ4 involved extracting and clustering interviewees' quotes based on their similarities. This process uncovered meta-themes indicating positive and negative factors affecting shared activities. Chapter 4.4.2 provides in-depth analysis, supported by quotes, highlighting enablers and obstacles to the connection between grandchildren and grandparents. Furthermore, the development of a design framework originated form a detailed examination of thematic coding, resulting in the identification of 17 interaction qualities across four layers. Those qualities are proved to be as keys to successful bonding experiences.

Following the establishment of design guidelines, RQ5 seeks to explore how these guidelines can be applied to address specific problems through the development of concrete ideas or concepts.

RQ5: How can technology be integrated into shared experiences to enhance intergenerational bonding?

In this phase, while our primary objective was using technology to enhance the bond between grandparents and grandchildren through shared experiences, it's important to clarify that technology need not be the focal point of the design. Technology itself is not necessarily to be center of the design, in this project, technology can be interpreted as any type of devices or tool, regardless of technology complexity. Our goal is to create successful bonding experience for grandparents and grandchildren. To this end, we organized two workshops, the first drew on insights from interviews to guide ideation, the second encouraged creativity and unconventional ideas. The outcome was the synthesis of eight distinct concepts, each taking a different approach to fostering intergenerational connections. These concepts were further brought to life through generative AI technology, resulting in detailed storyboards for a clearer visual understanding, as documented in Chapter 5.2.

RQ6: How can we evaluate to what extent the newly designed concepts could facilitate bonding between grandparents and grandchildren during face-to-face interactions?

The concluding phase of the project centered on evaluating the developed concepts. Initial expert review sessions were conducted to incorporate expert insights, resulting in the selection of the four most promising concepts from the original eight. Chapter 6.1.2 elaborates on the feedback received for each concept and also validates the design guidelines presented in Chapter 4.4.2. Experts recognized the guidelines' structure, acknowledging them as a valuable tool for evaluating future designs.

Following the expert review, further testing was carried out with real users, specifically grandchild-grandparent pairs, to assess the concepts' real-world applicability and impact. In this phase, the focus shifted from ranking concepts to gaining insights into the reasons behind participants' preferences, offering perspectives that differ from but complement those of experts. This approach aimed to understand the nuances of user experiences and preferences in a manner more closely aligned with real-world contexts.

To summarize, the validated criteria in chapter 4.4.2 could answer to this question. positioning both expert and user feedback documented in Chapter 6

7.2 Contributions

Our research addresses the gap in understanding how collocated grandparents and children can better connect through shared experiences by examining the mechanisms facilitating their bond. We also developed a series of design concept to help us understand succssful bonding between children and grandparents.

7.2.1 In Theory

We contribute a combined methodological approach:

Sentiment analysis as a guide: This analysis serves as a navigational tool for designers, prompting exploration into why certain activities yield high sentiment scores and others do not. It helps in identifying both positive and negative factors influencing these experiences. This form of analysis could even be extended, e.g. It is possible to find the characteristic words that correlate to positive and negative sentiments, which provides direction for further research, like attribution analysis, to discover contributors to positive sentiment. For example, some activities are communication-focused, while others have physical movements as enablers. By coding these attributes as dummy or continuous variables, we can employ quantitative methods to unveil statistical correlations between activity characteristics and sentiment scores.

Validation of assumptions: Sentiment scores can inform initial assumptions; for instance, high sentiment values for storytelling and family stories among grandparents suggest an educational driver. Subsequent qualitative analysis could then be conducted to verify if these activities are valued for their educational potential. By cross-referencing sentiment analysis with qualitative data, our results gain credibility and depth, offering a more convincing understanding of factors that affect intergenerational connections.

Revealing opportunities from inconsistencies:Situations where sentiment analysis and qualitative data reveal divergences offer crucial design insights. For example, while sentiment analysis might indicate a preference for cooking activities, qualitative data might highlight time constraints as a challenge. This contrast suggests a design direction that retains the positive aspects of cooking, such as the discovery and sharing of food, while also addressing the need for time efficiency. Such insights can guide the development of experiences that optimize the preferred elements of an activity while mitigating identified challenges.

This methodology also enables designers to extract rich, comprehensive data from a limited sample size. In this study, we engaged only 10 participants, but the depth and diversity of insights gathered from this small group were amplified through our analytical approach, demonstrating that even a small sample can produce meaningful and actionable results for design considerations.

This project extends the intergenerational solidarity model proposed by Bengtson & Roberts (1991), particularly in the domain of associational solidarity, which underscores the importance of contact types and frequency between generations for fostering their relationships. However, the current model's guidance for researchers remains vague. Our framework complements the concept of associational solidarity, or the "contact" between grandparents and grandchildren, by offering a theoretical explanation on enhancing their connectedness. It achieves this through a detailed exploration across four levels, providing a nuanced understanding of how elements of interactions can contribute to strengthening intergenerational bonds.

7.2.2 In Practice

The research process does not follow the tradition way of examinating a detailed problem and focused on solving the problem that hinders grandparents and grandchildren connection. Instead, it took a step back to investigate the factors that influencing intergenerational connections. The ideas are generated based on extracted qualities of the shared experiences and not limited to the form of the activities themselves. It offers a more holistic view of designing new activities for grandparents and grandchildren which covers more aspects of the desired interaction qualities.

Additionally, the development of the concepts utilized generative AI for visual presentations, offering fresh insights into image generation, including managing character consistency in Dall-E 3. The limitations of generative AI, such as inherited gender and ethnicity stereotypes, were also mentioned. Areas for improvement in generative AI technology is also discussed: advancements include generative AI with enhanced capabilities for generating text within images, prompts to control consistency of images and algorithms designed to minimize bias and stereotypes.

We also contributed two set of cards. The first, activity cards, serve as a participatory tool, encouraging interviewees to share more about their past experiences and underlying desires for quality time with their grandparents or grandchildren. The second set, design guideline cards, aims to inspire designers creating solutions for intergenerational togetherness. Additionally, these guideline cards can function as a tool for evaluating or refining concepts to better align with the needs and preferences of both children and grandparents.

7.3 Limitations

Location: Our study was limited to participants in the Netherlands, and their proficiency in English may have constrained the depth of expression.

Sample size: In Phase 1, insights were derived from a limited sample of only 10 participants, indicating a need for a broader and more diverse participant pool to uncover a wider range of insights. Similarly, the concept evaluation in Phase 3 involved just three family pairs, suggesting that engaging more participants could yield more comprehensive insights into the concepts' effectiveness and appeal.

Gender: All participating grandparents in the first phase were female, which might have influenced the nature of activities and interactions reported, potentially limiting the generalizability of our findings. As we did not specifically recruit female grandparents, the unbalance in the sample may also point towards different attitudes between genders in engaging in bonding activities (and hence in participating in research on that topic) – a speculation that might be included in follow-up research.

Cultural: The absence of diverse cultural perspectives in our study might affect the applicability of our findings across different cultural contexts.

Completion of concepts: The evaluation of our concepts was conducted solely through storyboards, lacking the dimension of physical interaction and experience. Furthermore, the speculative nature of some concepts posed challenges for users, impacting their ability to fully comprehend and interpret the proposed ideas.

7.4 Future work

Future research should broaden the geographical and cultural reach of the study to include a more diverse array of participants, thereby enriching the findings' depth and relevance. Increasing the sample size would offer a more comprehensive view of intergenerational dynamics. Additionally, developing physical interactive prototypes for real-user testing could further validate and refine the design concepts.

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DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: Xu

initials: H.Xu given name: Hongxin

student number: 5580455

street & no.:

zipcode & city:

country:

phone:

email:

Your master programme (only select the options that apply to you):

IDE master(s): ( ) IPD (★) DfI ( ) SPD

2nd non-IDE master:

individual programme: - - (give date of approval)

honours programme: ( ) Honours Programme Master

specialisation / annotation: ( ) Medisign

( ) Tech. in Sustainable Design

( ) Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: David Keyson dept. / section: HCD

** mentor: Wilfred van der Vegte dept. / section: SDE

2nd mentor:

organisation:

city: country:

comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Promoting Intergenerational Connectivity in a Shared Home Environment

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 19 - 06 - 2023 19 - 11 - 2023 end date

INTRODUCTION **

Please describe the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural and social norms, resources (time, money,...), technology,...

Multigenerational families are defined as households where two or more generations of related adults live together.(Burgess & Muir, 2019). Although this family structure is highly related to geographic and cultural factors, it is more frequent in Asian, African, Southern, and Eastern European countries, the number of multigenerational families saw a sharp increase over the world, and this trend has continued over the last decade(Cohn and Passel 2018). Economic pressure is the primary reason people of different generations live together. Another reason is the pandemic: according to a report from Generations United, 57 percent of multigenerational households say they started or are continuing to live together because of the COVID-19 pandemic. By staying together as an extended family, people benefit from mutual care as well as emotional support from each other during uncertain times.(Gilligan et al., 2020) The rising trend of multigenerational family living has sparked a variety of concerns. For instance, family members of different generations may experience more tension and conflicts regarding communication, lifestyle choices, and values, which may lead to further relationship issues like family estrangement, or disconnectivity. (Clarke et al., 1999) In addition to small units like family, it also brings new challenges to society. Individual well-being is highly affected by this family structure, and more considerations regarding policy-making and social support systems are needed for multigenerational living environments.(Hantrais et al., 2019)

To better support and adapt to the change in family structure, we should understand the family dynamics and help those families to build connectivity. Previous literature about intergenerational connectivity is almost all concentrated on elderly people and explores helping elderly people connect with their children or grandchildren over a distance. Lots of researchers examined communicational platforms such as Whatsapp, Zoom, and Facetime.(Padilla-Walker et al., 2012)(Furukawa & Driessnack, 2012) Other mediums such as games and collaborative activities are also mentioned (Reis et al., 2021b)(Shin et al., 2021) However, their focus is mainly on using technology to compensate for physical distance between family members, while in reality, this is not covering all situations. Even people living under the same roof can feel disconnected from time to time. This indicates a new opportunity for the research: we can try to foster connectedness between grandparents and grandchildren in the same home environment. In this context, the home environment can be interpreted from both the physical side(the entire living space) and the psycho-social side. (social connection with family members and emotional environment)

To conclude, this project aims at fostering connectivity between grandparents and grandchildren residing in the same household. Although the topic is largely related to regional and cultural factors, our objective is to develop solutions that positively impact the home environment and cultivate a sense of connectivity within it.

Reference list:
https://docs.google.com/document/d/1GYwAXDJH75czP_S3Xsc0FBIbx7J7PBG277v78KOj6tE/edit?usp=sharing

space available for images / figures on next page

Initials & Name: Student number:

Title of Project:

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The scope of the project is limited to cohabitating multigenerational family households, to enhance the connectivity between grandparents and grandchildren. This project will apply methodologies of co-speculation and design fiction, plus insights and evaluations from interviews, this project aims for delivering several simulated prototypes which can foster multigeneration connectivity.

Research Question: How to promote intergenerational connectivity in a shared home environment?

Several issues will be addressed:
1. What are the challenges that grandparents and grandchildren now face under the same roof?

2. what is the ideal home environment that grandparents and grandchildren expect for easily connecting with each other?

3. What are the effective factors of the design solution that facilitate intergenerational connectivity?

ASSIGNMENT **

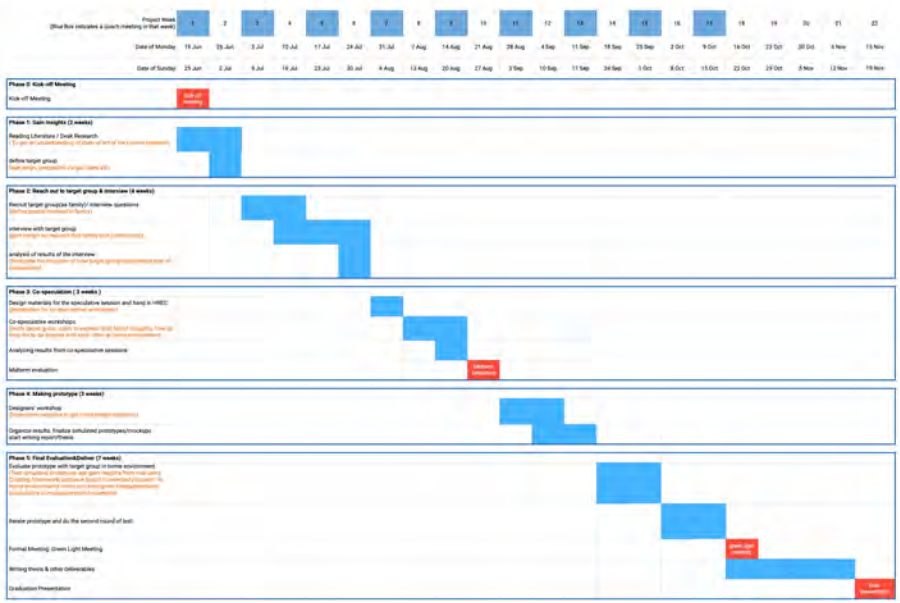
State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

The outcome of this project will be 1. several simulated prototypes (mockups) that help make grandparents and grandchildren "feel connected" 2. a framework or guidance for future "connected products" in home environments which can strengthen intergenerational connectivity in multigeneration households.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date - - - - end date



MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

1. I want to gain more knowledge in the IOT field as well as investigate how technology can be applied to foster meaningful human interactions.

2. I would like to experiment and try on planning and arranging creative sessions such as co-speculation and creative facilitation.

3. I want to practice skills regarding steering a whole project and time management.

4. Learning and practice how to write an academic paper.

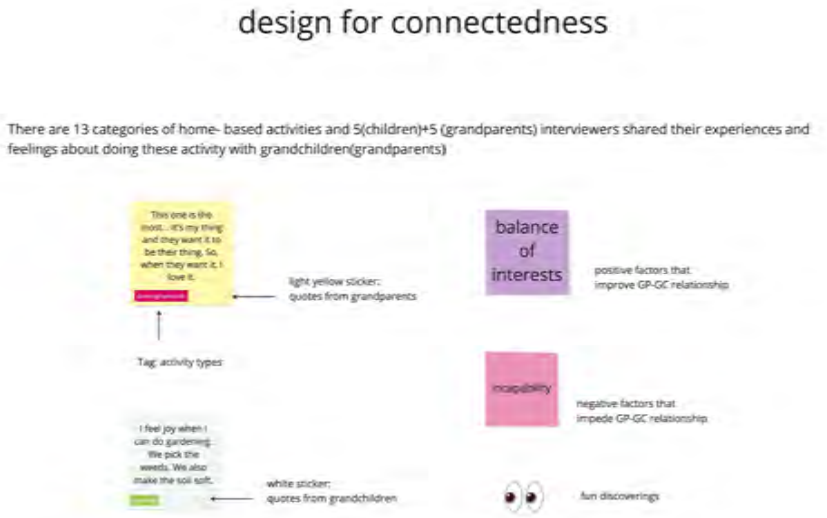
FINAL COMMENTS

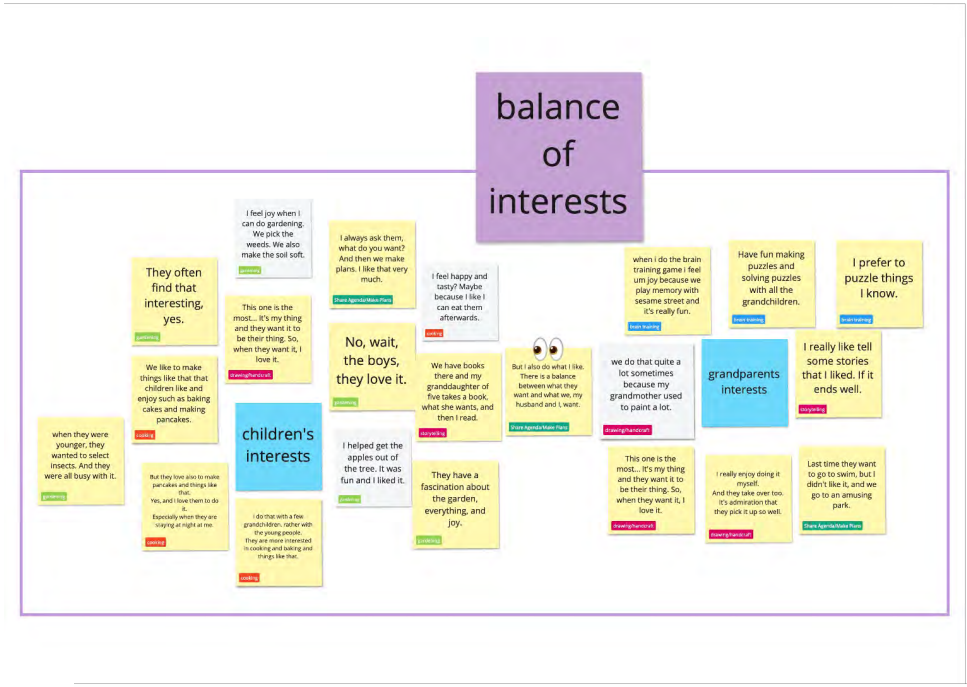
In case your project brief needs final comments, please add any information you think is relevant.

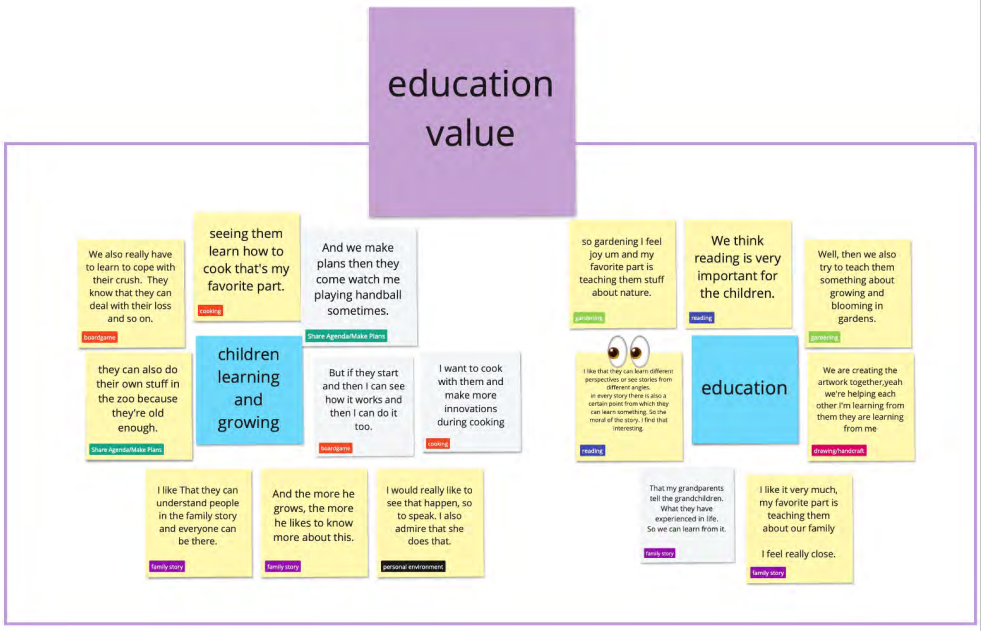
Initials & Name _____ Student number _____

Title of Project _____

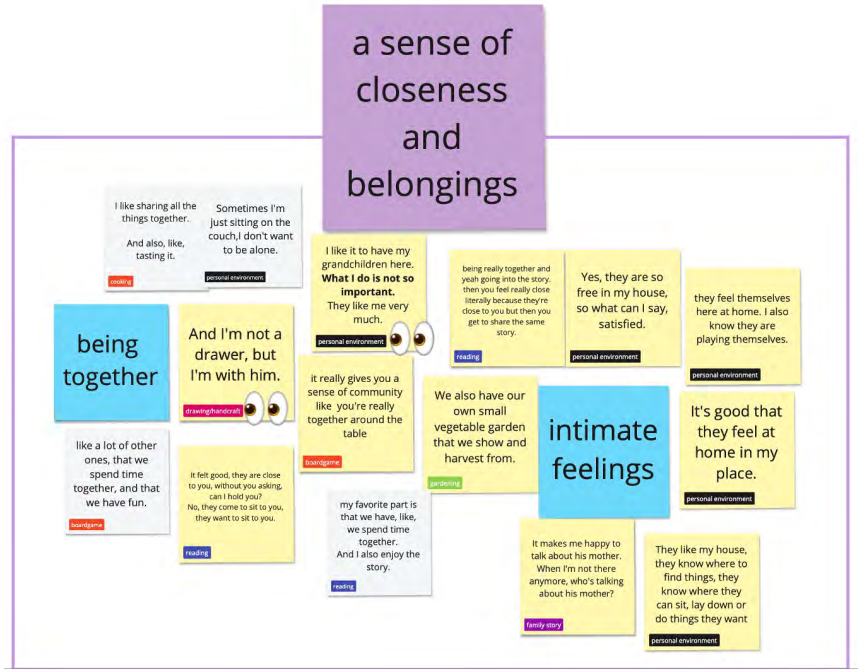
Appendix A - Results of group clustering

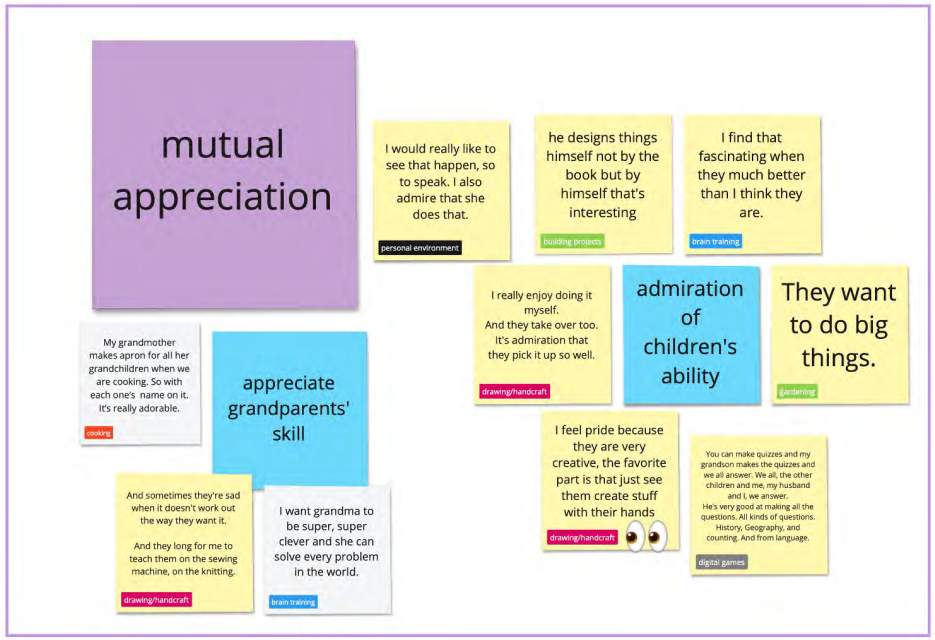


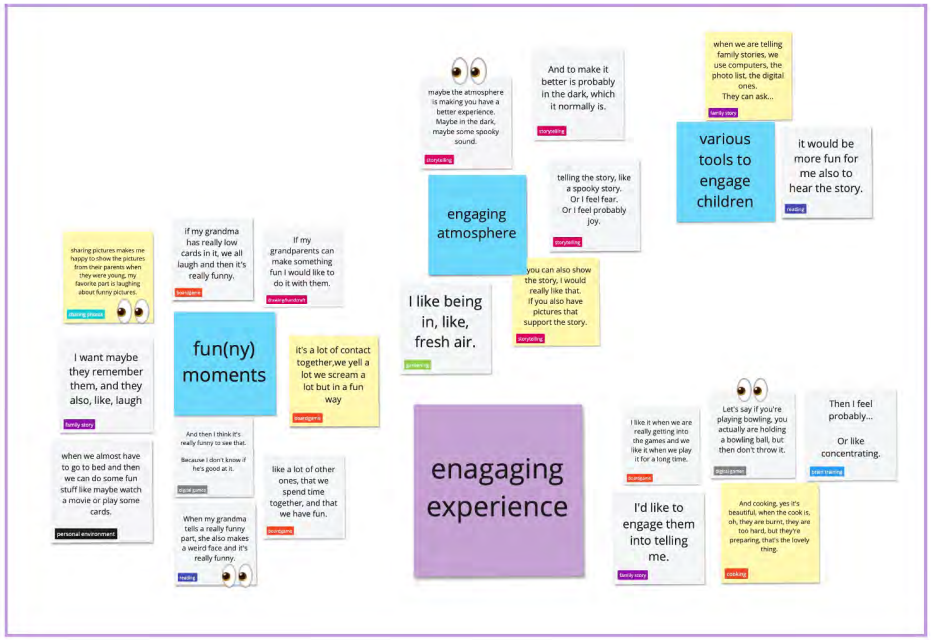




Appendix A - Results of group clustering







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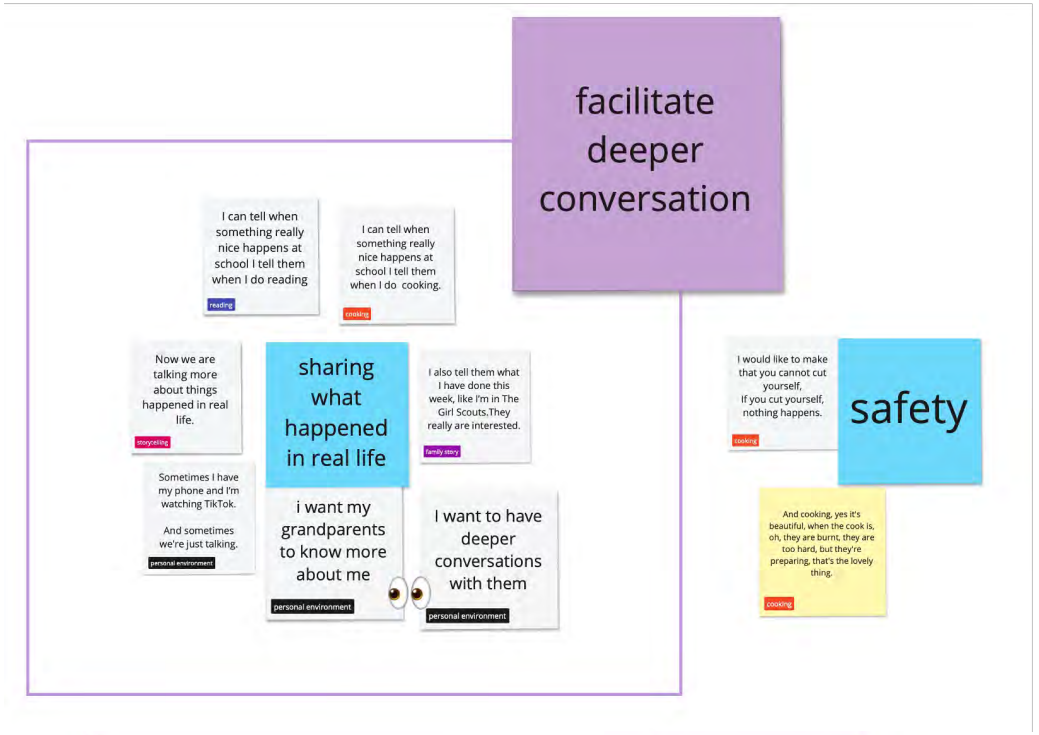
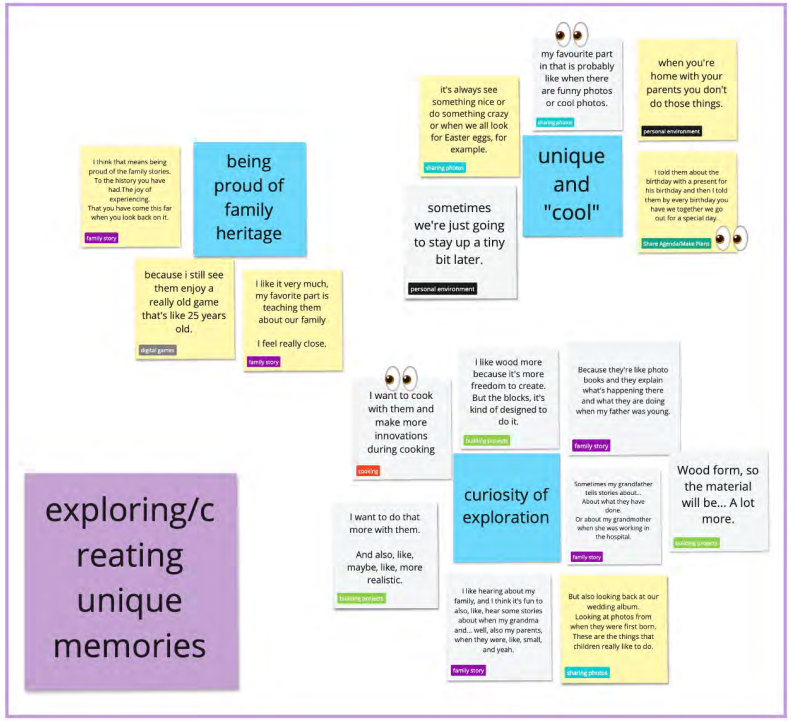
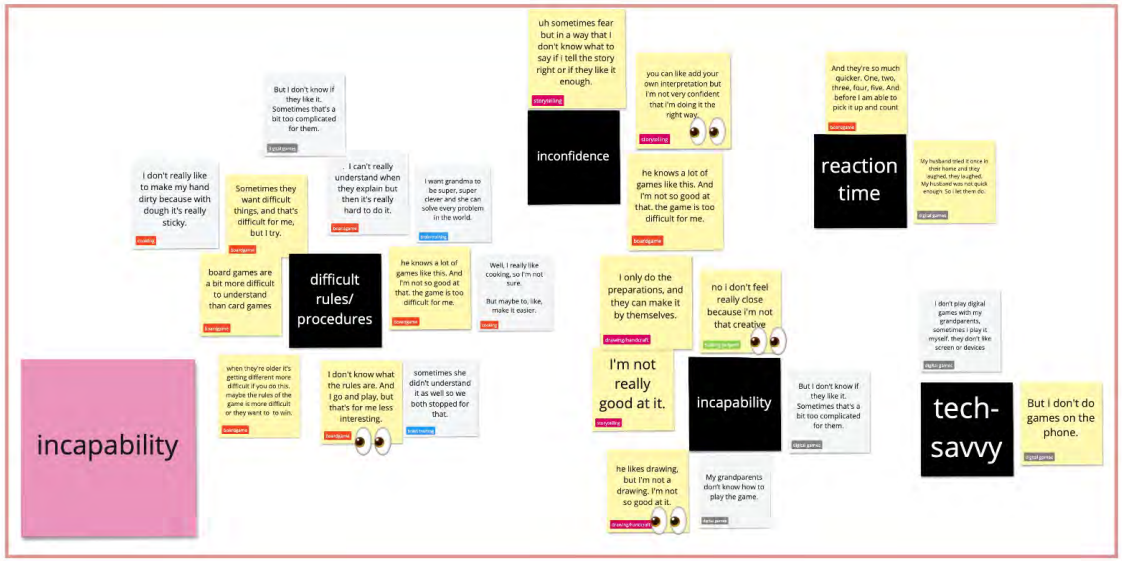




Appendix A - Results of group clustering



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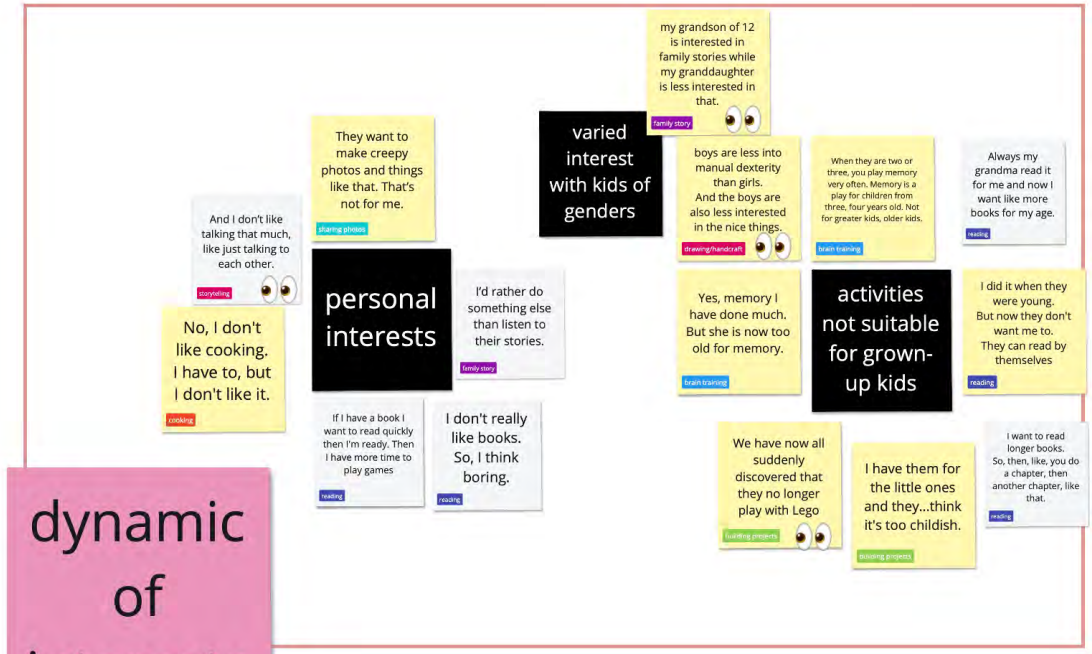
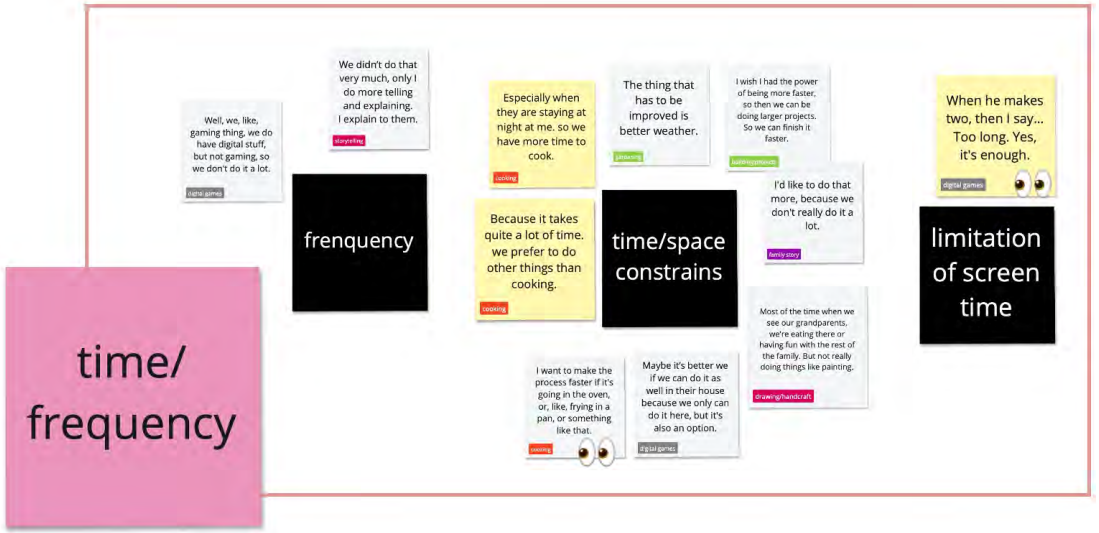




Appendix B - Role cards

Grandparents as a competitor

When grandparents and grandchildren are gaming, they compete with each other and want to win the game.

The problem is that grandparents and grandchildren can not always land in **the same level**. When grandchildren are young, grandparents intentionally let kids win to make them happy, they kids grow older, they want grandparents"fight for victory" but not "give it to them". Later, grandchildren pursue difficult game but grandparents "don't know how to play" so" it's less interesting for me"

Grandparents as a helper/supporter

Grandparents love to help grandchildren, it's common in game related activities. For example, one grandma said "When she can't find it(the puzzle), I like to show her how they find it." they also help grandchildren "explain the rules of puzzles" "provide help if they don't know how to go(an old computer game). Grandparents also help to make preparation work for kids to do such as "make color pencils and paper ready"

They are **not involved much and only help little** if there is a need, the main part of the activities are done by kids.

Grandparents as an educator

Grandparents highly valued education when they are doing activities. They teach kids moral of story from books, nature knowledge during gardening, life skills such as cooking and family history. **They love to see grandchildren learning and growing.**

For children, they are more focused on the "experience" but not learning itself. Some children complained that they feel reading boring and grandparents "force" them to read because reading is important.

Grandparents as a collaborator

In some cases grandparents are deeply involved, they share **equal effort** with grandchildren.

For example, a boy described how his grandpa creating wood craft with him "after my grandfather finish making wood,I guess I do paint stuff." One grandparent said "We are creating the artwork together,yeah we're helping each other". Grandma said:"He has a very beautiful drawing, and I suggest that he can draw a candle and then I can use my sew machine to make Christmas ornament"

Appendix B - Role cards

Grandparents as a watcher

This happens when grandparents have little or even no involvement with the activity.

Why? Some grandparents feel incapable of doing activities, like game rules too difficult for them, they could not operate digital device. Sometimes they are just **having fears on their mind**. "he(grandson) is so creative and I'm not good at it" "he knows a lot of games like this. And I'm not so good at that." They simply feel they are inferior to granchildren. Usually they will just sit aside and watch grandchildren playing.

Grandchildren as an explorer

Grandchildren are attracted by noval ideas and activities.
they mentioned that: It's pretty normal to share pictures so it's not special for me. But they like it when there are "**fun and cool stuff**" One boy said: I like it when there are funny photos or cool photos.

They like to explore unique experiences. One grandma said every grandchild all love the idea of special trip: "I told them by every birthday you have we together we go out for a special day." a boy said with grandparents he can do **new things which he can't do with parents**, like "we're just going to stay up a tiny bit later and do fun stuff".

Grandchildren as an initiator

Grandchildren always come up with the idea of "doing something" and grandparents always follow their choices.

One grandma said: "he always know what to play at my house. Oma shall we draw? shall we play this?"
While sometimes they cannot think of anything to do, they will turn to do own stuff (with their phone) or just stay without doing anything.

Grandchildren as an "evolver"

Grandchildren, particularly as they grow and mature, become evolving participants whose interests shift away from the activities and stories that once captivated them.

grandparents mentioned that some activities they have done a lot when kids were little age, but now kids are **not interested in it any more.**

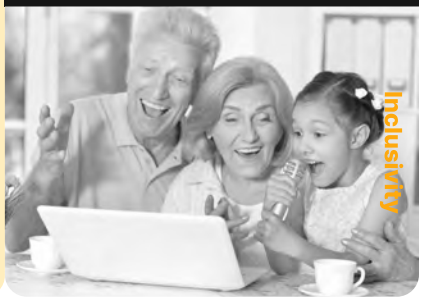
"Yes, memory I have done much. But she is now too old for memory."
"We have now all suddenly discovered that they no longer play with Lego"
"I did it(reading) when they were young.But now they don't want me to."

Appendix C - design guidelines cards

Prerequisite

essential conditions for generations to involve in

accommodate a wide age range



Prerequisite

essential conditions for generations to involve in

easily understandable, not require excessive resources

Techniques

practical methods to support the strategies

attention and recognition from each other

Techniques

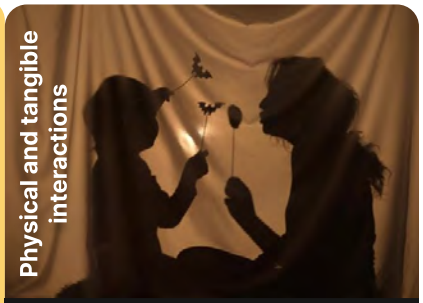
practical methods to support the strategies

Perceived fairness during competition make people feel engaged and valued

Appendix C - design guidelines cards

Techniques

practical methods to support the strategies



tangible elements strengthen the sense of physical togetherness and connection

Techniques

practical methods to support the strategies

Appropriate challenges can increase engagement, not fraustration

Techniques

practical methods to support the strategies

showing talent or skills provides a natural path towards collaboration or education

Techniques

practical methods to support the strategies

create a light-hearted atmosphere, encouraging joyful feelings

Appendix C - design guidelines cards

Techniques

practical methods to support the strategies

enable a sense of accomplishment, fostering pride and a shared sense of success

Strategies

strategies to fulfill the end goals

grandparents make them available to give any level of support that children request

Strategies

strategies to fulfill the end goals

freedom of exploration fulfill curiosity and willingness to discover

Strategies

strategies to fulfill the end goals

mutual learning, skill sharing between children and grandparents.

Appendix C - design guidelines cards

Strategies
strategies to fulfill the end goals

children and grandparents both invest and contribute in their own ways

Strategies
strategies to fulfill the end goals

children and grandparents develop the interation into a habit or ritual between them.

End Goals
main purpose and goals

leave both children and grandparents with pleasant memories and a desire to engage in future interactions

End Goals
main purpose and goals

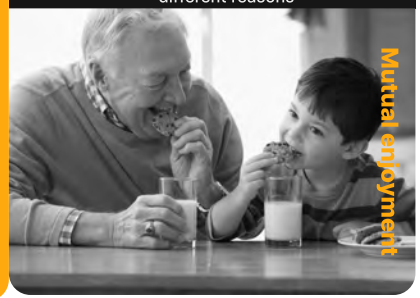
capture the interest of children and grandparents, maintaining their involvement and interaction throughout.

Appendix C - design guidelines cards

End Goals

main purpose and goals

enjoyable for both parties, for similar or different reasons



Appendix D - Ethics Application

TU Delft Delft University of Technology

Permission form

(for the usage of film material of 'interview on promoting the connection between grandchildren and grandparents')

I, ..., the parent or legal guardian of

.....[name child] grant permission to Hongxin Xu, graduating student at the TU Delft faculty of Industrial Design Engineering, to use the photographs and audio recording described as "interview on promoting connection between grandchildren and grandparents' for any legal use, including but not limited to: data analysis, publicity, illustration.

TU Delft master student Hongxin will make photos and audio recordings featuring children describing their relationship with their grandparents and preferences for doing activities with their grandparents and reasons behind it. This material will be used solely for the purposes of data analysis within the scope of the associated graduation project. All collected data, including photographs and audio recordings, will be treated with the utmost confidentiality. Identifying information will be obscured or removed where possible, participants will be identified by pseudonyms or code names (like P1) in any research report or publication to protect their identities. Any photographs used in the graduation report will be chosen carefully to ensure they do not compromise the privacy of any participant. Faces and other identifying features may be blurred if deemed appropriate. All data will be stored securely, accessible only to the research team. Participants and their legal guardians have the right to review the materials in which they are featured before they are used in the report or any other form. Participants have the right to request that their data be removed or altered if they have concerns about privacy or how they are represented.

Toestemmingsformulier

(voor het gebruik van filmmateriaal van 'interview over het bevorderen van de verbinding tussen kleinkinderen en grootouders')

Ik, ..., de ouder of wettelijke voogd van

.....[naam kind] geef toestemming aan Hongxin Xu, afstuderende student aan de faculteit Industrieel Ontwerpen van de TU Delft, om de foto's en audio-opnames beschreven als 'interview over het bevorderen van de verbinding tussen kleinkinderen en grootouders' te gebruiken voor elke legale toepassing, inclusief maar niet beperkt tot: gegevensanalyse, publiciteit, illustratie.

TU Delft masterstudent Hongxin zal foto's en audio-opnames maken waarin kinderen hun relatie met hun grootouders beschrijven en voorkeuren voor activiteiten met hun grootouders en de redenen daarachter. Dit materiaal wordt uitsluitend gebruikt voor de doeleinden van gegevensanalyse binnen het kader van het bijbehorende afstudeerproject. Alle verzamelde gegevens, inclusief foto's en audio-opnames, worden met de grootste vertrouwelijkheid behandeld. Identificerende informatie wordt waar mogelijk verdoezeld of verwijderd, deelnemers worden geïdentificeerd met pseudoniemen of codenamen (zoals P1) in elk onderzoeksrapport of publicatie om hun identiteit te beschermen. Eventuele foto's die in het afstudeerverslag worden gebruikt, worden zorgvuldig gekozen om te garanderen dat ze de privacy van geen enkele deelnemer schenden.
Gezichten en andere identificerende kenmerken kunnen worden vervaagd als dat passend wordt geacht. Alle gegevens worden veilig opgeslagen, alleen toegankelijk voor het onderzoeksteam.
Deelnemers en hun wettelijke voogden hebben het recht om het materiaal waarin zij voorkomen te bekijken voordat het wordt gebruikt in het rapport of enige andere vorm. Deelnemers hebben het recht om te verzoeken dat hun gegevens worden verwijderd of gewijzigd als zij zich zorgen maken over privacy of over hoe zij worden afgebeeld.

Handtekening ouder/voogd: .....

Plaats: ..... *Datum:* ...../...../.....

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TU Delft Delft University of Technology

Permission form

(for the usage of film material of 'interview on promoting the connection between grandchildren and grandparents')

I, ..., the parent or legal guardian of

.....[name child] grant permission to Hongxin Xu, graduating student at the TU Delft faculty of Industrial Design Engineering, to use the photographs and audio recording described as "interview on promoting connection between grandchildren and grandparents' for any legal use, including but not limited to: data analysis, publicity, illustration.

TU Delft master student Hongxin will make photos and audio recordings featuring children describing their relationship with their grandparents and preferences for doing activities with their grandparents and reasons behind it. This material will be used solely for the purposes of data analysis within the scope of the associated graduation project. All collected data, including photographs and audio recordings, will be treated with the utmost confidentiality. Identifying information will be obscured or removed where possible, participants will be identified by pseudonyms or code names (like P1) in any research report or publication to protect their identities. Any photographs used in the graduation report will be chosen carefully to ensure they do not compromise the privacy of any participant. Faces and other identifying features may be blurred if deemed appropriate. All data will be stored securely, accessible only to the research team. Participants and their legal guardians have the right to review the materials in which they are featured before they are used in the report or any other form. Participants have the right to request that their data be removed or altered if they have concerns about privacy or how they are represented.

Toestemmingsformulier

(voor het gebruik van filmmateriaal van 'interview over het bevorderen van de verbinding tussen kleinkinderen en grootouders')

Ik, ..., de ouder of wettelijke voogd van

.....[naam kind] geef toestemming aan Hongxin Xu, afstuderende student aan de faculteit Industrieel Ontwerpen van de TU Delft, om de foto's en audio-opnames beschreven als 'interview over het bevorderen van de verbinding tussen kleinkinderen en grootouders' te gebruiken voor elke legale toepassing, inclusief maar niet beperkt tot: gegevensanalyse, publiciteit, illustratie.

TU Delft masterstudent Hongxin zal foto's en audio-opnames maken waarin kinderen hun relatie met hun grootouders beschrijven en voorkeuren voor activiteiten met hun grootouders en de redenen daarachter. Dit materiaal wordt uitsluitend gebruikt voor de doeleinden van gegevensanalyse binnen het kader van het bijbehorende afstudeerproject. Alle verzamelde gegevens, inclusief foto's en audio-opnames, worden met de grootste vertrouwelijkheid behandeld. Identificerende informatie wordt waar mogelijk verdoezeld of verwijderd, deelnemers worden geïdentificeerd met pseudoniemen of codenamen (zoals P1) in elk onderzoeksrapport of publicatie om hun identiteit te beschermen. Eventuele foto's die in het afstudeerverslag worden gebruikt, worden zorgvuldig gekozen om te garanderen dat ze de privacy van geen enkele deelnemer schenden.
Gezichten en andere identificerende kenmerken kunnen worden vervaagd als dat passend wordt geacht. Alle gegevens worden veilig opgeslagen, alleen toegankelijk voor het onderzoeksteam. Deelnemers en hun wettelijke voogden hebben het recht om het materiaal waarin zij voorkomen te bekijken voordat het wordt gebruikt in het rapport of enige andere vorm. Deelnemers hebben het recht om te verzoeken dat hun gegevens worden verwijderd of gewijzigd als zij zich zorgen maken over privacy of over hoe zij worden afgebeeld.

Handtekening ouder/voogd: .....

Plaats: ..... *Datum:* .....-.....-.....

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Informed consent form

Participant (full name): _____

Conducting person (full name): _____

Time and place: _____

You are being invited to participate in a research study titled [*Promoting connectedness between grandparents and grandchildren*]. This study is being done by [*Hongxin Xu*] from the TU Delft. Please read the text below carefully and ask the conducting person about anything you do not understand or would like to know.

What is this research study about?
This research explores the emotional connection between grandparents and their grandchildren who have physical contact and interactions and investigates how technology can enhance their bonds.

What will you be asked to do?
You will be presented with three storyboards illustrating different concept designs to connect children and grandparents.

How is the interview process?
During the evaluation, the researcher will physically present the three concepts (accompanied by pictures) to the child and grandparent simultaneously. After the presentation, you will be invited to share your thoughts on the ideas, including aspects you like and dislike, and how you believe these ideas might benefit intergenerational relationships.

What are my rights during participation?
Your participation in this study is voluntary. You may cancel your participation at any time without specifying reasons and without any disadvantages.

Which data are collected?
Audio- recordings and some photos of the discussion process will be collected during the interview.

How will my data be handled?
This material will be used solely for the purposes of data analysis within the scope of the associated graduation project. All collected data, including photographs and audio recordings, will be treated with the utmost confidentiality. Identifying information will be obscured or removed where possible, participants will be identified by pseudonyms or code name (like P1) in any research report or publication to protect their identities. Any photographs used in the graduation report will be chosen carefully to ensure they do not compromise the privacy of any participant. Faces and other identifying features will be blurred. All data will be stored securely, accessible only to the research team. Participants and their legal guardians have the right to review the materials in which they are featured before they are used in the report or any other form. Participants have the right to request that their data be removed or altered if they have concerns about privacy or how they are represented.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICIPANT TASKS, AND VOLUNTARY PARTICIPATION		
1.I have read and understood the study information dated [/ /]. It has been explained to me, and I have had the opportunity to ask questions about the study. All my questions have been answered to my satisfaction.	☐	☐
2. I voluntarily give consent to participate in this study. I understand that I can refuse to answer questions and can withdraw from the study at any time, without having to provide a reason.	☐	☐
3. I understand that taking part in the study involves: Being presented with three design concepts and a further discussion of my views on the ideas, the whole process, approximately taking 30-40 mins and will be audio-recorded, and the recordings will be transcribed and then destroyed to ensure privacy.	☐	☐
4. I understand that the study will end around Jan,2024 - Feb,2024	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
5.I understand that my participation in the study involves potential emotional discomfort when discussing personal interactions with my grandchildren. These risks will be mitigated by ensuring all questions are posed sensitively and by securely storing and promptly destroying recordings after transcription.		
6.I understand that taking part in the study involves collecting specific personally identifiable information (PII) such as my age and gender, and photo of my face,	☐	☐

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audio recordings of my voice. This will be combined with associated personally identifiable research data (PIRD) from the interview. I recognize the potential risk of my identity being revealed but understand that measures will be in place to ensure the data is anonymized and securely stored.		
7. I understand that personal information collected about me that can identify me, such as my name or where I live and photos of my face, will not be shared beyond the study team.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
I understand that after the research study, the de-identified information will be used for a MSC thesis.	☐	☐
I agree that my responses, views, or other input can be quoted anonymously in research outputs.	☐	☐

Informed consent form

Participant (full name): _____

Conducting person (full name): _____

Time and place: _____

You are being invited to participate in a research study titled [*Promoting connectedness between grandparents and grandchildren*]. This study is being done by [*Hongxin Xu*] from the TU Delft. Please read the text below carefully and ask the conducting person about anything you do not understand or would like to know.

What is this research study about?
This research explores the emotional connection between grandparents and their grandchildren who have physical contact and interactions and investigates how technology can enhance their bonds.

What will you be asked to do?
You will be presented with three storyboards illustrating different concept designs to connect children and grandparents.

How is the interview process?
During the evaluation, the researcher will physically present the three concepts (accompanied by pictures) to the child and grandparent simultaneously. After the presentation, you will be invited to share your thoughts on the ideas, including aspects you like and dislike, and how you believe these ideas might benefit intergenerational relationships.

What are my rights during participation?
Your participation in this study is voluntary. You may cancel your participation at any time without specifying reasons and without any disadvantages.

Which data are collected?
Audio- recordings and some photos of the discussion process will be collected during the interview.

How will my data be handled?
This material will be used solely for the purposes of data analysis within the scope of the associated graduation project. All collected data, including photographs and audio recordings, will be treated with the utmost confidentiality. Identifying information will be

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obscured or removed where possible, participants will be identified by pseudonyms or code name (like P1) in any research report or publication to protect their identities. Any photographs used in the graduation report will be chosen carefully to ensure they do not compromise the privacy of any participant. Faces and other identifying features will be blurred. All data will be stored securely, accessible only to the research team. Participants and their legal guardians have the right to review the materials in which they are featured before they are used in the report or any other form. Participants have the right to request that their data be removed or altered if they have concerns about privacy or how they are represented.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICIPANT TASKS, AND VOLUNTARY PARTICIPATION		
1.As the legal guardian of the participant, have read and understood the study information dated [/ /]. If needed, it has been read and explained to both me and my child. We have had the opportunity to ask questions about the study, and all our questions have been answered to our satisfaction.	☐	☐
2. I, as the legal guardian of the participant, voluntarily give consent for my child to participate in this study. I understand that my child can refuse to answer questions and can withdraw from the study at any time, without having to provide a reason. I acknowledge that my child's participation is entirely voluntary and that they are not in a dependent or subordinate position to the researcher outside the context of this study.	☐	☐
3.I understand that taking part in the study involves: My child will be presented with three design concepts and a further discussion of their views on the ideas, the whole process, approximately 30-40 mins and will be audio-recorded, and the recordings will be transcribed and then destroyed to ensure privacy.	☐	☐
4. I understand that the study will end around Jan,2024 - Feb,2024	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
5. I, as the legal guardian of the participant, understand that my child's participation in the study involves the following risks: potential emotional discomfort when discussing personal interactions with grandparents.I understand that these risks will be mitigated by ensuring all questions are posed sensitively, allowing my child to skip any questions they're uncomfortable with, and by securely storing and promptly destroying recordings after transcription to maintain privacy. The researcher is trained to conduct interviews with children, ensuring a comfortable and non-intimidating environment for genuine feedback.		
6. I, as the legal guardian of the participant, understand that taking part in the study involves collecting specific personally identifiable information (PII) such as my child's age, gender, and feedback. This will be combined with associated personally identifiable research data (PIRD) from the interview process. I recognize the potential risk of my child's identity being revealed through the combination of PII and PIRD. However, I understand that measures will be in place to ensure the data is anonymized, and securely stored, and that any audio/video recordings will be destroyed after transcription to further protect my child's identity.	☐	☐
7. I, as the legal guardian of the participant, understand that personal information collected about my child that can identify them, such as their name or where they live, and photos which will include information about their face, these will not be shared beyond the study team.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
I understand that after the research study, the de-identified information will be used for a MSC thesis.	☐	☐
I, as the legal guardian of the participant, agree that my child's responses, views, or other input can be quoted anonymously in research outputs.	☐	☐

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Delft University of Technology
HUMAN RESEARCH ETHICS
CHECKLIST FOR HUMAN RESEARCH
(Version January 2022)

IMPORTANT NOTES ON PREPARING THIS CHECKLIST

1. An HREC application should be submitted for every research study that involves human participants (as Research Subjects) carried out by TU Delft researchers
2. Your HREC application should be submitted and approved **before** potential participants are approached to take part in your study
3. All submissions from Master's Students for their research thesis need approval from the relevant Responsible Researcher
4. The Responsible Researcher must indicate their approval of the completeness and quality of the submission by signing and dating this form OR by providing approval to the corresponding researcher via email (included as a PDF with the full HREC submission)
5. There are various aspects of human research compliance which fall outside of the remit of the HREC, but which must be in place to obtain HREC approval. These often require input from internal or external experts such as Faculty Data Stewards, Faculty HSE advisors, the TU Delft Privacy Team or external Medical research partners.
6. You can find detailed guidance on completing your HREC application here
7. Please note that incomplete submissions (whether in terms of documentation or the information provided therein) will be returned for completion **prior to any assessment**
8. If you have any feedback on any aspect of the HREC approval tools and/or process you can leave your comments here

I. Applicant Information

PROJECT TITLE:	**Promoting connectedness between collocated grandparents and grandchildren**
Research period: *Over what period of time will this specific part of the research take place*	**Sep.2023 – Feb.2024**
Faculty:	**Industrial design engineering**
Department:	**SDE**
Type of the research project: *(Bachelor's, Master's, DreamTeam, PhD, PostDoc, Senior Researcher, Organisational etc.)*	**Master's graduation**
Funder of research: *(EU, NWO, TUD, other – in which case please elaborate)*	
Name of Corresponding Researcher: *(If different from the Responsible Researcher)*	**Hongxin Xu**
E-mail Corresponding Researcher: *(If different from the Responsible Researcher)*	**Xhxin9@gmail.com**
Position of Corresponding Researcher: *(Masters, DreamTeam, PhD, PostDoc, Assistant/ Associate/ Full Professor)*	**Masters**
Name of Responsible Researcher: *Note: all student work must have a named Responsible Researcher to approve, sign and submit this application*	**Wilfred van der Vegte**
E-mail of Responsible Researcher: *Please ensure that an institutional email address (no Gmail, Yahoo, etc.) is used for all project documentation/ communications including Informed Consent materials*	**W.F.vanderVegte@tudelft.nl**
Position of Responsible Researcher : *(PhD, PostDoc, Associate/ Assistant/ Full Professor)*	**Assistant Professor**

II. Research Overview

NOTE: You can find more guidance on completing this checklist here

a) Please summarise your research very briefly (100-200 words)
What are you looking into, who is involved, how many participants there will be, how they will be recruited and what are they expected to do?

Add your text here – (please avoid jargon and abbrevations)

This research explores the emotional connection between collocated grandparents and their grandchildren (aged 8-12) and how to enhance their social interactions. Given the difficulty of language barriers and arranging for grandparents and grandchildren to take interview at the same time, the study is divided into two phases:

1. **Interviews:** We will conduct separate 30-minute face-to-face interviews with 6-8 grandparents and 6-8 grandchildren. Grandparents will be sourced from elderly communities around Delft, while children will be recruited from international schools in the Hague-Rotterdam area. The interviews will delve into their preferred modes of interaction and the reasons behind them.
2. **Prototype Testing**: Based on insights from the interviews, several design prototypes will be developed. These will be tested with 3-4 pairs of grandparents/grandchildren at their homes, where both grandparents and grandchildren will interact with the prototypes. The process of interaction will be recorded and noted. After the interaction, they will provide feedback on their experiences.

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III. Risk Assessment and Mitigation Plan

NOTE: You can find more guidance on completing this checklist here

Please complete the following table in full for all points to which your answer is "yes". Bear in mind that the vast majority of projects involving human participants as Research Subjects also involve the collection of Personally Identifiable Information (PII) and/or Personally Identifiable Research Data (PIRD) which may pose potential risks to participants as detailed in Section G: Data Processing and Privacy below.

To ensure alignment between your risk assessment, data management and what you agree with your Research Subjects you can use the last two columns in the table below to refer to specific points in your Data Management Plan (DMP) and Informed Consent Form (ICF) – **but this is not compulsory**.

It's worth noting that you're much more likely to need to resubmit your application if you neglect to identify potential risks, than if you identify a potential risk and demonstrate how you will mitigate it. If necessary, the HREC will always work with you and colleagues in the Privacy Team and Data Management Services to see how, if at all possible, your research can be conducted.

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
A: Partners and collaboration						
1. Will the research be carried out in collaboration with additional organisational partners such as: ☐ One or more collaborating research and/or commercial organisations ☐ Either a research, or a work experience internship provider[1] [1] *If yes, please include the graduation agreement in this application*		◉				
2. Is this research dependent on a Data Transfer or Processing Agreement with a collaborating partner or third party supplier? *If yes please provide a copy of the signed DTA/DPA*		◉				
3. Has this research been approved by another (external) research ethics committee (e.g.: HREC and/or MREC/METC)? *If yes, please provide a copy of the approval (if possible) and summarise any key points in your Risk Management section below*		◉				

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			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
B: Location		◉				
4. Will the research take place in a country or countries, other than the Netherlands, within the EU?		◉				
5. Will the research take place in a country or countries outside the EU?		◉				
6. Will the research take place in a place/region or of higher risk – including known dangerous locations (in any country) or locations with non-democratic regimes?		◉				
C: Participants						
7. Will the study involve participants who **may** be vulnerable and possibly (legally) unable to give informed consent? (e.g., children below the legal age for giving consent, people with learning difficulties, people living in care or nursing homes,).	◉		There may be difficulties ensuring that all participants fully understand the research process, especially for the children. Conversations about personal relationships could be sensitive, and discussing these topics could lead to discomfort or emotional distress for both grandparents and grandchildren. Some older participants might have undiagnosed cognitive challenges that could affect their ability to understand the interview questions or interact with the prototypes. Recording interactions in private homes raises significant privacy concerns. Participants might inadvertently share personal information during recorded sessions.	Obtain informed consent from the grandchildren's parents or legal guardians. Ensure that the children's assent is also obtained using age-appropriate language. For grandparents, ensure consent forms are clear and jargon-free. Offer to explain the forms verbally and confirm understanding. Be observant and patient, allowing extra time for responses or questions from participants with potential cognitive challenges. Securely store all recordings and ensure they are only accessed by authorized personnel. Inform participants about the scope of the recordings and obtain explicit consent for recording in their homes.		
8. Will the study involve participants who **may** be vulnerable under specific circumstances and in specific contexts, such as victims and witnesses of violence, including domestic violence; sex workers; members of minority groups, refugees, irregular migrants or dissidents?		◉				
9. Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children, own students or employees of either TU Delft and/or a collaborating partner organisation)? *It is essential that you safeguard against possible adverse consequences of this situation (such as allowing a student's failure to participate to your satisfaction to affect your evaluation of their coursework).*		◉				

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			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
10. Is there a high possibility of re-identification for your participants? (e.g., do they have a very specialist job of which there are only a small number in a given country, are they members of a small community, or employees from a partner company collaborating in the research? Or are they one of only a handful of (expert) participants in the study?	◉		Since participants are being sourced from specific communities and schools, the pool of potential participants is relatively small, which could lead to re-identification. If the data collected contains unique attributes or quotes that are identifiable, this increases the risk of participant re-identification. There is a risk of accidental disclosure of participant information during the dissemination of research findings, especially in local areas where communities are tight-knit. Conducting prototype testing in homes could inadvertently reveal participants to neighbors or others who were not intended to be privy to their participation.	Implement robust anonymization techniques, ensuring that all published data is stripped of any potential identifiers. Use pseudonyms and avoid mentioning specific locations or attributes that could lead to re-identification. Establish strict data access protocols so that only essential personnel have access to raw data. Clearly explain to participants the measures taken to protect their identity and the potential risks of re-identification. Carefully review all research outputs, such as papers and presentations, to ensure they do not contain identifying information. Inform participants about how to talk about the study with others in a way that does not compromise their anonymity.		
D: Recruiting Participants						
11. Will your participants be recruited through your own, professional, channels such as conference attendance lists, or through specific network/s such as self-help groups		◉				
12. Will the participants be recruited or accessed in the longer term by a (legal or customary) gatekeeper? (e.g., an adult professional working with children; a community leader or family member who has this customary role – within or outside the EU; the data producer of a long-term cohort study)		◉				
13. Will you be recruiting your participants through a crowd-sourcing service and/or involve a third party data-gathering service, such as a survey platform?		◉				
14. Will you be offering any financial, or other, remuneration to participants, and might this induce or bias participation?		◉				
E: Subject Matter *Research related to medical questions/health may require special attention. See also the website of the CCMO before contacting the HREC.*						
15. Will your research involve any of the following: ☐ Medical research and/or clinical trials ☐ Invasive sampling and/or medical imaging ☐ Medical and *In Vitro Diagnostic Medical* Devices Research		◉				

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			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
16. Will drugs, placebos, or other substances (e.g., drinks, foods, food or drink constituents, dietary supplements) be administered to the study participants? *If yes see here to determine whether medical ethical approval is required*		◉				
17. Will blood or tissue samples be obtained from participants? *If yes see here to determine whether medical ethical approval is required*		◉				
18. Does the study risk causing psychological stress or anxiety beyond that normally encountered by the participants in their life outside research?		◉				
19. Will the study involve discussion of personal sensitive data which could put participants at increased legal, financial, reputational, security or other risk? (e.g., financial data, location data, data relating to children or other vulnerable groups) *Definitions of sensitive personal data, and special cases are provided on the TUD Privacy Team website.*	◉		The research might involve discussions about personal experiences, preferences, or challenges in intergenerational relationships. While not directly financial or location-based, these discussions could reveal sensitive aspects of family dynamics or personal feelings. If sensitive data were to be mishandled or disclosed, participants could face emotional distress, strained family relationships, or reputational harm.	1. Ensure that interview questions are crafted with sensitivity, avoiding overly intrusive or potentially harmful topics. 2. Allow participants to skip questions or withdraw from the discussion if they feel uncomfortable. 3. Ensure participants are aware of the nature of the questions and potential risks during the consent process. Obtain informed consent from their parents or legal guardians. 2. Ensure that the child assents to participate and feels comfortable throughout the process. 3. Store and handle data related to children with extra care and security measures. Ensure strict confidentiality protocols. 2. Anonymize data immediately upon collection. 3. Store data securely, using encryption if necessary. 4. Limit data access only to the research team. 5. Ensure data is deleted or securely archived after research completion.		
20. Will the study involve disclosing commercially or professionally sensitive, or confidential information? (e.g., relating to decision-making processes or business strategies which might, for example, be of interest to competitors)		◉				
21. Has your study been identified by the TU Delft Privacy Team as requiring a Data Processing Impact Assessment (DPIA)? *If yes please attach the advice/ approval from the Privacy Team to this application*		◉				
22. Does your research investigate causes or areas of conflict? *If yes please confirm that your fieldwork has been discussed with the appropriate safety/security advisors and approved by your Department/Faculty.*		◉				

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			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
23. Does your research involve observing illegal activities or data processed or provided by authorities responsible for preventing, investigating, detecting or prosecuting criminal offences *If so please confirm that your work has been discussed with the appropriate legal advisors and approved by your Department/Faculty.*		◉				
F: Research Methods						
24. Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g., covert observation of people in non-public places).	◉		While the research involves direct interviews and prototype testing, the act of recording interactions during the prototype testing phase introduces potential risks. Participants might forget they're being recorded or might not fully grasp the extent to which their actions and words are being captured, leading to potential feelings of violation or discomfort	1. Clearly inform participants that the interaction will be recorded. 2. Obtain explicit consent for recording, ensuring they understand the purpose and how the recordings will be used. 3. Allow participants the option to pause or stop the recording at any point if they feel uncomfortable. Ensure transparency in all research interactions, especially regarding the recording process. 3. Provide participants with a way to view the recording if they wish and offer the option to have certain parts deleted. 4. Assure participants that recordings will be stored securely and only accessed by the research team.		
25. Will the study involve actively deceiving the participants? (For example, will participants be deliberately falsely informed, will information be withheld from them or will they be misled in such a way that they are likely to object or show unease when debriefed about the study).		◉				
26. Is pain or more than mild discomfort likely to result from the study? And/or could your research activity cause an accident involving (non-) participants?		◉				
27. Will the experiment involve the use of devices that are not 'CE' certified? *Only, if 'yes': continue with the following questions:*		◉				
☐ Was the device built in-house?						
☐ Was it inspected by a safety expert at TU Delft? *If yes, please provide a signed device report*						
☐ If it was not built in-house and not CE-certified, was it inspected by some other, qualified authority in safety and approved? *If yes, please provide records of the inspection*						

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			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
28. Will your research involve face-to-face encounters with your participants and if so how will you assess and address Covid considerations?	●		**Maybe the covid issue is not applying at the time of the study.**	**Maybe the covid issue is not applying at the time of the study.**		
29. Will your research involve **either:** a) "big data", combined datasets, new data-gathering or new data-merging techniques which might lead to re-identification of your participants **and/or** b) artificial intelligence or algorithm training where, for example biased datasets could lead to biased outcomes?		●				
G: Data Processing and Privacy						
30. Will the research involve collecting, processing and/or storing any directly identifiable PII (Personally Identifiable Information) including name or email address that will be used for administrative purposes only? (eg: obtaining Informed Consent or disbursing remuneration)	●		To coordinate interviews and prototype testing, we'll likely need to collect names, contact details, or addresses of participants. This PII, especially when linked to the sensitive topic of family relationships and technology use, can lead to potential privacy breaches or misuse of data. The specific demographics (elderly from Delft and children from international schools in the Hague-Rotterdam area) make the data more sensitive. Any breach of PII could lead to significant distress or harm to participants.	1. Limit the collection of PII to only essential details needed for coordination (e.g., name, phone number). 2. Store this data separately from research data to prevent linkage. 3. Use secure, encrypted methods for storing and transmitting PII.		
31. Will the research involve collecting, processing and/or storing any directly or indirectly identifiable PIRD (Personally Identifiable Research Data) including videos, pictures, IP address, gender, age etc and **what other Personal Research Data** (including personal or professional views) will you be collecting?	●		The research involves recording interactions during prototype testing, which could include videos or pictures. This data can directly identify participants. Data like age, gender, or views on technology and intergenerational relationships can indirectly identify participants, especially when combined.	1. Inform participants about the nature and purpose of the recordings. 2. Obtain explicit consent for recording. 3. Store recordings securely, using encryption if necessary. 4. Anonymize or blur faces in videos or pictures if they are to be shared or presented.		
32. Will this research involve collecting data from the internet, social media and/or publicly available datasets which have been originally contributed by human participants		●				
33. Will your research findings be published in one or more forms in the public domain, as e.g., Masters thesis, journal publication, conference presentation or wider public dissemination?	●		It will be published in the form of Master Thesis, Publishing research findings can inadvertently include directly or indirectly identifiable PIRD, leading to potential privacy breaches. Once in the	1. Ensure that all published data is thoroughly anonymized or aggregated. 2. Avoid using specific details that could lead to re-identification, especially given the unique demographics of the study. 3. Clearly		

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			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
			public domain, research findings can be taken out of context, misinterpreted, or misused, potentially leading to harm or misinforming the public. Participants or their families might feel exposed or judged based on the published findings, especially if they believe their identities could be discerned.	define the scope, limitations, and context of the research in any publication. 4. Provide clear interpretations and avoid overgeneralizing findings.		
34. Will your research data be archived for re-use and/or teaching in an open, private or semi-open archive?		◉				

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REVISIONS TEMPLATE
(Version: January 2022)

This revisions template should be used to address queries raised by the Human Research Ethics Committee (HREC) in an ongoing ethics approval and uploaded into your live submission.

If you have any questions about your applying for HREC approval which are not dealt with on the Research Ethics webpages, please contact HREC@tudelft.nl

I. **Response to HREC queries:**

Query 1:

HREC Query	HREC Checklist: please specify these prototypes, it is unclear what these are and what the interaction with them will look like.
Response	**(in this phase, we haven't decide what kind of protptypes that we are going to test, in order to have a general feeling/overview about what we are going to test, we could provide some examples of ideas and what kind of interactions with them will be look like. Also, given that only 2-3 families are going to test with the prototype, we will update the consent form and include the purpose of the prototype, function of the prototype, key features of the prototype and how they would use the prototype,** and the potential risk the prototype might bring to them and how we are going to take measures to minimize the risks. In this way participants can have a deeper understanding about what they are going to do and possible risks during the test.) **Everyday objects scavenger:** This interactive prototype, combines technology with traditional storytelling and puzzle-solving to foster communication and connection between grandchildren and grandparents. **Physical part:** The cup and teapot are made from durable, child-friendly materials with built-in speakers that could trigger dialogue with children. Digital part: Each object contains a small computer module capable of storing and playing back audio. They are equipped with microphones for receiving voice commands and sensors to detect interaction (such as being picked up). **What interactions will be like :**The cup initiates a puzzle-solving game, giving the grandkid clues to find the next object within the house, integrating elements of a scavenger hunt.The teapot plays the role of a storytelling device, asking questions about the grandparents' experiences with various objects, leading the child to engage in conversations with their grandparents to learn stories and facts about family history. **Possible risks:** Emotional Distress: Incorrect answers or difficulty in solving puzzles could frustrate the child. Dependency: Overreliance on the device for interaction instead of organic conversation. Privacy Invasion: Collecting personal stories might raise concerns about data privacy. **How to mitigate:** Supportive Design: Ensure the games and puzzles have adjustable difficulty levels and include supportive prompts to reduce frustration. Balanced Interaction: Schedule device usage to encourage regular interaction without developing dependency. Promote equal time for organic, device-free interaction. Privacy Considerations: Do not include wireless connectivity that could lead to data breaches. Ensure all interactions are stored locally and encrypted, and clarify to users that no personal data will be collected or stored beyond the local device. Provide clear instructions on how to delete stored data. **Silent storytelling:** This prototype offers an engaging way for grandparents and grandchildren to bond through interactive, physical storytelling. **Physical part:** a screen capable of clearly displaying projected shadows and a camera system with motion-sensing technology to capture the participants' movements. Digital Part: Software that translates these movements into shadow characters on the screen, allowing for real-time interaction and storytelling. An interface for selecting different characters or themes for the storytelling session. What Interactions will be like : Participants select their preferred characters or story themes through an interactive menu. As they move in front of the backdrop screen, their motions are captured by the camera and translated into live shadow projections, allowing them to act out stories using their body movements. Possible risks: Physical Strain: Extended physical activity could be strenuous for some grandparents. Technical Difficulties: Issues with camera tracking or software could disrupt the storytelling experience. Privacy Concerns: Using a camera system may raise concerns about recording and data storage. How to mitigate: Ergonomic Design: Ensure that the physical activity required is suitable for all ages and abilities. Provide breaks and alternative options for those unable to participate fully. Reliable Technology: Use robust motion-capture technology and have backup systems in place to minimize technical disruptions.Privacy Safeguards: The camera system should not record video or store any data unless explicitly required for the function of the story. Any such data should be strictly controlled and secured, with clear consent from the participants about its use.

Query 2:

HREC Query	In the DMP, please reflect on the devices you will be using to collect these data, and how you will ensure these preserve the privacy of prospective participants.
Response	All the data will first be recorded with the personal device (researcher's mobile phone), and then the transcribing session will be done by local transcribing software on the researcher's laptop(no internet connection) to minimize the risk of data leaking. After transcribing is done, audio recordings will be uploaded to SURFdrive and deleted in the researcher's devices (both mobile phone and laptop), and participants will be tagged with the label "grandparent PX" or "grandchild PX." (x is the order in which he/she participated in the interview) so any identifying information is removed. For the video recording, the researcher will analyze the audio in the same process as the audio recording. After transcription and uploading to SURFdrive, it will be removed from the personal device(where the original data is being collected). The researcher will do extra analysis to the video (observational and analytical results (for example, at which phase grandparent and grandchildren is feeling confused or engaged with the prototype that is being tested). If an additional screenshot is necessary to support the finding, the researcher will blur the entire figure and use the drawing to depict the outline of participants, in this way protecting the security of participants. If additional video is necessary to support the finding (like movement between grandchild and grandparent), the researcher will blur the faces of participants and use stickers to cover their faces; their home environment will also be blurred to ensure privacy. All original data (the audio, and video recordings and derivative data will be destroyed immediately after uploading and only accessible to the research team)

Query 3:

HREC Query	The IC forms need to be in Dutch (as well), to increase understanding. Furthermore, the current phrasing is very lenient with data usage, e.g. photographs and audio being used for publicity. Please make sure that all language is geared towards informing participants, including about the protections in place.
Response	1. Revision in data usage part: This material will be used solely for the purposes of data analysis within the scope of the associated graduation project. All collected data, including photographs and audio recordings, will be treated with the utmost confidentiality. Identifying information will be obscured or removed where possible, participants will be identified by pseudonyms or code name (like P1) in any research report or publication to protect their identities. Any photographs used in the graduation report will be chosen carefully to ensure they do not compromise the privacy of any participant. Faces and other identifying features will be blurred. All data will be stored securely, accessible only to the research team. Participants and their legal guardians have the right to review the materials in which they are featured before they are used in the report or any other form. Participants have the right to request that their data be removed or altered if they have concerns about privacy or how they are represented. 2. Language of IC forms After a more detailed explanation as above, all English forms will be attached with a Dutch version to increase understanding.

Appendix D - Ethics Application

Plan Overview

A Data Management Plan created using DMPonline

Title: Promoting connectedness between grandparents and grandchildren

Creator:hongxin xu

Principal Investigator: Hongxin Xu

Data Manager: Mathieu Gielen

Project Administrator: Hongxin Xu

Contributor: Wilfred van der Vegte

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2021)

Project abstract:

This research explores the emotional connection between collocated grandparents and their grandchildren (aged 8-12) and how to enhance their social interactions. Given the difficulty of language barriers and arranging for grandparents and grandchildren to take interviews at the same time, the study is divided into two phases:

1. Interviews: We will conduct separate 30-minute face-to-face interviews with 6-8 grandparents and 6-8 grandchildren. Grandparents will be sourced from elderly communities around Delft, while children will be recruited from international schools in the Hague-Rotterdam area. The interviews will delve into their preferred modes of interaction and the reasons behind them. (audio recordings of the whole interview process will be gained after participants sign the consent form with the researcher's mobile phone)
2. Prototype Testing: Based on insights from the interviews, several interactive design prototypes will be developed. These will be tested with 2-3 pairs of grandparents/grandchildren at their homes, where both grandparents and grandchildren will interact with the prototypes. The process of interaction will be recorded and noted. After the interaction, they will provide feedback on their experiences.
(video recordings of the whole interview process will be gained after participants sign the consent form with the researcher's mobile phone)

ID: 134925

Start date: 03-07-2023

End date: 29-02-2024

Last modified: 12-12-2023

Promoting connectedness between grandparents and grandchildren

0. Administrative questions

1. Name of data management support staff consulted during the preparation of this plan.

Question not answered.

2. Date of consultation with support staff.

Question not answered.

I. Data description and collection or re-use of existing data

3. Provide a general description of the type of data you will be working with, including any re-used data:

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Type of data	File format(s)	How will data be collected (for re-used data: source and terms of use)?	Purpose of processing	Storage location	Who will have access to the data
anonymized data on opinions about personal preferred activities with grandparents(grandchildren)and relationship with grandparents(grandchildren)	.mp3 files	recorded by the researcher's mobile phone recorder from interview	To understand target groups (grandparents and grandchildren) likes and dislikes when they have social interaction with each other and how do they feel connected	SURF drive	The project team (Mathieu Gielen, Wilfred van der Vegte, and Hongxin Xu)
video recordings on how grandparents and grandchildren interact with the prototype together	.mp4 files	recorded by researcher's mobile phone camera(video-recording) from the tester's home	To understand the tester's reaction toward the prototype as well as their communication and interaction process with each other. Sometimes body reactions and facial expressions can reveal more resourceful information than only sound	SURF drive	The project team (Mathieu Gielen, Wilfred van der Vegte, and Hongxin Xu)
anonymized data about the tester's feedback on the prototypes	.mp3 files	recorded by the researcher's mobile phone recorderfrom the tester's home	To understand their experience and feedback on the prototypes and examine if the prototype can have positive effective on their emotional connectedness	SURF drive	The project team (Mathieu Gielen, Wilfred van der Vegte, and Hongxin Xu)

4. How much data storage will you require during the project lifetime?

- < 250 GB

II. Documentation and data quality

5. What documentation will accompany data?

- Methodology of data collection

III. Storage and backup during research process

6. Where will the data (and code, if applicable) be stored and backed-up during the project lifetime?

- SURFdrive

All the data will first be recorded with the personal device (researcher's mobile phone), and then the transcribing session will be done by local transcribing software on the researcher's laptop(no internet connection) to minimize the risk of data leaking. After transcribing is done, audio recordings will be uploaded to SURFdrive and deleted in the researcher's devices (both mobile phone and laptop), and participants will be tagged with the label "grandparent PX" or "grandchild PX." (x is the order in which he/she participated in the interview) so any identifying information is removed.

For the video recording, the researcher will analyze the audio in the same process as the audio recording. After transcription and uploading to SURFdrive, it will be removed from the personal device(where the original data is being collected). The researcher will do extra analysis to the video (observational and analytical results (for example, at which phase grandparent and grandchildren is feeling confused or engaged with the prototype that is being tested). If an additional screenshot is necessary to support the finding, the researcher will blur the entire figure and use the drawing to depict the outline of participants, in this way protecting the security of participants. If additional video is necessary to support the finding (like movement between grandchild and grandparent), the researcher will blur the faces of participants and use stickers to cover their faces; their home environment will also be blurred to ensure privacy.

All original data (the audio, and video recordings and derivative data will be destroyed immediately after uploading and only accessible to the research team)

IV. Legal and ethical requirements, codes of conduct

7. Does your research involve human subjects or 3rd party datasets collected from human participants?

- Yes

8A. Will you work with personal data? (information about an identified or identifiable natural person)

If you are not sure which option to select, first ask your Faculty Data Steward for advice. You can also check with the privacy website. If you would like to contact the privacy team: privacy-tud@tudelft.nl, please bring your DMP.

- Yes

8B. Will you work with any other types of confidential or classified data or code as listed below? (tick all that apply)

If you are not sure which option to select, ask your Faculty Data Steward for advice.

- No, I will not work with any confidential or classified data/code

9. How will ownership of the data and intellectual property rights to the data be managed?

For projects involving commercially-sensitive research or research involving third parties, seek advice of your Faculty Contract Manager when answering this question. If this is not the case, you can use the example below.

We don't have a third parties involved so the data and IP rights are belong to and be managed within TU Delft

10. Which personal data will you process? Tick all that apply

- Names and addresses
- Email addresses and/or other addresses for digital communication
- Gender, date of birth and/or age
- Photographs, video materials, performance appraisals or student results
- Signed consent forms
- Data collected in Informed Consent form (names and email addresses)

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11. Please list the categories of data subjects

For Phase 1(interview):
children (8-12 years old)
Senior people who have grandchildren aged between 8-12
For Phase 2(testing):
Children(8-12 years old) who live close to their grandparents

12. Will you be sharing personal data with individuals/organisations outside of the EEA (European Economic Area)?

- No

15. What is the legal ground for personal data processing?

- Informed consent

16. Please describe the informed consent procedure you will follow:

I will explain my identity and project information orally first and give the consent form to participants to sign their names.

17. Where will you store the signed consent forms?

- Same storage solutions as explained in question 6

18. Does the processing of the personal data result in a high risk to the data subjects?

If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data during your research (check all that apply).
If two or more of the options listed below apply, you will have to complete the DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to receive support with DPIA.
If only one of the options listed below applies, your project might need a DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to get advice as to whether DPIA is necessary.
If you have any additional comments, please add them in the box below.

- None of the above applies

22. What will happen with personal research data after the end of the research project?

- Personal research data will be destroyed after the end of the research project

V. Data sharing and long-term preservation

27. Apart from personal data mentioned in question 22, will any other data be publicly shared?

- All other non-personal data (and code) underlying published articles / reports / theses

29. How will you share research data (and code), including the one mentioned in question 22?

- All anonymised or aggregated data, and/or all other non-personal data will be uploaded to 4TU.ResearchData with public access

30. How much of your data will be shared in a research data repository?

- < 100 GB

31. When will the data (or code) be shared?

- As soon as corresponding results (papers, theses, reports) are published

32. Under what licence will be the data/code released?

- CC BY-NC-SA

VI. Data management responsibilities and resources

33. Is TU Delft the lead institution for this project?

- Yes, the only institution involved

34. If you leave TU Delft (or are unavailable), who is going to be responsible for the data resulting from this project?

My supervisors
Mathieu Gielen M.A.Gielen@tudelft.nl
Wilfred van der Vegte W.F.vanderVegte@tudelft.nl

35. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

4TU.ResearchData is able to archive 1TB of data per researcher per year free of charge for all TU Delft researchers. We do not expect to exceed this and therefore there are no additional costs of long term preservation