

DESIGN AND EVALUATION OF A QUIZ GAME TO SUPPORT INTERGENERATIONAL SOCIAL CONNECTEDNESS

A MULTISTAGED APPROACH IN DESIGNING A GAME THAT CAN ENHANCE INTERGENERATIONAL FAMILIAL RELATIONSHIPS

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ABSTRACT

This thesis explores the design and evaluation of a quiz game, aimed at enhancing intergenerational familial relationships, between grandparents and grandchildren. The author recognizes the rapid advance of technology, that widens the generational digital divide, and integrates insights from existing literature with data acquired through interviews, in this thesis. This research aims to advance the understanding of the manner in which technology can have a positive impact in human-human interaction and overall well-being, by creating a game that places its focus on its asymmetric features. The research process involved initial interviews ($N=7$), in order to validate the findings of the literature research, and guide the design of the game user interface. Following the development of the game prototype (UI), a second stage of interviews ($N=7$) was conducted, where participants (couples of grandparent-/grandchild) interacted with the game, and each other, and provided feedback on both their experience, and perceived enhancement of social connectedness. The evaluation of the prototype suggested that the game has the potential to enhance intergenerational familial relationships, through game-based communication. Limitations did exist, something that highlights the need for further research and development. Future work should focus on addressing these limitations, as well as, considering new prospects for the project, such as a cross-cultural approach, for the sake of research.

KEYWORDS

Intergenerational social connectedness, Digital games, Quiz game, Familial Relationships, Human-computer interaction (HCI)

GITHUB REPOSITORY

<https://github.com/StefanosNtouvlis/intergenerational-quiz-public/tree/main>

1 INTRODUCTION

In the last few decades, technology has taken major advances forward, introducing everyone into a new reality. This is evident from the fact that “less than 1% of the world’s technologically stored information was in digital format in the late 1980s, surpassing more than 99% by 2012”, as documented by Hilbert [17]. While young people learn from the very beginning of their lives, to live and utilize these technologies, older adults, still face a digital divide [23], and thus a generational gap is formed. Putting into the equation the fact that in the current era, one of the biggest demographic trends is population aging [6], and the end result is a divided population, where a large portion of it (older individuals), is having trouble communicating effectively with the rest.

One approach to enhance intergenerational, familial bonds is through engagement in shared activities, that appeal to both sides of the age spectrum [30].

A type of activity that has been the subject of substantial research, in the past years, has been gaming. The gamification of communication and relationship bonding is gaining increasingly more attention in research, as evident by the comprehensive scoping

review of Reis et al. [32]. Scientists have been conducting numerous, different studies on how gaming affects relationships [41] and especially familial ones [10, 21], with the results being positive and suggesting that more research could prove to be beneficial [8].

Delving into the interdisciplinary domain of Human-Computer Interaction (HCI), in this paper, a quiz game is presented, as an aid in the bridging of relationships between family members of different generations.

The main research question (RQ) that guides the paper is:
Which features in a quiz game can support social connectedness between older adults and adolescents/young adults?

Subquestions (S.RQs) that stem from the main RQ are:

- S.RQ1 Which design characteristics in a quiz game context appeal to older adults vs. younger adults?
- S.RQ2 How can such design characteristics be integrated in an asymmetric design for older adults to play with younger adults to support social connectedness?
- S.RQ3 Can an asymmetric quiz game, designed to appeal to both older and younger adults, support feelings of social connectedness for users of both age groups?

As mentioned above, there is active research on this subject, as indicated by the thoroughness and scope of the literature reviews [8, 32], and there are already a number of papers concerning Intergenerational Gaming [39, 43]. While that holds true, this specific scientific field is recent, and as mentioned in most papers, more research has to be done on it. Especially regarding the asymmetrical features that can be incorporated in an intergenerational, familial, game-based communication setting, there is considerable space for development [8, 10, 32]. Furthermore, while there have been studies with demo (test) games, created for the sake of research [10, 21, 29], having asymmetric roles as the center of their study, there still, to my knowledge, has not been an attempt to create an intergenerational game that focuses on providing asymmetric features in its design, thus promoting equal playing opportunities to all users, while accommodating their differing needs and abilities.

All in all, the creation of a quiz game, with particular emphasis placed on its asymmetric design elements that aid social connectedness between older and younger adults, presents an exciting prospect in the field of Human-Computer Interaction. By attempting to enhance familial bonds and promote social connectedness among family members of different generations, this research aims to contribute to the broader understanding of how technology can positively impact human-human interaction and overall well-being. The high extent that this is possible is evident by the positive results of the numerous studies concerning the subject [8, 32]. Furthermore, the research highlights the significance of incorporating such insights into the design and development of future interactive systems, potentially transforming the landscape of both technology-mediated and face-to-face interactions.

2 RELATED WORK

While there are already a number of scientific papers [8, 30, 40] concerning the subject of intergenerational relationships and the effect that gamified or game-based communication can have on them,

a game developed with an approach that employs an asymmetric game design perspective, providing equal playing opportunities to all users and taking into account their specific needs and abilities, has yet to be seen. Based on previous research, this paper will attempt to fill that gap.

2.1 Research Methodology

For this study, the approach that was used consisted of several steps. First, the search revolved around utilizing Google Scholar to find, relevant to the subject, papers from multiple scientific websites and databases. These included: Science Direct, PubMed, Sage Journals, MDPI, IEEE Xplore, Frontiers, SpringerLink and ACM DIGITAL LIBRARY. A number of keywords were used to narrow down the search: “gaming”, “intergenerational”, “asymmetrical design”, “intergenerational-gaming”, “generations”, “family-bonding”, “demo-game”, “family-relationships”, “game-design”, “gamified-communication”.

The papers were assessed and reviewed to prioritize papers with a number of citations, as well as systematic reviews (for their overview), with the criterion that they discuss the effect of intergenerational gaming on familial relationships and features that intergenerational games should have.

2.2 Asymmetric game design - *Past Research*

In their paper Harris et al. [16], discuss asymmetric multiplayer games, their design, as well as, ways it can be improved, in order to enhance the users’ engagement, whilst taking into consideration their differences (e.g., preferences, needs, abilities). They present such a game, called “Beam Me ‘Round Scotty!”, to showcase the elements of asymmetry that can be utilized in designing this type of games, and finally, they propose an initial conceptual structure for designing asymmetric games. Using the MDA framework [19] as the basis for their game design, and through user testing and interviewing, they managed to do a thematic analysis of the gameplay-test results, identifying striking themes that can be utilized in the research and design of asymmetric games. “Leadership and Primacy”, was one of the main themes, with the role taking being dependent on many factors, such as previous game experience, (similar to the findings of Volda and Greenberg [40]), and with the writers highlighting the importance of future research to focus on that specific theme. It is notable, that other studies, with their respective frameworks [7, 28, 33], draw heavily from Harris et al. [16], showcasing both the importance of further research on the subject, and the value of this specific paper.

2.3 Intergenerational Gaming - *Past Research*

Below, some of the core papers that this research is grounded upon are presented, categorized by their main theme.

2.3.1 Features and factors to be considered, in the creation of Intergenerational Games. Kow et al. [22] provide an extensive guide on the features that an intergenerational game must have, based on the Chinese social networking game QQ Farm. To achieve that, they conducted a series of interviews with both parents and children, asking about the interaction they have with the game, as well as, with each other. Their key findings were focused on design features in QQ Farm that support and encourage intergenerational play.

A low entry barrier, a widely appealing game theme, a low time commitment, online interactions that extend real-life relationships, and asynchronous play were the most significant features. Lastly, cultural-related features were given a special mention (e.g., stealing of crops for the Chinese population) [22].

The systematic review of De la Hera et al. [8], highlights various benefits (reinforcing family bond, increasing understanding of the other generation, reducing social anxiousness, enhancing reciprocal learning) and factors (old-young interactions, motivation to play and game preferences, goal/space-related forms of interaction) to be taken into consideration for the design of intergenerational digital games. It thoroughly examines the differences in abilities as a critical (player-centric) factor, since it one of the factors that show the greatest level of disparity. The factors presented in the review, are divided into game and player centric, and are showcased in a table format, alongside the number of different studies discussing them and their implications discussed in the literature.

Lastly, the paper references the study of Derboven et al. [10], that showed that the addition of a communication function, in a multi-player, intergenerational game is something welcomed by members of both generations (older adults with an average age of 68 and their (grand)children of 22), and something that also enhances the sharing of each other’s knowledge and experience.

2.3.2 Gamified (game centered) relationship bonding in contrast to traditional one. Pecchioni and Osmanovic [30] showcase, in their study, the positive impact that intergenerational gaming can have in the relationship of family members. In their research, they had the participants (mainly grandparents and grandchildren) play video games together over a period of six weeks, and compared their relationship progress to that of a similar group, that was simply told to converse with each other, for a certain amount of time, through the same period. The results of the gaming group were very positive (especially in contrast to the second group) showcasing a clear increase in the Inclusion of others (IOS) scale. The paper also underlines an issue of major significance. While the study does highlight the importance of relationship closeness and the way gaming can enhance that, it also brings to light the high importance of the selection of an appropriate game, for both sides to be equally motivated and engaged [30].

2.3.3 Review of Prior Research. In a scoping review, Reis et al. [32] investigated existing literature in order to identify technologies designed or employed to encourage interactions between different generations. Their aim is to uncover common themes and suggest potential areas for future research. They specifically point out the importance of the existence of such a technology in the current era, when families are, oftentimes, geographically dispersed. Moreover, based on other sources as well (e.g., Costa and Veloso [5]), they point out that gaming can promote intergenerational interactions by contributing to multiple aspects, such as individual well-being and prosocial behaviors, especially highlighting knowledge-sharing. Furthermore, they underline a big issue in the design process of the gaming studies, and that is the fact there was no interaction and no feedback, from the gamers themselves [32].

2.3.4 Intergenerational Gaming Roles. Another paper that focuses its research on intergenerational gaming, is that of Voda and Greenberg [40]. Focusing their research on console gaming, and involving four different generations of participants in their study, they found evidence to support the idea that gaming in different generations provides ample opportunities for intergenerational interaction, as well as, many developmental benefits to participants, with their roles (e.g., instructor/instructed, decision maker/supplicant, configurer/bystander) being differentiable depending on the game and the need in hand. For instance, the adults and/or mature adults were the main decision makers regarding the start and end of gaming sessions and all decisions concerning turn-taking, while the youngsters assumed a more passive role (negotiator). Conversely, youths mainly assumed the role of decision makers for other types of decisions. Amongst those were the game choices, the role assignments, as well as the respective actions that each one would have to take in the game. Lastly, the study presented design recommendations for future reference in designing intergenerational games [40].

2.4 Gaps in Intergenerational Gaming Research

After reviewing these papers, it becomes apparent that there has been a substantial amount of research concerning Intergenerational Gaming. As most of these papers mention, though, it is still a young field that needs to be researched more. There is a necessity for exploring a wider range of intergenerational relationships beyond just grandparents and grandchildren, as mentioned in the study of De la Hera et al. [8]. Reis et al. [32] underline, the need for more standardized approaches to studying intergenerational connectivity still exists. Moreover, they highlight that the current geographical dispersion creates a solid demand for the existence of such technologies, something also backed up by Pecchioni and Osmanovic [30]. Furthermore, Derboven et al. [10] suggest conducting experiments in the users' natural environments, with unobtrusive, remote testing, in order to gain a more accurate understanding of real-life communication during gaming, in comparison to lab-based settings.

2.5 Value of Proposed Solution

The application of asymmetric design features is highly suited to this particular domain of computer-supported human-human interaction, and aligns with key questions in human-computer interaction in how it centers social connection and wellbeing, through supporting technologies.

Through the ability to play seamlessly, with attention paid to their respective needs, a new level of comfort will be introduced to family members of different age-groups, thus strengthening their relationships. Lastly, the iterative process of user reviewing, feedback and revisions, that this project will entail, will lead to a deeper understanding of the actual wants and needs of people, and as an outcome propose an extensive set of design recommendations, for games that foster intergenerational bonds.

3 METHODOLOGY

In this thesis, a user-centered, multi-staged approach was utilized. The stages included an initial round of interviews (& questionnaires), followed by the creation of a prototype, guided by the interview results, which led to the user study phase, and concluded

with the prototype's refinement. After initial research on intergenerational (familial) relationships and the potential effects that gamified, or game-based communication can have on them (Section 2), the first interviewing stage took place. The insights gained from the semi-structured interviews were thematically analyzed following Mishra and Dey [26] and Ryan and Bernard [34], and were used in order to guide the design of the game-prototype. Based on the results of this stage and previous research [22], the prototype design was developed. Afterward, the same participants were relied upon again in order to evaluate the prototype, give their feedback on possible improvements, and through the IOS scale [2] assess their relationship's strength. Finally, a short refinement stage took place, where the feedback of the participants was used to further improve the prototype.

3.1 Research Design

This paper uses a mixed-methods research design utilizing both qualitative and quantitative approaches. The combination of the two, provides a comprehensive understanding, enhances validity through triangulation [4], contextualizes findings and leverages their complementary strengths. The project researches, develops and evaluates an asymmetric intergenerational game, that enhances the relationships between the participants. The research design is iterative, since it allows for continuous refinement of the gaming and communication experience based on user feedback. The iterations involve going through the prototype design at least two times, with each iteration refining it, based on user feedback and testing results. The number of iterations is dependent on factors such as the complexity of the game, the extent of feedback received, and the resources available for refinement.

3.2 Design Approach

The approach of the game's design and implementation is user-centered [24], since both the original implementation and future refinement are heavily based on the users' feedback. By combining insights from already existing research with first-hand input from the potential users, the approach ensures that the resulting game design aligns closely with the needs and desires of its intended audience. Moreover, as mentioned in the previous sections, the game design heavily emphasizes asymmetry, evident in the numerous asymmetrical features the game will include (e.g., accessibility features, roles) [16]. The rationale behind this choice lies in the value that such a design can have in the enhancement of relationships, as suggested by multiple other papers on this aspect [7, 16, 28, 33].

3.3 Interviews and Questionnaire (1st Stage)

A set of custom questions was developed, in order to gain valuable insight to guide the creation of the game prototype. The questions were mainly focused on the participant's needs, wants, as well as past (digital) game experiences (see Appendix C). Additionally, a demographics survey was created to gather statistical data from the participants and document their affinity for technology interaction, with the use of an Affinity for Technology Interaction (ATI) scale [13] (see Appendix B). The entire procedure, consisting of the questionnaire and the interview, was reviewed via an ethics application by a domain expert within the Informatics Institute, at

the University of Amsterdam, before the survey questionnaire was distributed. Participants were approached and recruited through “convenience sampling” [12], where individuals fitting the inclusion criteria are selected based on their availability and willingness to participate. The inclusion criteria were:

- Participants are family members, pairs of grandparents and grandchildren (any gender).
- They are aged 60+ and 18-30, respectively.
- They both agree to participate (interview in pairs).

The recruitment was conducted through the student investigator’s personal networks and contacts, in Greece, leveraging relationships with individuals who meet the specified criteria. This approach enabled a more accessible and convenient recruitment process. Additionally, it aided in maintaining ethical considerations, concerning informed consent, as well as voluntary participation. Furthermore, snowball sampling was employed to inquire participants concerning the possibility of them recommending people, in their own social circle, who would be willing to participate as well. All participation happened voluntarily and without compensation. This first interview stage took place between 4 June and 6 June 2024. During that time, 7 interviews were conducted, with no withdrawals. The interviews were held face-to-face, at the participants’ homes and were conducted in Greek (the participants’ native language), to promote comfort, as well, as interactivity, for a more fruitful feedback analysis. The interviews were semi-structured, typical for qualitative research [11], allowing the participants to expand and stray from the main questions, in favor of getting more insights on their personal views. These interviews were a major, defining step, affecting heavily the game design and implementation. Since the design is user-centric, a large portion of the decision-making concerning the features of the game, is decided at this stage. It is noteworthy that past research [32] underlines the importance of this step, highlighting occasions where omission of such user input led to suboptimal outcomes and errors in the implementation [35, 38].

3.3.1 Measures. The ATI scale was used to evaluate the participants’ relationship with technology. It is a 9-item scale, created to measure how frequently, as well as, willingly a person interacts with technology.

3.3.2 Analysis of the data. The analysis of the data, collected from the first stage interviews, was twofold: quantitative analysis of the demographic data and qualitative analysis of the interview/discussion responses. Qualitative as well as quantitative results are reported in a descriptive manner, including the minimum value (min), maximum value (max), the median (mdn) and interquartile range (IQR) for non-normative data, according to scientific publication standards [15]. Through this dual analysis approach, a comprehensive understanding of both the statistical and thematic elements that informed the game’s design, was achieved:

- (1) Quantitative Analysis: The data from the demographic survey were analyzed in order to identify patterns. Apart, from the classic demographic statistics (e.g., age, occupation, education), key variables included interaction and familiarity with technology and frequency of communication between

grandparents and grandchildren. As mentioned above, all survey questions can be found in Appendix B.

- (2) Qualitative Analysis: The qualitative data from the open-ended questions were analyzed thematically, in order to gain insights into participants’ needs, wants, and experience with digital games. After the transcription of all interviews, through the general-purpose speech recognition model Whisper [27], their translation through DeepL [9] and manual data cleaning by the author, the responses were then coded inductively to subsequently develop themes. The article concerning thematic analysis by Mishra and Dey [26] was taken into consideration during this process. As Ryan and Bernard [34] suggests, extra attention was given to repeated words or phrases, since this could provide the signal for the potential generation of a theme. Moreover, an eye was kept out for cultural specific habits.

The above papers highlight the necessity for multiple iterations of code revision, and thus it was performed at the question-response level (in cases, where a dialog led to participants expanding their answer, the coding was applied to the entirety of the response). Almost all answers gave valuable insights, with only a few being too short to provide substantial information. Each iteration followed the pattern of comparison/revision, merge/reduction and aggregation of codes [26]. The final themes reflect the most common topics/answers between the participants that also provided considerable data, and are discussed in Section 4.

3.3.3 Participants. The 14 participants, were couples of grandparent-grandchild from Greek families of diverse backgrounds and experiences, in terms of education, levels of technological proficiency and familial dynamics. They were located in 3 different cities at the time of the interviews; the greatest number was located in Trikala (n=10). The sample comprised 6 females and 8 males. The participants’ ages ranged between 19 and 77 (mdn=43, IQR=46). On a scale of 1 to 7, with 1 being Daily and 7 being Never, participants reported a median result of 2.5 for the frequency of their engagement with digital games (min=6, max=1, mdn=2.5, IQR=4).

In further detail, grandparents recorded: mdn=6, min=6, max=1, iqr=1, while grandchildren noted: mdn=2, min3=, max=2, iqr=0.

3.4 Prototype Creation

3.4.1 Prototype Design: Before Interviews and Questionnaire. The game itself is a quiz, with the reasoning behind this choice being multifaceted. Firstly, a quiz is a game that interests people from different generations, as evident from the numerous family television shows, that have been broadcasting for several years (e.g., Jeopardy! [42]). Secondly, a quiz game can facilitate intergenerational relationships, since it can provide a structured platform for reciprocal role-taking and exchange between participants, which is of major significance for fostering understanding and mutual respect across different generations[40].

3.4.2 Prototype Design: Integrating Research Insights and Design Choices. The results derived from the interviews (Section 4) and the past research (Section 2) guided the design of the game prototype. Special mention can be made to the paper examining the game “QQ

Farm” by Kow et al. [22], since it provided a highly comprehensive list of features (e.g., low entry barrier), that was later backed by the interview results. The end product was an interactive user interface, created through the online platform “Uizard” [1], that guided the participants through a potential, future gaming experience. The goal of this prototype was to create a game-based communication room, for the enhancement of the relationships between grandparents and grandchildren.

3.4.3 System Requirements. This section details a set of system requirements, ordered following the pattern S.RX, that the prototype follows, or to be more precise, that a finalized version of the game should adhere to.

- S.R1 **Platform Compatibility** The game must be compatible with all common platforms such as iOS, Android, Windows, macOS, and potentially even web browsers in order to ensure accessibility across different devices. Interview results indicated that participants mainly use laptops and mobiles, with no clear indication regarding the operating system (OS). Nonetheless, the game should accommodate as many users as possible, without the OS being an obstacle.
- S.R2 **Minimum Device Specifications** The game must have minimal specification requirements, given that especially elderly do not usually have access to high-end machines, and usually opt for simple mobiles, as reported by the older participants during the interviews.
- S.R3 **Multiplayer Support** The focus of the game is to enhance intergenerational familial relationships, so it is mandatory that it has multiplayer support to allow for the connection between the family members (grandparent-grandchild).
- S.R4 **Internet Connectivity** Since the game is designed to be an online, multiplayer one, an internet connection is mandatory to play. The nature of the game (no low ping/latency requirements) allows for low internet speeds, even below 10Mbps.
- S.R5 **Offline Functionality** Since the game supports asynchronous play, there has to be offline functionality, so that one player can start the quiz solving process, without needing to connect with their partner.
- S.R6 **Accessibility Features** The game has to include accessibility features such as, color contrast options, language, and audio/volume selections to accommodate players with diverse needs, as indicated by the survey results.
- S.R7 **Gameplay Mechanics** The gameplay mechanics as well as the contacting functionality between the players have to be simple and easy to understand, in order to seamlessly facilitate intergenerational familial bonds. This requirement is pointed out extensively in the interviews.
- S.R8 **Content Updates** After the initial creation of the game and the storing of numerous quizzes, the game should have regular updates, where more quizzes are added and fixes are implemented.
- S.R9 **Feedback Mechanisms** Feedback mechanisms, such as comments or messages, addressed to the researcher/developer could be implemented, especially when considering long-term evaluation (see Section 6.2).

3.4.4 Interaction Design. The prototype was created to accommodate the needs and wants of the participants, both older and younger individuals. The UI consists of more than 20 different screens, showcasing a full game journey, considering multiple possibilities. The interactive end-product was implemented through uizard.io [1]. Amongst the different possibilities presented were: synchronous or asynchronous play, playing as the lead or as the helper, communication during the game via a video call, a phone call, or through texting. From the Landing page, to the Home Page, to the Game screens, the Chat screens, the Push Notification screen, the Accessibility Settings screen and the Profile screen, everything is created to emulate a complete gaming experience (see Appendix F).

The prototype’s design is derived from the examination and merge of information, gathered from both prior research and the participants’ interview answers. Thus, a list of Interaction Design Requirements was created, following the pattern I.RX:

- I.R1 **Low Entry Barrier** The game should be characterized by ease of use and a highly user-friendly interface. Especially, grandparents either do not want to or cannot understand complex functionalities and designs. Its smooth gaming experience, with simple navigation buttons and easy setting adjustments, provides the opportunity to focus on interacting and bonding between the players.
- I.R2 **Low time commitment** The game must not require players to play continuously for a long period of time in each gaming session. As a common theme, that emerged from the interviews (see Section 4), the flexibility of short gameplay sessions is deemed a necessity since it allows both parties to participate without having a negative effect in their real-life activities (This theme was primarily observed in grandparents).
- I.R3 **Appealing game genre** The game should be something that appeals to both parties (grandparents-grandkids) to motivate players, and as explained in the beginning of the Prototype Design section, was decided to be a quiz.
- I.R4 **Privacy** The system should respect the privacy of the user and handle their personal data, such as their private chats, with care.

3.5 User Study (2nd Stage)

In this second stage, a user study was designed, in order to examine if the designed prototype could, in fact, have a positive effect in the closeness between the participants. Therefore, the same group of people as in the first stage, was contacted in order to interact with the prototype, and provide feedback on its design. Two questionnaires were developed (one demographic) to assess—e.g., through the IOS scale [2]—whether their bond could be strengthened through such a form of communication. Interviews were also employed again for more in-depth results. The setting of the interviews was kept the same, in favor of convenience for the participants. The entire procedure, including the questionnaires, was reviewed via an ethics application by a domain expert within the Informatics Institute, at the University of Amsterdam, before the user study sessions were conducted. This second stage took place on 19 and 20 June 2024.

3.5.1 Measures. In order to measure participants' relationship closeness, the Inclusion of Other in the Self (IOS) scale was used. It is important, therefore, to clearly define the scale, mentioned by Reis et al. [32], and introduced in its pictorial form by Aron et al. [2]. IOS is a concept that is essential in order to truly understand interpersonal relationships. IOS measures the closeness of a relationship, as the overlap between an individual's self and that of their partner. As an individual integrates their partner's perspectives, identities, so does their inclusion of other in the self increase, and thus so is their relationship strengthened. Within families, IOS can have a significant role in shaping intergenerational dynamics. High IOS between family members, can be an indication of strong emotional bonds and familial cohesion, often indicated by mutual support. As for the measurement of IOS, its pictorial form (Figure 1) of Aron et al. [2] is chosen. It consists of a series of Venn diagrams, each depicting different degrees of overlap, from minimal to nearly complete. Overall, IOS provides a solid framework that aids in the understanding of the complexities of human connection and the significance of relational closeness in personal and relational well-being.

To evaluate the participants' affinity for technology, the ATI scale was utilized in this stage as well.

3.5.2 Procedure. The in-person user study comprised of three distinct steps. First, the participants filled the same demographic survey (see Appendix D) they did in the previous meeting, with the difference being, that this time, in the end of the questionnaire, the participants were asked to complete the IOS scale [2] and indicate at which state they believed, that their relationship stood at that moment.

Subsequently, they dedicated approximately 15–20 minutes to testing the interactive prototype and engaging with it as well as with each other. An example video showing a walkthrough of the prototype can be found on the [GitHub repository](#) of the project.

Lastly, they were asked to fill out another questionnaire (see Appendix E) that consisted of both multiple-choice and open-ended questions to provide feedback on the game itself and their overall experience. This questionnaire also included the IOS scale [2], this time with the question accompanying it phrased as: “**If you were to play this game with your grandchild/parent**, which picture do you think would best describe your relationship with your them?”, as opposed to the original: “Which picture best describes your relationship with your grandparent?”. Through this question, the pairs of participants (individually) judged whether this game-based communication could potentially enhance their bond, and thus increase their mutual feeling of closeness. It is notable that while filling the answers related to the IOS scale, the participants could not see each other's answers, and thus get affected (e.g., by the Hawthorne effect [25]).

3.5.3 Analysis of the data. The analysis of the data followed the same pattern as in the first interview stage.

3.5.4 Participants. All the participants of the previous interview agreed to participate in this user study stage as well, with no dropouts or withdrawals.

3.6 Refinement

Refinements were made to optimize the user experience and address identified issues. An adjustment, requested by the participants, was the addition of more available quiz topics. Of course, prioritization of the found issues took place, to address the most critical areas for improvement first. For example, a request regarding more advanced graphics, was dismissed at the current stage of development.

4 RESULTS

The goal of the first interview stage was to provide an answer to S.RQ1 and S.RQ2, and, as an extension to the main RQ, to inform the design of the game prototype with (asymmetric) features that appeal to both age spectrums (grandparents/grandchildren) and support social connectedness. Based on the answers of the interview questions, seven recurring themes were constructed, which are reported in Section 4.1. In Section 4.2 the developed game prototype is briefly presented. Following a similar pattern to the first phase, the second stage user study answers SRQ3, showcasing results from the IOS scale that support the author's hypothesis, that an asymmetric quiz game designed to appeal to both older and younger adults, can in fact, support feelings of social connectedness for users of both age groups. In Section 4.3 and its subsections, the results of the user-study stage are presented, including the evaluation of the prototype by the participants, and the speculated growth of their connectedness. Participants' quotes are annotated with OA or YA, referring to older or younger adults, respectively.

4.1 Interviews and Questionnaire (1st Stage)

Seven recurring themes were constructed based on the interviews, and are presented here in subsections with anchor quotes.

4.1.1 Co-playing experience. Six out of seven couples, participating in the study, reported that they have played games together in the past. They described these gaming sessions as highly enjoyable occasions, that enhanced their connection and served as a bonding experience for them. However, the majority of them had never played a *digital* game together before. Their most common game choices included board games and (traditional Greek) card games.

P1_{OA} «When we get together we usually play board games, truth be told. We watch some games on TV too. ... we have a lot of fun and it's a nice bonding time, when that happens, we get closer.»

4.1.2 Participants' area of focus concerning the game. The study highlighted a major difference, concerning the participants' area of focus in the game. While almost all the grandchildren focused on the theme and the graphics quality of the game, valuing mostly engaging narratives, as well as appealing visuals, the grandparents were more concerned with the difficulty and duration of the game. They preferred games that are easy to understand and play, avoiding those with a high entry barrier. Moreover, they seemed to opt for games that have short sessions, and thus would not cause issues with their (or their grandchildren's) everyday activities.

P5_{YA} «I definitely think the first one is the theme. It should be something that encourages us to get into the process of playing. Personally I really like history so it should definitely be something relevant to that, and not something that is time consuming and too difficult for grandma to understand and play.»

Of course, as in most cases, there was an exception, with one grandparent highlighting the need for younger adults to develop patience and learn to appreciate something that takes time:

P2_{OA}: «I would say our games used to be more complicated. Now the youngsters don't want that. They want easier and easier games, and they want them to be over faster. Patience is nowhere to be found. I'd like for the game to kind of take its time, let us get more involved more into it and through that bond more.»

Moreover, both participant groups highlighted the need for simple and active communication in the game, since this would be the main feature that enhances their bond:

P7_{OA}: «Apart from the topic being important, as I said before, I do think that having live communication would be a major feature. After all when playing a game with your grandparent you are mostly doing it for that connection.»

4.1.3 Preference in competitive and cooperative gameplay. Most grandchildren chose competitive games as their desired option, enjoying the challenge and excitement that competing against others offers them:

P4_{YA}: «Rivalry is better than being more cooperative, it provides a bigger incentive.»

On the other hand, most grandparents preferred cooperative games, which emphasize teamwork and seem less stressful:

P8_{OA}: «I do prefer cooperative games because competitive games make me rather nervous. I am a grandmother now, I have 3 children and 7 grandchildren, I cannot stress about a game as well now, can I? (Haha)»

It is noteworthy that despite their preference for competitive play, most grandchildren acknowledged that cooperative games would be better suited for playing with their grandparents, as this scenario would make them feel more comfortable and at ease, thus fostering a supportive and collaborative gaming environment.

P10_{YA}: «Look, generally, I'm more into the competitive game, but with my grandma, we better find a game where we can help each other. It will be easier and more fun for all of us.»

4.1.4 Lack of worries about playing with the family. Not one of the participants appeared to have any concerns about playing with each other, and other members of the family, and all agreed that such a game would only aid their relationships and enhance their bonds:

P13_{OA}: «Well, I think it's the perfect way to build relationships with each other. Well, there's no reservation about that, I don't see that as a negative thing or anything like that.»

4.1.5 Need for closer connection. Most of the older participants were the ones who desired increased communication and a closer relationship with their grandkids, although they did show understanding of their (grandkids') busy individual lifestyles:

P13_{OA}: «Okay, I would like to see each other more often, of course, but I still feel satisfied as the grandson does not have the unlimited time that I have nowadays.»

On the opposite side, the grandchildren were generally content with the current state of their relationship, but did acknowledge that engaging in game-based activity could be an interesting way to strengthen their bond:

P14_{YA}: «Generally speaking, the time we spend at the moment is satisfactory for me. Of course, a game that would give us an extra reason to talk wouldn't hurt me and it would be better for grandpa too.»

4.1.6 Roles. Both parties were more than happy to assume a helping or a leading role in order to facilitate the interaction. In most cases, they both agreed on the grandparent being in the helping position, in order for them to be more relaxed and not concerned with undertaking the main/leading role and the responsibilities that follow that:

P11_{OA}: «... I would rather help, at first at least, so I don't have too much pressure on me (haha).»

4.1.7 Preference in synchronous and asynchronous gameplay. While many papers highlight the importance of asynchronous gameplay [22], the majority of the interview participants agreed that they preferred to play at the same time. They claimed that such gameplay is more meaningful as it provides a more "real" communication, whilst playing at separate times would not be as appealing for them:

P10_{YA}: «... we're going to do this to get closer together, so playing at different times doesn't mean much to me.»

It is important to mention that all participants are Greek, and in Greece, immediate, face-to-face communication is highly valued, based on anecdotal evidence. In fact, most of them mentioned that a video call feature would be highly beneficial. They emphasized that it bridges the distance gap and enhances communication by providing a more vivid and engaging interaction:

P13_{OA}: «Ideally I would like a conversation between us, a call, messages, voice communication would be ideal. Video call, if possible ...»

4.2 Prototype

The created prototype, a fully interactive user interface, provided the participants with the experience of a complete user-journey, in a quiz game created to enhance intergenerational familial relationships. Upon accessing the prototype, users were presented with a Landing Page, that sent them to the Home Page. From there, they could navigate through the prototype via numerous routes: choosing a featured quiz, sending a play request through the message function, changing their profile, or altering their app settings.

After initiating a game session and going through the connecting process, the users would have to choose both the role that they would like to undertake during that game session, and the means of their communication. Depending on their choices, between leader or helper, and voice call, video call or texting, they would go to a different game screen where they could experience how the game process works. The leader, designated by the crown icon, could choose an answer, while the helper (helping-hand icon) could assist them, through their chosen means of communication. Finally, following the quiz completion (after feedback and answer-updating in case of asynchronous play) they would be presented with a game over screen that showcased the player's final score, as well as, their high score as a leader and a helper, considering all previous game sessions. Illustrations of the prototype's UI can be found in Appendix F

4.3 User Study (2nd Stage)

4.3.1 Pre-Measurement of Social Connection. The measurement of relationship closeness through IOS scale [2], was the final step of the demographic questionnaire of this stage. Three out of the seven (43%) grandchild-grandparent couples measured their bond to be of the second-highest degree in the scale. Another equal number of participants (43%) pointed out that their relationships stood more on the fifth out of the seven relationship pictorial forms of the scale, while the last couple (14%) pointed out that their relationship was better defined by the 4th pictorial form. It is noteworthy that every participant agreed with their respective relative, concerning the strength of their relationship.

4.3.2 Prototype Interaction and Feedback. Participants spent 15–20 minutes interacting with the prototype. After a brief introduction from the student researcher, they cooperated in traversing and understanding the interactive user interface. All participants recorded a positive overall experience, e.g.:

P1_{YA}: «It was actually a pretty fun time. We tried out something completely new to us, since we never play digital games together, but it was rather interesting.»

The aspects that they appreciated the most were the simplicity of the game and the user-friendly interface, as well as the attention that the game paid to the communication aspect. Moreover, they enjoyed the dual functionality of helper and leader role in the game:

P6_{YA} «I like its simplicity above all, since it makes it easy for the elders to understand it. Moreover, communication was a key factor and it was done in a nice way in the game.»

They all found the game controls and user interface highly intuitive; all agreed that cooperation and teamwork was promoted through the game, and were satisfied with the accessibility controls. All the participants responded that the main motivation for continuing to play the game is the fact that it is an opportunity for them to come close to each other.

P_{OA} «To come a bit closer with my granddaughter. We rarely spend time together nowadays, and I would like for that to change.»

The main improvement that was suggested by a number of participants (36%) was to extend the topic collection for the quizzes.

Lastly, when asked if they would recommend the game to another family, they all responded positively, highlighting that it would be a good opportunity for more people to bond with their loved ones:

P12_{YA} «Yes I would, cause it seems like a good opportunity to connect with each other in a fun way.»

4.3.3 Post-Measure of Social Connection. The bond between the participants was measured again after the user testing (as described in Section 3.6, with adapted phrasing). The participants would judge and speculate whether a game like this would be able to bring them closer. The results were positive. All couples went up one “level” in the IOS scale’s [2] pictorial form, a substantial increase of 14%, showing that, indeed, they believe that their relationships could benefit from this type of game-based communication.

4.4 Refinement

Due to time limitations and the low number of suggestions for the prototype, by the user testing participants, the refinement of the prototype was constrained. After the participants’ evaluation

of the prototype, the collection of quiz topics showcased in the game’s user interface became more extensive. To be more precise, the themes depicted in the Home Page went up by four, increasing the topic variety, while keeping a user-friendly design. Moreover, the number of the topics presented in the Theme Select screen rose by sixteen, providing a much bigger selection range for the users (see Appendix G).

5 DISCUSSION

5.1 Findings in Context

5.1.1 Features and factors in consideration for intergenerational game design. Following the guides and suggestions of De la Hera et al. [8], Kow et al. [22] and Derboven et al. [10], a game-prototype that can facilitate interaction between people (family members) of different generations was designed. The first-stage interview results confirmed the past research, in the low entry barrier and the low time commitment [8, 22] being reported as needed features of the game. The older adults, leaned more to intellectual types of games, such as quizzes and puzzles, while younger adults preferred more adventure oriented ones [8]. Moreover, both parties considered communication to be a major aspect of the game [10]. The design of the prototype took into consideration all the listed features, being simple and easy to use, having short gaming sessions and multiple communication means. Through the positive feedback from the participants, it became apparent that the game genre choice (quiz) was a success.

5.1.2 Role Undertaking. The interview results indicated a flexible approach to role undertaking by the participants. The younger adults were, most often, seen as guides and teachers in the game interaction, helping the grandparents navigate through the prototype and understand the game. The older ones respected that their grandchildren had more experience in the subject and were pleased to be assisted. On the other hand, in some of the specific quiz topics (e.g., history), elders reported a greater proficiency, showcased in their interview and questionnaire answers, and were willing to lead this time. These results support the research by Harris et al. [16], who expands on the subject of role undertaking in asymmetric multiplayer games, highlighting the exchange of roles depending on multiple factors, such as previous experience, and Voids and Greenberg [40] who had similar results, focusing on intergenerational games. In the prototype, this interaction is facilitated through the feature of the dual leader/helper mode, where participants can freely choose their role, for each specific gaming session. This feature was met with positive reactions from both parties, as reported in the after-testing questionnaire feedback.

5.1.3 Supporting positive effects of game-centered communication in relationship bonding. The final questionnaire results supported the research of Pecchioni and Osmanovic [30], who showcase in their paper the beneficial effect that intergenerational gaming can have in familial relationships. Utilizing the same means of measurement, the IOS scale [2], the questionnaire data of the thesis’ feedback stage clearly shows a speculated increase in the relationship closeness of the participants. While in this thesis, the user testing stage lasted only (approximately) twenty minutes, in comparison to the six-week-long one, conducted by Pecchioni and Osmanovic [30],

the positive outcomes were promising. It became apparent that the intergenerational game proposed, even at its prototype state, was seen positively and was viewed as potentially beneficial. The positive reception of the game shows a glimpse of the capabilities of intergenerational games in promoting familial relationships.

5.1.4 Knowledge-sharing as a result of intergenerational gaming. The results of the interviews and questionnaires of this thesis supported the research of Reis et al. [32] and Costa and Veloso [5], who pointed out that through gaming, intergenerational interactions can be promoted, through various forms of engagement, including knowledge-sharing. Grandkids mostly focused on helping their grandparents understand how the game works, while elders, utilizing the quiz theme of the game, wanted to share their knowledge with their grandchildren. Both parties, especially older adults, seemed to be pleased to have the opportunity to teach each other and through that come closer, as reported in the interviews.

5.1.5 Asynchronous Play. As mentioned in the interview-stage results, one major difference with what is reported on the past research [22] was the choice between synchronous and asynchronous play. While asynchronous play might seem optional for an intergenerational multiplayer game, considering that family members often drift apart and have separate lifestyles and responsibilities [22], the majority of the participants of this study stated that they prefer synchronous play. As detailed in the interview answers, they did not believe that playing separately would have a major effect in their relationships, whereas they expected that playing together concurrently and interacting with each other would indeed have benefits regarding their bond. While this is contradicting to existing research, it is noteworthy that all participants were Greek, where (based on anecdotal evidence) immediate communication is preferred. It is noteworthy that different cultures, have differing views concerning communication and its preferred forms, as detailed by Kayan et al. [20]. This contradictory situation, is an example of an HCI study highlighting the need for cultural awareness. This is a subject that has been growing in popularity recently [14], and although it is a young field, it is being actively researched, as detailed by Aryana and Ørtsland [3], who focus more on mobile HCI. While there are studies defining cultural dimensions, that can act as guides (e.g., [18]) these are not models, developed for a design approach [3], and even though there has been research successfully utilizing them, as detailed by Gasparini et al. [14], continuous research is mandatory in order to reach a satisfactory cultural point of view for HCI.

5.2 Limitations

5.2.1 Sample Size and Diversity. One limitation of this thesis is its sample size and the diversity of the study. The number of participants in both interview stages was small ($N=14$), something that can be considered insufficient for the generalization of the findings to a broader population [36]. Furthermore, while people from different cities (e.g., Trikala, Athens, Mouzaki) were recruited, in the end the participants were all from the same country (Greece) and their socio-economic backgrounds show similarities (most participants belong in the middle class, the prevailing class in Greece [37]).

Lastly, there was little differentiation regarding cultural contexts, limiting the diversity of perspectives captured in the paper.

5.2.2 Short, Speculative Evaluation. Another major limitation of the thesis was the amount of time given for the prototype evaluation and its speculative nature (with the prototype emulating the experience). The game's impact on intergenerational connectedness was analyzed based on a relatively short exposure (15–20mins) and participant speculation regarding impact. That means that actual, experienced effects, as well as long-term effects and sustained engagement were not assessed, thus limiting the understanding of whether the game can foster enduring improvements in relationships between grandparents and grandchildren.

5.2.3 Limited Time for Development. The limited amount of time for the completion of the thesis restricted the scope of the game's development, resulting in a prototype, a simple interactive user interface (UI). While the UI is useful for emulating a full gaming experience and navigating the participants through a full user-journey, it remains a UI, a non fully developed product. A full-fledged, comprehensive game could offer an even greater user experience and thus support intergenerational connectedness more effectively.

5.3 Ethical Considerations

The entire research plan, including the questionnaires and the interview questions of both stages, were reviewed by a domain expert within the Informatics Institute at the University of Amsterdam. All participants were required to confirm their voluntary participation by reading and accepting an Informed Consent Form. This form described the purpose of the study, the procedures involved, the potential risks, the manner of data collection and usage, their rights and contact information for further inquiries or concerns. All data were carefully anonymized, to ensure the participants' privacy.

6 FUTURE WORK AND CONCLUSION

6.1 Future Work

6.1.1 Enhanced Game Development. More time should be given for the creation of a fully working game, that could provide more useful research data. Future work should focus on addressing the limitations of the current prototype. A fully operational game should be created, with a working backend that can store and funnel data for research. The features proposed could be improved, thus enhancing the overall user experience.

6.1.2 Increasing Sample Size and Diversity. As mentioned, future research should aim to include a larger and more diverse sample of participants. Through expanding the demographic, socio-economic and cultural diversity of the study population, the level of generalization of the findings would greatly improve. This could be achieved by recruiting participants not only from different regions (as done in this thesis), but also from different countries and if possible continents, to achieve a more comprehensive understanding of how to design for intergenerational connection. Especially considering cross-cultural studies, necessary changes should be made in the game in order to adapt to the respective cultural contexts [31]. A commercialization of the game could be an effective way of capturing data worldwide, without needing to arrange specific

interviews, with all the complications that they bring (e.g., distance, time, schedule differences).

6.1.3 Long-Term Evaluation. For a more concrete understanding of the game's impact on intergenerational familial relationships, future studies should consider conducting long-term evaluations, with participants interacting with a game prototype over an extended period of time, thus providing the chance to observe sustained engagement and changes in social connectedness. Commercializing the game, on platforms such as Play Store, could address this limitation, facilitating a wider adoption and use, enabling the collection of extensive data from a major user base and offering deeper insights into the game's effectiveness and areas for improvement.

6.2 Conclusion

Through a multi-stage approach, this study sought to create an interactive game-based communication activity that enhances familial interactions and overcomes the generational gap. The findings suggest that such a game has the potential to positively impact and enhance intergenerational familial relationships. The participants' answers to the initial interviews indicated a positive outlook on such an endeavor, reaffirming the results of past research. They also highlighted the need for more communication between the two generations, while showcasing high flexibility in the area of game roles (leader/helper). In the user study, the participants provided positive feedback both for the proposed game and the overall playing/bonding experience they went through. Their positive outlook on this interaction was also evident in the IOS scale [2] changes, that were recorded before and after their testing session. All participants reported that a potential (complete) interaction with the game would increase their relationship closeness. The study identifies several points for discussion and limitations. The need for cultural awareness in the HCI field was highlighted as a major, potential point of focus for future research, and guiding literature was presented. This literature emphasized the importance of cultural awareness, in favor of developing more inclusive and effective design frameworks. Moreover, the short and speculative evaluation of the project is noted as another limitation of the thesis, that future work should address. The commercialization of the game is proposed as a potential (partial) solution for these limitations, significantly broadening the game's reach and providing extensive data for ongoing analysis.

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Appendix A IOS SCALE

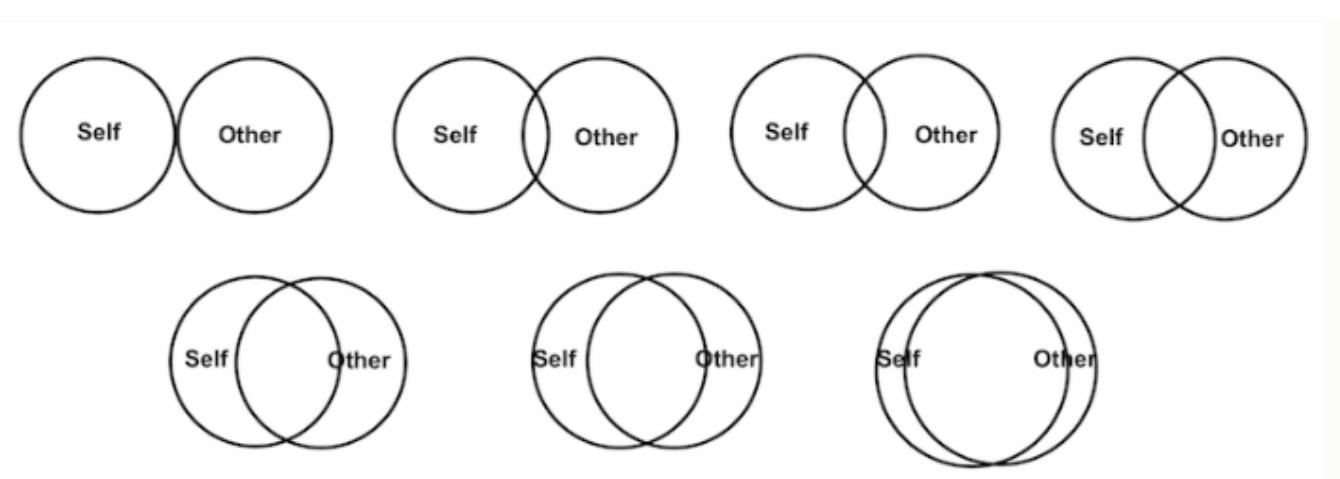


Figure 1: The Inclusion of Other in the Self (IOS) scale [2]

Appendix B FIRST DEMOGRAPHIC QUESTIONNAIRE

Question Tour Block 1

Study Information

Thank you so much for being willing to participate in this interview. Before we start, I want to explain how we will collect and analyze your data.

Purpose of the study

You are invited to participate in an interview study by the University of Amsterdam.

Participation is limited to adults aged 18-30 (with at least one grandparent aged 60+) or 60+ years old (with at least one grandchild aged 18-30). By attempting to enhance familial bonds and promote social connectedness among family members of different generations through game-based communication, this research aims to contribute to the broader understanding of how technology can positively impact human-human interaction and overall well-being. The study takes ~15-20 minutes to be completed.

Study procedure

First, you will be asked to fill out a brief questionnaire. Then an interview, in a simple conversation format, will take place. The interview will be audio-recorded.

Benefits and risks of participation

The risks associated with participation in this study are no greater than those ordinarily encountered in daily life. There may be no direct benefit to you. However, the research results that come from your data can contribute knowledge to humanity.

Procedures for withdrawal from the study

Your participation in this study is entirely voluntary, and you can withdraw at any time. You are free to omit any question. You can contact the student investigator to withdraw your data within 3 days of this interview. After this point, any information tying you to the collected data will be deleted and it will no longer be possible to identify and withdraw your data.

Data collection and processing

We will not collect personal identifiers. We will process the anonymous data you contribute to the questionnaires, and the interview audio recordings will be transcribed and checked for identifying information for analysis, after which the raw audio data will be deleted. Any

information that could be used to deduce your identity will be pseudonymized before analysis, and before it is made available.

Data usage and privacy

The results may be published in thesis and research papers, technical reports, or academic presentations. We will aim for open-access publication. During the active phase of research, the student investigator will oversee the access rights to data (and other outputs), as well as any requests for access from external parties. Sharing of data with others will only be done in such a manner that participants will not be identified (e.g., in the form of quotes). We will host the data on password-protected storage.

Furthermore, the transcripts and the questionnaire data will be carefully checked, in order to remove any potentially identifying data, and then uploaded to an open science hosting platform, such as the Open Science Framework (OSF), in the interest of open science principles.

Research participant rights

If you have concerns or questions about this research study, or if you believe that you have been harmed due to participation in this study, please contact the student investigator Stefanos Ntouvlis at stefanos.ntouvlis@student.uva.nl or the academic supervisor Dr. Katja Rogers at k.s.rogers@uva.nl.

Provide your consent - please check to indicate your agreement:

- I have read and understood the study information. I consent voluntarily to participate in this study and understand that I can refuse to answer questions, and I can withdraw from the study at any time without having to give a reason. I understand that taking part in the study involves a questionnaire, answering interview questions and being audio-recorded. I understand that the information I provide will be used for data analysis, and the anonymous data and the results may be released publicly in research outputs, including academic papers, technical reports, online articles, and academic presentations. I agree that the data I provided in the study can be quoted in research outputs. I give permission for the non-identifiable data that I provide to be archived into an anonymized dataset so it can be used for future research and learning.
- I do not consent

Demographic questions

Age

Gender

- Male
- Female
- Non-binary
- Prefer not to disclose
- Prefer to self-describe

City

Highest Completed Educational Level

- High School
- Undergraduate Degree
- Graduate Degree
- Doctoral Degree
- Habilitation

Occupation

- Student (Field of Studies)
- Unemployed
- Employed (Career Field)
- Retired
- Other (Please specify)

Block 4

In the following questionnaire, we will ask you about your interaction with technical systems. The term "technical systems" refers to apps and other software applications, as well as entire digital devices (e.g., mobile phone, computer, TV, car navigation).

Please indicate the degree to which you agree/disagree with the following statements.

Have you ever played digital games before? If yes, how frequently do you engage with them?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

Which digital devices do you currently own? (Select all that apply)

- Smartphone
- Tablet
- Laptop
- Desktop
- Other

Please indicate your agreement with this statement: **I enjoy playing digital games.**

| | | | | | | |
|--------------------------|--------------------------|--------------------------|-------------------------------|--------------------------|--------------------------|--------------------------|
| strongly disagree | disagree | somewhat disagree | neither agree nor disagree | somewhat agree | agree | strongly agree |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Question Tour Block 2

What types of games do you prefer? (e.g., puzzle games, strategy games, adventure games)

What motivates you to engage with digital technology? (e.g., entertainment, social interaction, learning)

How often do you communicate with your grandchildren?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

How often do you communicate with your grandparents?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

How often do you spend time with your grandparents?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

How often do you spend time with your grandchildren?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

What activities do you enjoy doing with your grandchildren?

What activities do you enjoy doing with your grandparents?

On a scale of 1 (=not at all) to 5 (=very much so), how tech-savvy do you consider your grandparents to be?

1 2 3 4 5

How tech-savvy do
you consider your
grandparents to be?

On a scale of 1 (=not at all) to 5 (=very much so), how tech-savvy do you consider your grandchildren to be?

1 = not at all 2 3 4 5 = very
much so

How tech-savvy do
you consider your
grandchildren to be?

Appendix C INTERVIEW QUESTIONS (1ST STAGE)

Interview Questions: (B = both, E = elders, C = grandchildren)

Can you describe your experiences with playing games, both digital and non-digital, with your family members? -> B

What do you think are the key elements that make a game enjoyable, as well as, valuable and meaningful for both younger and older generations? -> B

From your perspective, what are the barriers that might prevent you from engaging with digital games with your grandchildren/grandparents? -> B

What features or aspects would make you more likely to try or continue playing a game with your grandparents/grandchildren? -> B

Do you have a preference for cooperative or competitive games and if so, why? -> B

Are there any specific themes or topics that would appeal well to you if integrated in a game? -> B

What type of user interface or control scheme do you think would be most accessible and intuitive for you? -> B

What type of user interface or control scheme do you think would be most accessible and intuitive for your grandparent? -> C

What type of user interface or control scheme do you believe would be most accessible and intuitive for your grandchildren? -> E

Are there any specific customization or personalization options you would like to see in a game to tailor it to your preferences (accessibility features, difficulty settings)? -> B

How often would you want to interact and communicate with your grandparents/grandchild(ren) through a game, and why? -> B

In what way would you like this interaction/communication through the game to take place, and why? -> B

Do you have any concerns or reservations about playing games with other family members? -> B

How important do you think it is for the game to have features that allow for asynchronous play, where family members can participate at different times? -> B

What types of rewards or incentives do you believe would motivate you to continue playing and engaging with the game? -> B

What kinds of platforms would you want a game for you to play with your grandparents/grandchildren to be available on? Which platforms do you have access to? Which are you comfortable using? ->B

How often do you currently communicate with your grandparents/grandchild(ren), and through what means? Can you describe the role of technology in enabling this communication?-> B

Are you happy with the extent of communication you currently have with your grandparents/grandchild(ran)? Can you describe how you think this communication could be adjusted or supported in a way that you would prefer? -> B

Would you be willing to take on a specific role (e.g., helper) in the game to facilitate interaction? In what way would you like to undertake that role, and why? (e.g. Active Help = playing the game together, Controlled-Optional Help = “Help” button signalling aid request) -E

**Helper: Supporting character that aids the main character in achieving their goal. E.g. in Quiz games the optional, but limited , “crowd help”.

Appendix D SECOND DEMOGRAPHIC QUESTIONNAIRE

Question Tour Block 1

Study Information

Thank you so much for being willing to participate in this study.

Purpose of the study

You are invited to participate in this study by the University of Amsterdam. Participation is limited to adults aged 18-30 (with at least one grandparent aged 60+) or 60+ years old (with at least one grandchild aged 18-30). By attempting to enhance familial bonds and promote social connectedness among family members of different generations through game-based communication, this research aims to contribute to the broader understanding of how technology can positively impact human-human interaction and overall well-being. Overall, the study should take approximately 30-40 minutes.

Study procedure

First, you will be asked to fill out a brief questionnaire concerning demographics and your relationship with your grandparent / grandchild (as applicable).

Then you will have some time to go through a prototype (interactive user interface), that has been designed as a quiz game for grandparents and grandchildren to play together.

Lastly, you will be asked to fill in another questionnaire to again describe your relationship with your grandparent / grandchild but now taking into consideration the effect such a game could have on your relationship, and answer a few additional feedback questions.

Benefits and risks of participation

The risks associated with participation in this study are no greater than those ordinarily encountered in daily life. There may be no direct benefit to you. However, the research results that come from your data can contribute knowledge to humanity.

Procedures for withdrawal from the study

Your participation in this study is entirely voluntary, and you can withdraw at any time. You are free to omit any question. You can also contact the student investigator to withdraw your data within 3 days of this interview. After that time period, any information connecting you to your provided responses will be deleted and it will no longer be possible to identify and remove your data.

Data collection and processing

We will not collect personal identifiers. We will process the anonymous data you contribute to the questionnaires. Any information that could have been used to deduce your identity will be pseudonymized before analysis, and before it is made available.

Data usage and privacy

The results may be published in thesis and research papers, technical reports, or academic presentations. We will aim for open-access publication. During the active phase of research, the student investigator will oversee the access rights to data (and other outputs), as well as any requests for access from external parties. Sharing of data with others will only be done in such a manner that participants will not be identified (e.g., in the form of quotes). We will host the data on password-protected storage.

Furthermore, the transcripts and the questionnaire data will be carefully checked, in order to remove any potentially identifying data, and then uploaded to an open science hosting platform, such as the Open Science Framework (OSF), in the interest of open science principles.

Research participant rights

If you have concerns or questions about this research study, or if you believe that you have been harmed due to participation in this study, please contact the student investigator Stefanos Ntouvlis at stefanos.ntouvlis@student.uva.nl or the academic supervisor Dr. Katja Rogers at k.s.rogers@uva.nl.

Provide your consent - please check to indicate your agreement:

- I have read and understood the study information. I consent voluntarily to participate in this study and understand that I can refuse to answer questions, and I can withdraw from the study at any time without having to give a reason. I understand that taking part in the study involves taking questionnaires and examining a game prototype. I understand that the information I provide will be used for data analysis, and the anonymous data and the results may be released publicly in research outputs, including academic papers, technical reports, online articles, and academic presentations. I agree that the data I provided in the study can be quoted in research outputs. I give permission for the non-identifiable data that I provide to be archived into an anonymized dataset so it can be used for future research and learning.
- I do not consent

Demographic questions

Age

Gender

- Male
- Female
- Non-binary
- Prefer not to disclose
- Prefer to self-describe

City

Highest Completed Educational Level

- High School
- Undergraduate Degree
- Graduate Degree
- Doctoral Degree
- Habilitation

Occupation

- Student (Field of Studies)
- Unemployed
- Employed (Career Field)
- Retired
- Other (Please specify)

Block 4

In the following questionnaire, we will ask you about your interaction with technical systems. The term "technical systems" refers to apps and other software applications, as well as entire digital devices (e.g., mobile phone, computer, TV, car navigation).

Please indicate the degree to which you agree/disagree with the following statements.

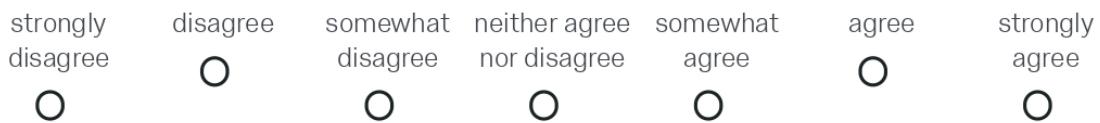
Have you ever played digital games before? If yes, how frequently do you engage with them?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

Which digital devices do you currently own? (Select all that apply)

- Smartphone
- Tablet
- Laptop
- Desktop
- Other

Please indicate your agreement with this statement: **I enjoy playing digital games.**



Question Tour Block 2

What motivates you to engage with digital technology? (e.g., entertainment, social interaction, learning)

What types of games do you prefer? (e.g., puzzle games, strategy games, adventure

games)

/

How often do you communicate with your grandchild(ren)?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

How often do you communicate with your grandparent(s)?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

How often do you spend time with your grandparent(s)?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

How often do you spend time with your grandchild(ren)?

- Daily
- Several times a week
- Once a week
- Several times a month
- Once a month
- Rarely
- Never

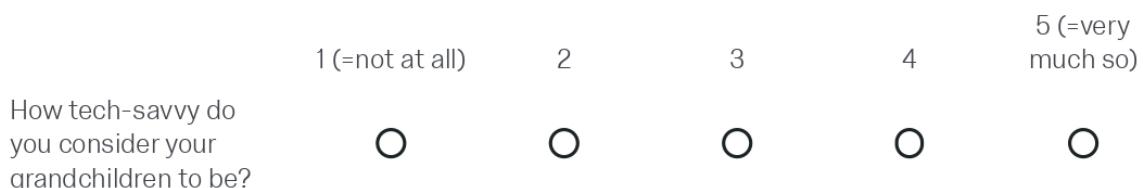
What activities do you enjoy doing with your grandchild(ren)?

What activities do you enjoy doing with your grandparent(s)?

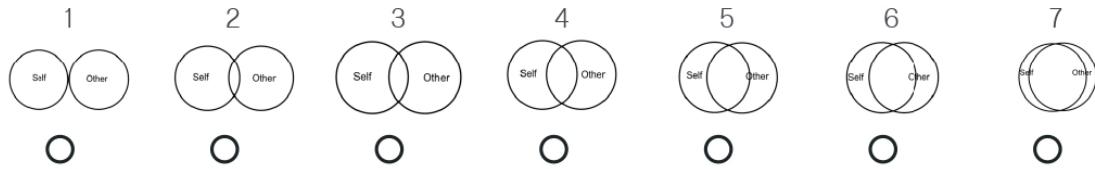
On a scale of 1 (=not at all) to 5 (=very much so), how tech-savvy do you consider your grandparents to be?



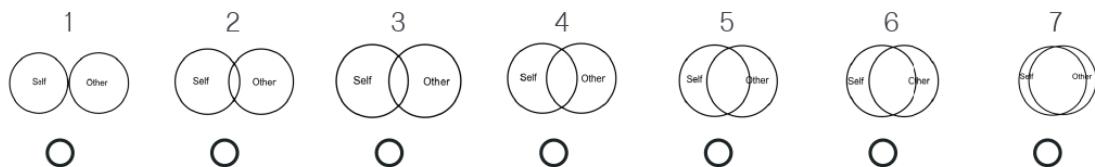
On a scale of 1 (=not at all) to 5 (=very much so), how tech-savvy do you consider your grandchildren to be?



Which picture best describes your relationship with your grandchild?



Which picture best describes your relationship with your grandparent?

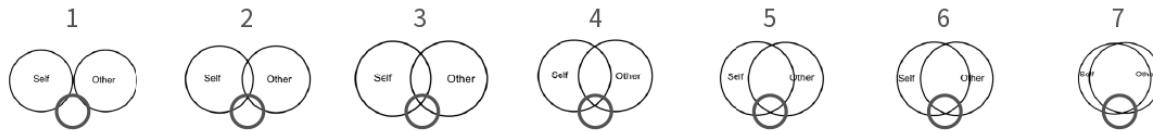


Appendix E USER TESTING QUESTIONNAIRE

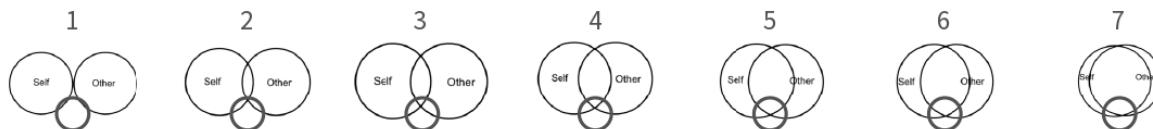


Default Question Block

If you were to play this game with your grandchild, which picture do you think would best describe your relationship with your them?



If you were to play this game with your grandparent, which picture do you think would best describe your relationship with your them?



Please describe your overall experience with the game prototype:

What aspects of the game did you enjoy the most?

How intuitive did you find the game controls and user interface?

| | | | | |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| Extremely unclear | Somewhat unclear | Neither clear nor unclear | Somewhat clear | Extremely clear |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

How well did the game facilitate interaction and communication ?

| | | | | |
|----------------------------------|----------------------------------|-----------------------|-----------------------|-----------------------|
| Not well at all | Slightly well | Moderately well | Very well | Extremely well |
| <input checked="" type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Did you feel that the game promoted teamwork and cooperation between players of different ages?

Were the themes and topics of the game engaging for both you and your family members?

The accessibility features were sufficient for players with different abilities.

| | | | | |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| Strongly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Strongly agree |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

How could the accessibility features be improved?

Is there something that motivates you to continue playing the game?

Did you encounter any technical issues or bugs while playing the game?

| | | | | |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| None at all | A few | A moderate amount | A lot | A great deal |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

What changes or improvements would you suggest for the game?

Would you recommend this game to other families? Why or why not?

Powered by Qualtrics

Appendix F USER INTERFACE

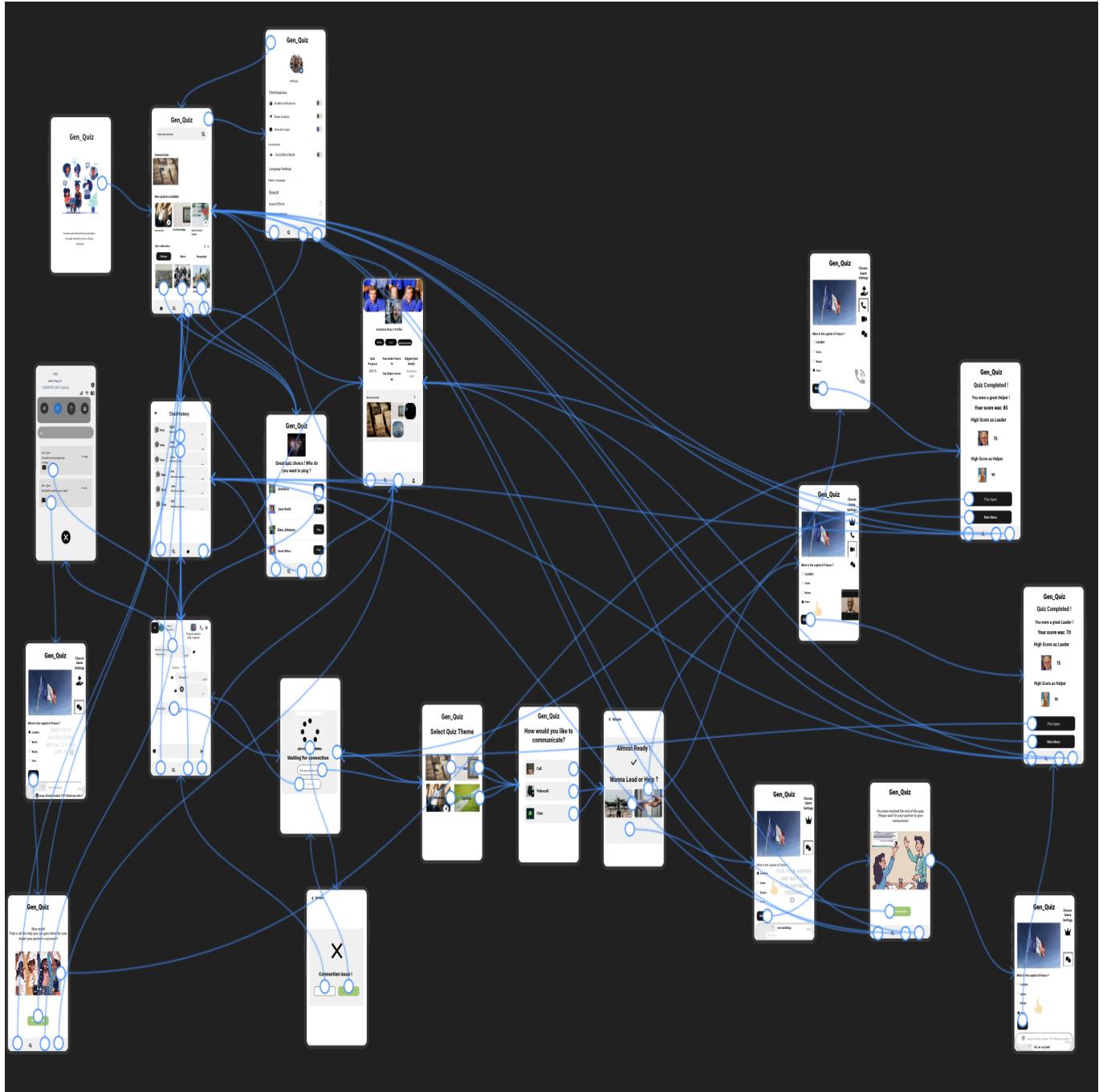


Figure 2: The full user interface, with the interactions present.

F.1 Screens/Components of the User Interface.

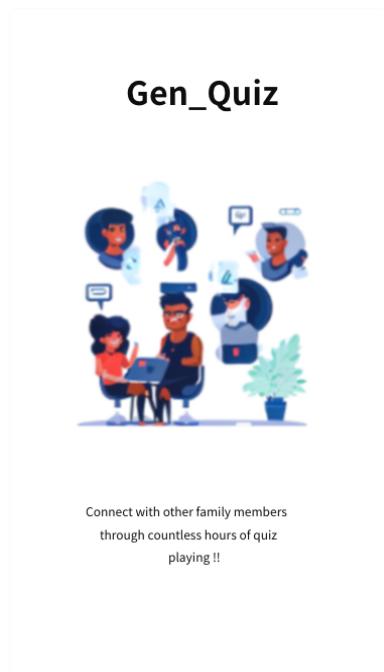


Figure 3: Landing Page.

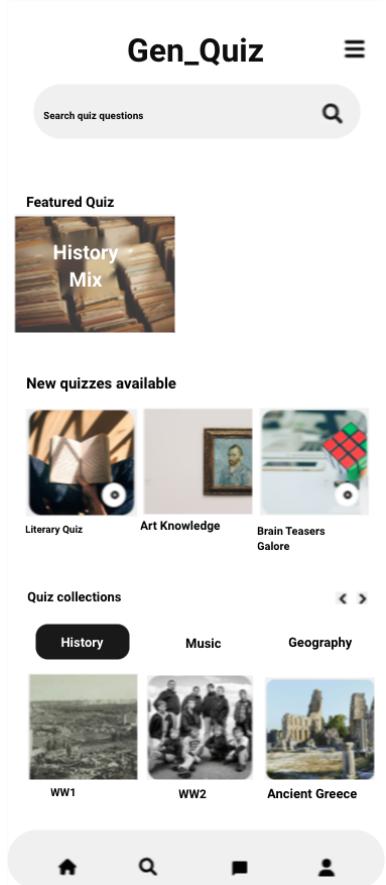


Figure 4: Home Page.

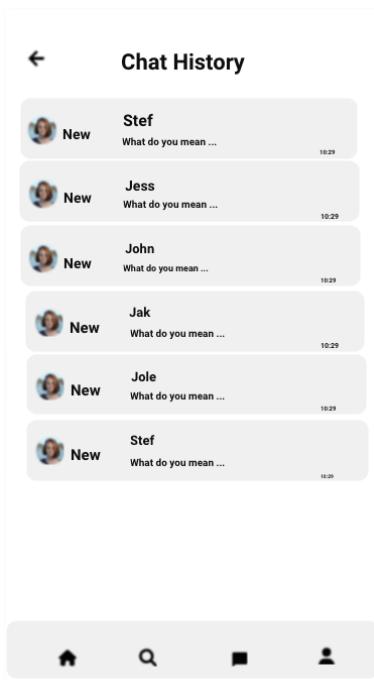


Figure 5: Chat History Page.

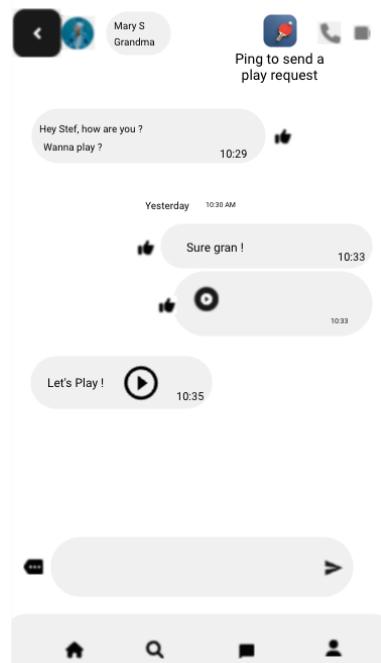


Figure 6: Chat Page.

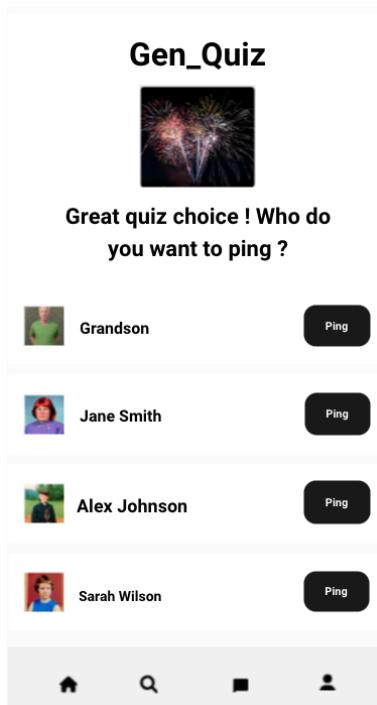


Figure 7: Ping Page (from the Home Page).

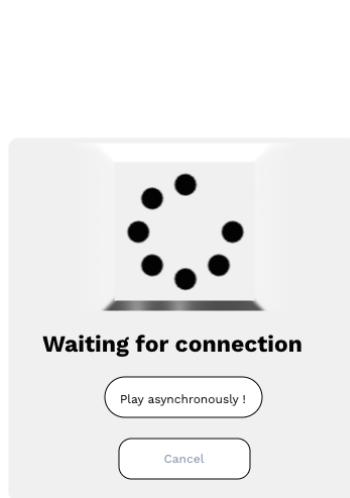


Figure 8: Waiting for Connection Page.

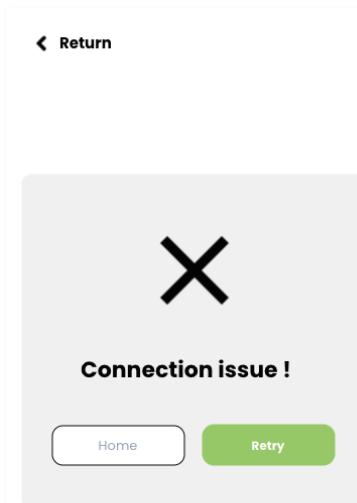


Figure 9: Connection Error Page.

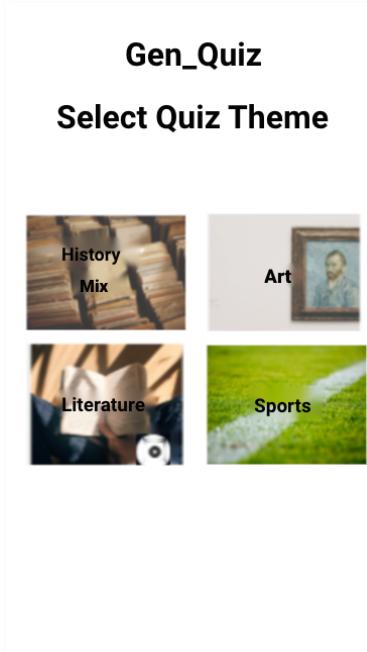


Figure 10: Theme Selection Page.

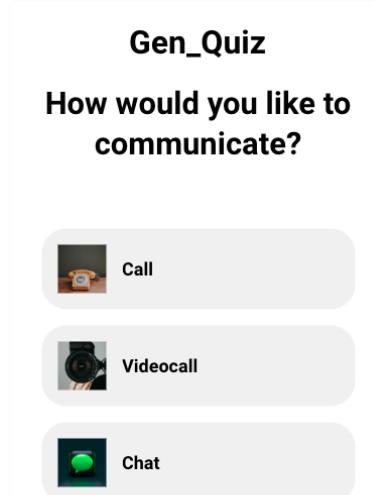


Figure 11: Communication Media Selection Page.

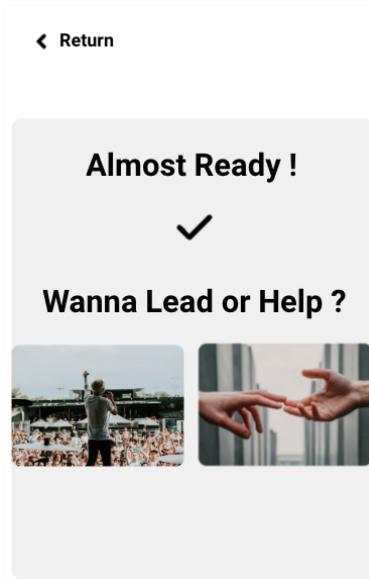


Figure 12: Role Selection Page.

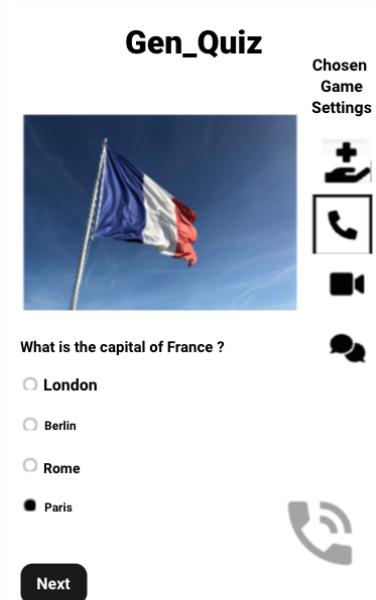


Figure 13: Helper Call Page.

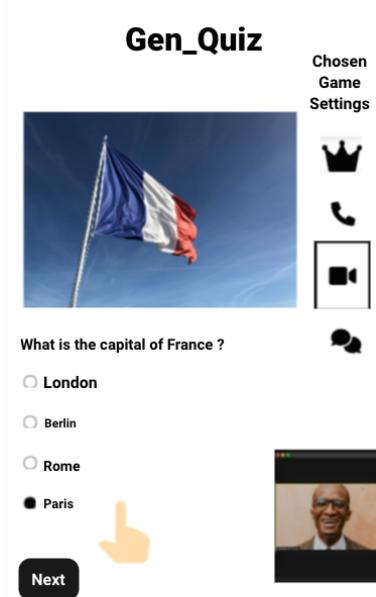


Figure 14: Leader Videocall Page.

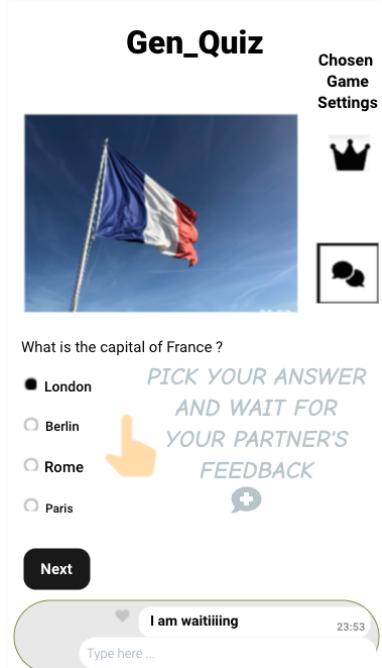


Figure 15: Leader Asynchronous Page.

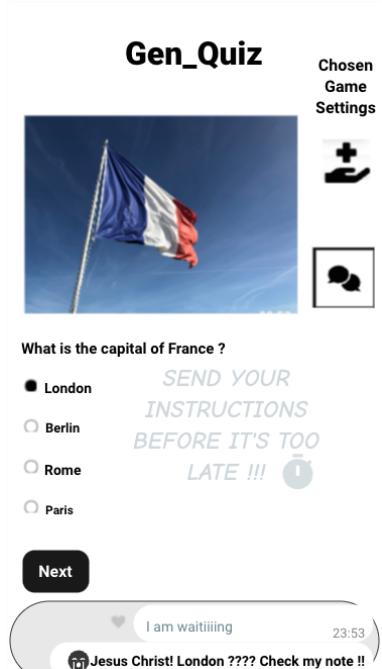


Figure 16: Helper Asynchronous Page.

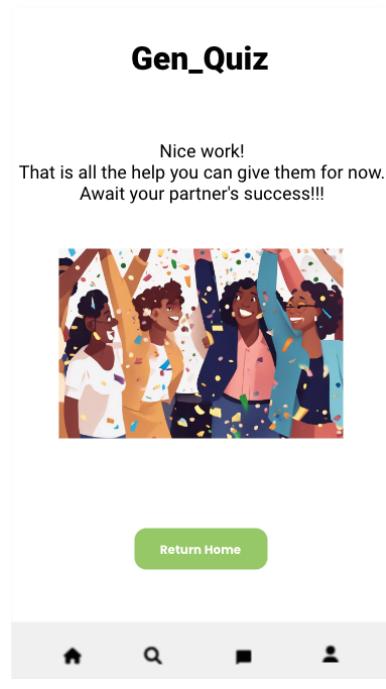


Figure 17: Helper Wait Page.

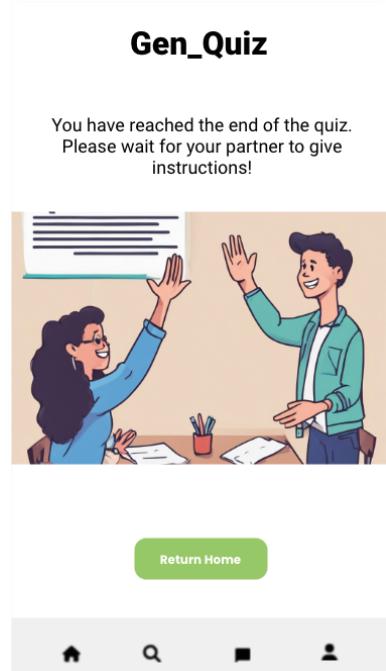


Figure 18: Leader Wait for Partner Page.

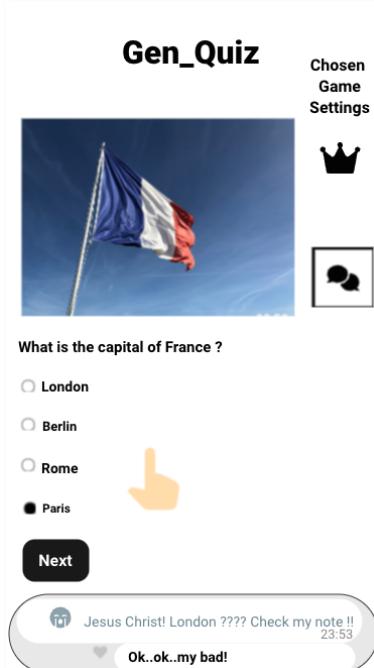


Figure 19: Leader Apply Partner's Suggestions Page.

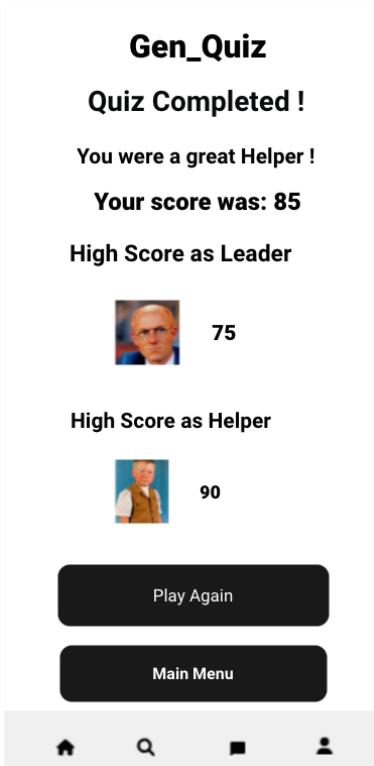


Figure 20: Final Score (helper) Page.

Gen_Quiz

Quiz Completed !

You were a great Leader !

Your score was: 70

High Score as Leader



75

High Score as Helper



90

Play Again

Main Menu

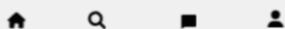


Figure 21: Final Score (leader) Page.

← Gen_Quiz



Settings

Permissions

- Enable notifications
- Share location
- Biometric login

Accessibility

- Color Blind Mode

Language Settings

Select Language : English

Sound

- Sound Effects
- Background Music

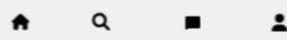


Figure 22: Settings Page.



Figure 23: Push Notifications Page.



Grandma Mary's Profile

[Share](#) [Invite](#) [Achievements](#)

| | | |
|----------------------|--------------------------|---------------------------|
| Quiz Progress | Top Leader Score: | Biggest Quiz Buddy |
| 100 % | 75 | |
| | Top Helper Score: | Grandson Stef 90 |

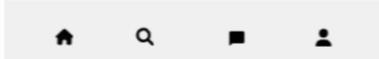
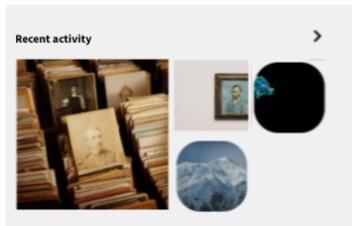


Figure 24: Profile Page.

Appendix G UI REFINEMENT

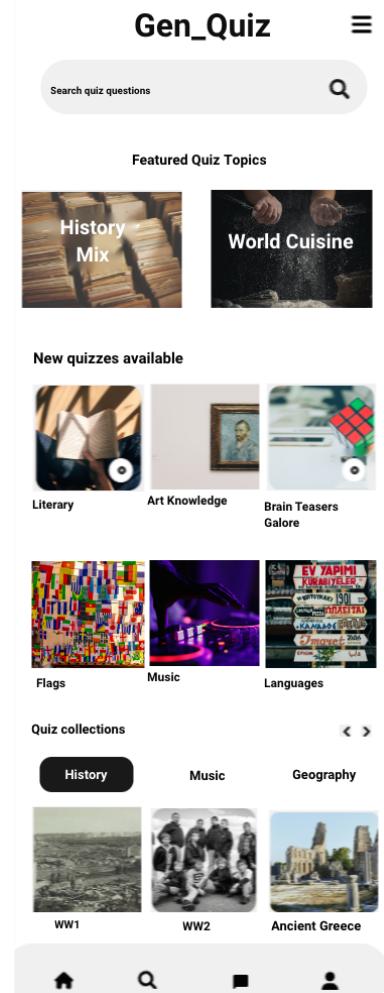


Figure 25: Update Home Page.

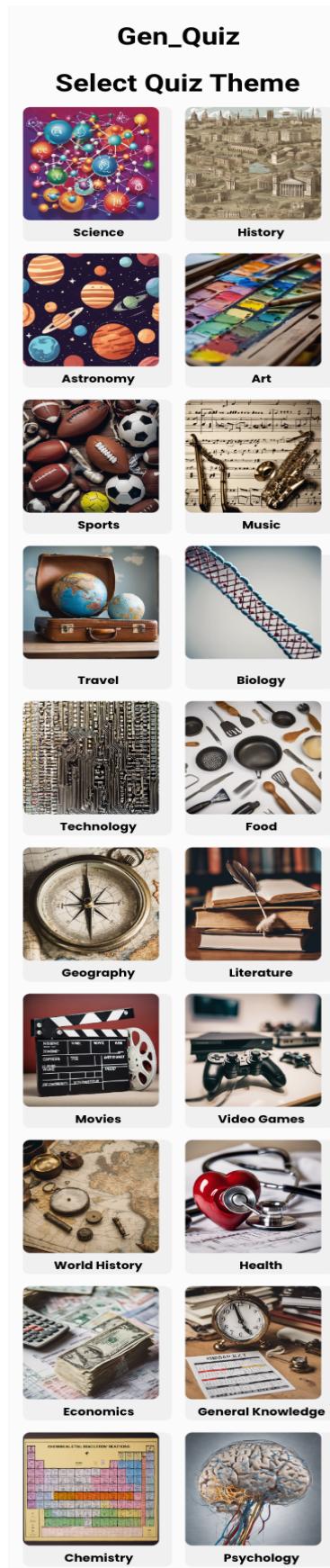


Figure 26: Updated Theme Select Page.