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Bachelor in Computer Science

ASYMMETRIC ROLES IN INTERGENERATIONAL GAMES

MASTER IN COMPUTER SCIENCE

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Abstract

Gaming together has been shown to have a variety of social and emotional benefits, including for families that play together. However, the majority of games are designed for the stereotypical gamer not taking into consideration the different play restrictions of family members. In this thesis, we first sought to understand what were the barriers for family play. Next, recognizing the different requirements for intergenerational play, we explored the use of asymmetric game design to cater to adult-child pairs to enable shared play.

Previous work suggests that preferences and motivations change with age, giving preference to less reaction-based games and being less motivated by their performance in these games. For this thesis, a first study was conducted, collecting 402 responses from an online survey, where it was possible to understand the motivations and preferences of families (where intergenerational interactions naturally occur) in Portugal. We found that while family gaming is generally well received, some barriers can pull players away from these experiences. Specifically, **differences in time available** and **differences in gaming skills and expertise**.

These results were used to inform the design and development of a game with two radically different parts designed to tackle the main requirements found in the first study. This game was then used in a second study with 6 adult-child pairs where we were able to assess how the different roles were able to give a response to these requirements. Our goal was to provide play experiences for both players, promoting communication in the real world while ensuring a sense of shared play. The results from this study show that implementing radically different roles, specifically designed for each player, while seemingly divisive at first, can create a space where both players play in their own way and are still able to meaningfully affect the game without compromising on the sense of shared play.

Keywords: Asymmetry, Asynchrony, Family Play, Gaming, Inclusiveness, Roles, Mobile, Desktop

Resumo

Tem-se demonstrado que jogar com outras pessoas tem uma variedade de benefícios, incluindo para famílias que jogam juntas. Ainda assim, a maioria dos jogos são desenhados para um jogador estereotipado, sem ter em consideração as diferentes necessidades e preferências de jogo de cada membro da família. Nesta tese, primeiro procurámos perceber quais são as barreiras com que as famílias se deparam ao jogarem juntas. Depois de identificar os diferentes requisitos que caracterizam contextos intergeracionais, explorámos o desenho de jogos assimétricos para atender aos requisitos de pares adulto-criança e promover experiências de jogo partilhadas.

Trabalho anterior sugere que as preferências e motivações mudam com a idade, sendo que normalmente se instala uma preferência por jogos com menos limites de tempo e se perde a motivação originada pelo desempenho nos jogos. Para esta tese, foi conduzido um primeiro estudo, em que obtivémos 402 repostas através de um questionário online, onde foi possível perceber melhor as motivações e preferências de familias (onde interações intergeracionais acontecem naturalmente) em Portugal. Descobrimos que, ao passo que jogos em família são geralmente bem recebidos, algumas barreiras podem afastar os jogadores destas experiências. Especificamente, **diferenças no tempo disponível** e **diferenças nas habilidades e perícia**.

Estes resultados foram usados para informar o desenho e desenvolvimento de um jogo com duas partes radicalmente diferentes, desenhado para ir de encontro aos principais requisitos identificados no primeiro estudo. Este jogo foi então usado num segundo estudo com 6 pares de adulto-criança onde pudémos aferir como é que os diferentes papéis poderiam dar uma resposta a estes requisitos. O nosso objectivo foi providenciar uma experiência de jogo para os dois jogadores, promovendo a comunicação no mundo real e garantindo um sentimento de partilha. Os resultados deste estudo mostram que implementar papéis radicalmente diferentes, desenhados especificamente para cada jogador, embora pareça divisivo de ínicio, pode criar um espaço onde ambos os jogadores jogam à sua maneira e são ainda capazes de afetar o jogo de forma significativa, sem comprometer o sentimento de partilha.

Palavras-chave: Assimetria, Assincronia, Jogar em Família, Jogos, Inclusividade, Papéis, Móvel, Computador

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1

Introduction

Digital games have grown in popularity across the board. According to the Entertainment Software Association (ESA), in 2021, in the United States of America, 76% of those under 18 years old and 67% of adults (over 18 years old) were video game players [1]. Additionally, 42% of video game players are more than 35 years old (14% 35-44 years old, 12% 45-54 years old, 9% 55-64 years old and 7% more than 65 years old) [1].

Gaming entails substantial social potential. Previous work shows the relevance of digital gaming for different generations, as a means to expand social interactions and friendships [28, 46, 38]. Likewise, existing work also shows gaming as a social space for intergenerational play and, in particular, family play, where intergenerational interactions naturally occur. In previous work [34], older adults have expressed the social benefits of digital gaming, in dealing with loneliness and spending time with the family. Additionally, some online games enable families to generate conversational topics and keep track of their real life activities [61].

It has also been shown that, with age, preferences and motivations for playing tend to change [8, 34]. More specifically, previous work suggests that, as we age, preferences shift from performance-based games to having a complete experience (finding all the collectibles, for example), feeling autonomous and enjoying the experience [8]. Older adults also report frustration with reaction-based games, drifting towards slower paced ones like puzzle and strategy games [34].

These differences in abilities, preferences and motivations can make designing experiences that appeal to different generations challenging. It is necessary to characterize the population to move towards a more inclusive gaming space, and find ways that consider and cater to different players and different needs.

Digital games tend to be symmetrical experiences, in which all players have the same rules and objectives. Because of this, intergenerational experiences generally require some players to conform to a less appealing experience. For example, some games expect players to invest a considerable amount of their time in the experience, either to be proficient or simply to have a feeling of progression, creating a divisive experience between a child, who generally has more time to dedicate to a game, and a parent, who tends to

have more responsibilities and less time to invest in such experiences. This is in line with previous work, as families report a general lack of time [56]. All these constraints make the design of intergenerational games challenging.

In some games, however, players are not bound to the same sets of rules or goals (i.e. are asymmetric). There are several types of asymmetry, such as asymmetry of information, ability, interface, challenge and goals, to name a few. We argue these types of asymmetry can be used to cater to the different needs and requirements of the families, moving towards a more inclusive experience.

1.1 Asymmetric Family Play

The goal of this thesis was to explore the use of asymmetric roles in the context of family play, creating an experience that can feel meaningful to the participating players and still fit the families' necessities. For this, the first step was to conduct a characterization study focused on understanding how families play together, what their motivations are, or, if they don't play together, what drives them away from having these experiences together. Then, the second step was to design a testbed game, making use of asymmetric roles to create an experience that aims to tackle a set of the barriers found in the first study (in particular, differences in available time) and validate the approach through a user study with adult-child pairs.

We aim to answer the following research questions with this work:

- How do motivations and preferences differ between different generations?
- What are the constraints of gaming in an intergenerational context, particularly within families?
- How can asymmetry meet the different requirements of different generations?
- What types of asymmetry better cater to these differences?

1.2 Contributions

This work contributes in the following points:

- Characterization of gaming experiences and motivations within families, specifically in Portugal, and identification of limitations and opportunities for intergenerational play.
- Exploration of a conceptual approach where asymmetry is used to overcome differences between the players (namely, differences in available time) by designing different roles that cater to each player's needs and preferences.
- Design and development of a proof-of-concept game following this approach.

- Validation of the approach through play-testing and user studies, where we assess its potential to create engaging and inclusive family play experiences

1.3 Structure

This thesis has the following chapters:

- **Chapter 2 – Related Work:** An overview of the work that has been done on intergenerational games, with a focus on family play. Examples of commercial and research asymmetric games are given, as well as frameworks and models for discussing games and players motivations.
- **Chapter 3 – Understanding Family Play:** A report on a first characterization study of the motivations, preferences and gaming habits of families, specifically in Portugal. The results are discussed, providing insights into the themes brought up by the qualitative analysis on the open-ended responses.
- **Chapter 4 – Designing Asymmetric Games for Families:** Here, a brief overview of the game is given and the design and development process of the game is discussed, focusing on the decisions that were made and the implementation of the game's systems.
- **Chapter 5 – Game Evaluation with Intergenerational Groups:** A study with 4 pairs was conducted, where they played the game for a week. In this chapter, we present the perceptions of our participants and the data collected throughout the experience, highlighting the potential of the approach for these contexts.
- **Chapter 6 – Conclusion:** We conclude with some thoughts on the results and prospects for future work.

2

Related Work

Studies have shown that digital games offer several benefits to the player, including a cultivation of a persistent and optimistic motivational style, and improved cognitive and social skills [28]. Specifically for families, benefits include reinforcement of relationships [13] and increased family closeness [60].

Families are often a heterogeneous group, with widely differing preferences, motivations and skills. When creating a game that can be truly enjoyable by such a group, it might be infeasible to try to appeal to everyone at the same time. Our approach centers on the possibility of designing individual roles within the same game, shaped to cater to each player.

In this section, we delve into previous work that focuses on exploring intergenerational and family play, characterizing how age affects gaming experiences and preferences, asymmetry in games and frameworks and models for game design.

2.1 Intergenerational and Family Play

While digital games are still a relatively new medium, they were shown before to be an important tool for families to connect, for example by providing new talking points which families can connect over [61]. They also offer flexibility as they tend to not take too much space and can be played in a remote fashion.

Although parents worry about their children's screen time, more recent studies suggest that gaming as a family activity appeases those worries and can, sometimes, lead to a new activity over which families can bond [52, 43]. Specifically, Sobel et al. [52] explore how games can be used as a joint family activity and how Joint Media Engagement can lead to family bonding. The authors surveyed parents that played Pokémon GO with their children on their habits playing the game and their thoughts on location-based gameplay. They found that while concerns about screen time and safety in real-world environments exist, parents appreciated the increased exercise and time outdoors and how play led to family bonding experiences. Additionally, Musick et al. [43] interviewed 20 adults who had co-played digital games with their parents and/or children, investigating their

relationships mediated by playing these games. The study reveals modern parent-child interaction dynamics emerging through gaming. Namely, the "democratization" of the playing space. Parents and children collaborated in selecting the games to play and fluidly and dynamically switched leadership positions while playing. Families have shown a preference for co-located experiences and, if the game only offers a remote option, some still find ways to enjoy the experience in the same room, to increase their sense of co-presence. Participants also mentioned the frequency of interactions rooted in the games they play, even outside of gameplay sessions. Furthermore, parents reported using these topics to transition into other more meaningful conversations. Some suggestions were made, to promote the positive aspects reported:

- **Encouraging conversations both in and after gameplay** - either by directly prompting the players (as in children's television programs) or by creating conversation guides to go along with the game.
- **Promoting co-viewing to strengthen connections through shared interests** - implementing ways in which spectators can take part in the game, affecting it in other ways.

Wang et al. [60] recruited 361 adults to answer a survey on gaming habits and family closeness. The results suggest that playing digital games could improve family relationships, going beyond the correlation and establishing a causal relationship. Participants also mentioned desired features in family digital games like cooperation, teaching and thinking. However, these features were not prioritized in choosing games. Fun and engagement came first with social features being the second priority. De la Hera et al. [13] conducted a systematic literature review and found some factors that should be considered when designing intergenerational games. The factors to consider in the design process were divided into two categories: Player-Centric, including interactions between young and old players, different motivations, preferences and differences in abilities; and Game-Centric, including Goal-Related Forms of Interaction (positive interdependence facilitates social interaction) and Space-Related Forms of Interaction (Co-located or Virtual).

Ulicsak et al. [56] performed another literature review raising important concerns such as the roles that different generations take in family play, how cost can be an issue for accessing this medium or how parents report lack of time to play videogames with their children.

A mixed-method study [59] with 36 participants detected that the traditional roles of the adult as a teacher and the child as a learner were reversed in video games. Younger players would take the role of the leader and teach how to play as well. Besides this, the same study noticed that there was a knowledge trade between generations. While young ones have the gaming know-how, older players have the social know-how, moderating social interactions while the younger players practice teaching and leadership.

Some intergenerational games have also been developed for research purposes. Curball [35] is a remote bowling game where a grandchild can play with their grandparent through the use of augmented reality. The grandchild sets up a space with obstacles that get instantiated in the digital space. Then, the grandparent performs a throwing gesture with a physical ball to decide the motion of the digital ball. The goal is for the virtual ball to reach the other side of the level without touching any obstacles. The game was tested and iterated over three times finishing with a user study of two older people and one child. The two older players quickly understood how to play the game (performing a throwing gesture with the ball) but felt that communication needed practice to improve. The paper argues that there is significant potential for "ubiquitous games" (ubi-games) for older people if the focus is on communicating with the grandchildren.

Age Invaders [36] was another game developed to involve the whole family. Grandparents and grandchildren would play on a platform consisting of displays they could move on, and shoot each other with Bluetooth controllers (spawning projectiles on the displays) while the parents could join remotely and affect gameplay, spawning bonuses for the players on the platform. The game was evaluated through a user study with five older players and five younger players where the participants were asked to answer a questionnaire and later interviewed one by one. The work identified social interaction as an important factor in enjoyment of the game. In the interviews, players reported feeling excited to play the game. The paper also points out how the gameplay also has a performance aspect where the physical movement of the players can be fun for spectators.

Abeele and De Schutter [57] propose that, instead of physical interaction, it is enactive interaction that ensures equal ease-of-use between different generations while playing a digital game. Enactive interaction is the usage of real life knowledge to facilitate interaction, for example hammering down a nail. The work tested this idea with 4 commercial mini-games and then developed their own mini-game with this in mind. Although digital games are a good way for families to play together, this is not the only type of digital family play. One example is the Collage [58] where a family could be in contact with the grandparents through a device with a touchscreen, being able to communicate through photographs and text messages in a synchronised environment. This generated several play behaviours. For example, when a grandchild was organizing photographs and the grandparent would move some out of place as a way of teasing them.

2.2 Age & Gaming

With digital games more and more present in different households with family members from different generations [56], it is essential to investigate how age and factors associated with it affect the experience and what are the implications for design.

Although digital games offer several benefits, they also have inherent costs, mainly economic ones but also how some digital knowledge is required to be successfully part of the medium. In [49], gaming as a marginalized activity is discussed where, from the

perspective of an outsider, it can be seen as a socially isolated activity, providing little to no benefit. This perception can deter new adopters of this medium. Birk et al. [8] performed a cross-sectional study with over 2,000 people which suggests that, with age, players' motivations drift away from performance towards enjoyment, choice (i.e. being autonomous in the experience) and completion, as well as increasing preference for casual and puzzle games and decreasing preference for performance-related games.

McLaughlin et al. [41] observed and analysed over 30 older players, and propose 3 major categories of costs for choosing to play digital games, *costs related to physical changes*, where the physical interaction with the game (pressing buttons, reading text in the screen) can be difficult, *costs related to cognitive changes*, or how games naturally incur a cognitive weight on its players, for example, requiring players to remember game items and their effects, and *affective costs*, where the paper refers to the stereotype threat [53] as an example, which is the presupposition that an older player cannot perform adequately in digital games. Although these costs are important in making the decision of playing digital games or not, the paper identified that costs and benefits are not given equal weight. It may not be sufficient to decrease the costs while, on the other hand, a high perceived benefit can make the costs more acceptable.

As we age and our priorities change, so do our preferences and motivations when it comes to entertainment. De Schutter and Brown [14] identified three factors for modelling digital game enjoyment. These are:

- **Hedonic Enjoyment** - Joy of experiencing positive emotions
- **Eudaimonic Enjoyment** - Joy of contributing to personal growth (related to one's aspirations and self-identification).
- **Telic Enjoyment** - Joy of improving current performance in terms of health, cognitive skills or mental stability. Emotional self-regulation is also mentioned.

As the two qualitative studies the paper used were from different contexts (one from the United States of America, and another from Europe), they were able to identify how game enjoyment can change with context. Specifically, older adults in the USA were more concerned with using games as a tool for maintaining cognitive health while European respondents reported broader benefits, including physical and therapeutic ones.

Another study surveyed over 400 older adults in Canada [34], aiming to assess the socioemotional and cognitive benefits of gaming, as self-perceived by participants. Perceived socioemotional benefits were reported but most perceived benefits were on the cognitive level, with focusing attention and memory being the most perceived, and reasoning being the least perceived.

2.3 Examining Games

There have been some attempts at defining how players interact with games. One of these is the Mechanics, Dynamics, and Aesthetics (MDA) framework [31], which proposes a formal approach to understand and communicate about game design decisions. Mechanics relate to the low-level rules of the game (e.g. shuffling, dealing in card games), Dynamics are how, in runtime, these mechanics behave according to the user input and when interacting with each other (e.g. bluffing in a card game), Aesthetics describe the emotional response of the player to the dynamics (e.g. games as a challenge, social framework or a sense-pleasure).

It is also important to understand the motivations for playing. Bartle's Taxonomy [7] groups players into four categories: Killers, Achievers, Socialisers and Explorers. These categories are placed in two axes: Acting vs Interacting and Players vs World. So, for example, explorers interact with the world while killers act on players. BrainHex [44, 32], based on neurobiological research, is a model for player satisfaction which groups players into seven archetypes: Seeker, Survivor, Daredevil, Mastermind, Conqueror, Socialiser, Achiever:

- **Seeker:** Curious about the game world and enjoys moments of wonder
- **Survivor:** Enjoys fear and terror
- **Daredevil:** Seeks thrilling, exciting and risk taking experiences
- **Mastermind:** Enjoys puzzles, strategizing and efficient decisions
- **Conqueror:** Looks for challenging experiences to overcome
- **Socialiser:** Likes hanging around people, talking and helping them
- **Achiever:** Focused on goals and completing them. Completionist.

BrainHex improves on Bartle's Taxonomy by establishing that the different motivations are not mutually exclusive. Instead, the scores of each type are summed in order to find the primary and secondary types.

Quantic Foundry [62] used data from a survey with over 450,000 respondents and developed a player motivation model (see figure 2.1) with six categories each with two sub-categories (12 total): Action (Destruction, Excitement), Social (Competition, Community), Mastery (Challenge, Strategy), Achievement (Completion, Power), Immersion (Fantasy, Story), Creativity (Design, Discovery). Although these categories will, most likely, not apply to the diverse spectrum of players, they are important to inform an increasingly inclusive design which meets their different requirements. Accessibility is another important topic in regards to inclusiveness in the videogame industry. Most games are developed with people with no disabilities in mind, leaving part of the population aside. This is often worked over only after the game is designed and sometimes only

Figure 2.1: Quantic Foundry's Gamer Motivation Model [62]

in late stages of development. Grammenos et al. [27] propose a new concept of Universal Game Design, where a game is designed from the beginning with accessibility in mind, testing and iterating the game with the community and accessibility experts but also, more importantly, designing ways in which the game can adapt to the players limitations. Another concept the paper introduces is the concept of Parallel Universes which, in this context, refers to having each player playing in their own specific "universe" (even if they are cooperating or competing with each other) while maintaining communication and interaction with their fellow players. While this might not work with every game, it produces better results than trying to make a game more accessible after the fact.

2.4 Asymmetry in Games

Asymmetry in games implies that players do not have the same set of rules or goals. This can be utilized to create games with roles catered to a player's preferences and necessities, creating an egalitarian space, where each player can have a different experience but one which is balanced to their own particularities. We envision asymmetry as a way for players with different preferences and motivations to play together. Here we present some games developed commercially and for research in this field.

Asymmetry has been successfully implemented in some commercial games. Namely, "A Way Out" [5] and "It Takes Two" [6] make use of asymmetry to let the players experience the story of two characters individually, but while playing together, at the same time. "It Takes Two" has several levels where the gameplay is radically different for each player. Specifically, there is a level where one player controls an airplane, as if they

were playing a space flight game, while the other is playing a generic fighting game on top of the airplane. Besides implementing asymmetry, the game makes extensive use of interdependence, forcing players to work together and communicate in order to progress.

(a) Scotty's perspective (b) Kirk's perspective

Figure 2.2: The two perspectives in "Beam me 'Round Scotty"[29]

"Beam me 'Round Scotty" [30, 29] was developed as a platform to experiment with several levels of interdependence and types of asymmetry. In this cooperative game one player has a top-down perspective ("Scotty"), while the other one has a ground-level third-person perspective ("Kirk"), as seen in figures 2.2a and 2.2b. The goal is to guide "Kirk" to the end of the level, while dealing with obstacles and enemies. The top-down player interacts with the game using a mouse or touchscreen while the ground-level player uses a controller. The game was used in a first study in 2016 [30] to explore interdependence and asymmetry dynamics, where some concepts were introduced such as Directional Dependence (the direction in which a player depends on other) and Synchronicity and Timing (how long before an action of player A affects player B).

Later, in 2019 [29] the same game was used in two studies. The first to explore how asymmetry (one player as "Kirk" and the other as "Scotty") compares to symmetry (both players as "Kirk" or both players as "Scotty") in the perceived connectedness between players, where asymmetry had a positive effect. However, in the symmetric experiments, there were cases of "emergent cooperation" — e.g. players healing each other as "Kirk" — and "emergent competition" — e.g. both players racing to the end of the level as "Kirk".

In the second study, the concept of "degree of interdependence" was introduced with three levels (loose, medium and tight coupling) aiming to get a more nuanced result. This was achieved by tweaking the abilities so they would require more (tight coupling) or less (loose coupling) intervention from the other player to be useful. Overall, players felt more engaged and connected under the tight coupling condition. However, it is worth noting that lower skilled players preferred loose coupling.

Asymmetry has also been explored in regards to mixed-ability games. For example, Last Tank Rolling [21] made use of the Kinect to design a motion-based game in which one able-bodied player plays as a foot soldier and a wheelchair user controls a tank, each

able to move and shoot individually, however they could enter "joint firing mode" to fire together, combining their strengths. The wheelchair is used as a metaphor for the tank which the able-bodied player had to repair or hide behind for cover, providing a novel way for mixed-ability players to play together without having to conform to a game not made accessible to them.

Gonçalves et al. [24, 25] developed two games, leveraging asymmetry to create inclusive games for mixed-visual-ability contexts, designing one role based on auditory challenges and the other role based on visual challenges. In one game, the sighted player takes the role of a pilot while the blind player takes the role of an engineer. In the other game, the roles are reversed. The games were evaluated with mixed-visual ability pairs and most participants reported an engaging and balanced experience in which they felt competent and autonomous. The work found that the asymmetric games created an equitable space, in which the difference in abilities was not limiting.

The aforementioned game Age Invaders [36], designed for intergenerational play, also implemented asymmetry. Here, the projectiles targeting the elderly could be customized to move slower in order to balance for reaction-time differences and while the grandchildren and grandparents had physical gameplay, the parents could join remotely through their own devices and affect the gameplay by creating bonuses in the game board. This asymmetry enables players of different skills (and in different spaces, in the case of the parents) to come together and enjoy a balanced playful experience

2.5 Summary

Games can offer several benefits to the individual, but also as a familial activity. They offer a shared space, with new activities and interactions, possibly creating new opportunities for families to connect. However, as our preferences and motivations towards games change as we age, there is a divide in what different generations seek in these experiences.

Additionally asymmetry can be leveraged in games to meet these different demands, implementing a different set of rules and mechanics catered to the different players. Furthermore, interdependence between the players can lead to them feeling more engaged and connected with the other. Although these two concepts have been successfully joined to create positive social experiences, there is still a lack of knowledge on how they can be applied in family contexts.

3

Understanding Family Play

For the first goal of this thesis, aiming to understand and characterize how families play together (or why they do not), a survey was created and shared, in Portuguese and English, across social media and forums, gaming communities, through personal connections and word of mouth, collecting 402 responses in one month. The survey aimed to collect the perceptions of both gamers and non-gamers about their gaming habits (or lack thereof), as well as opportunities and barriers associated with family play. Ten respondents, randomly selected from the sample, were rewarded with a 20€ voucher. The questions we sought to answer were the following:

- How do motivations and preferences differ between different generations?
- What are the constraints of gaming in families?
- What requirements can we tackle using asymmetry?

3.1 Procedure

The survey[1] was created with Google Forms [26] and consisted of a first section where the participants consented to participate in the study, followed by a section of general demographic questions. Then, the participants were asked if they played digital games, if not, they were directed to a section where they had the opportunity to write down why they do not play digital games and what could be done to change this. If the participants reported playing digital games, they were asked about their gaming habits (alone, with friends and with family) as well as their gaming motivations (where we used the motivations suggested by Quantic Foundry [62]). Participants who reported playing games with their family also had the opportunity to share some of their experiences (positive or negative) through open-ended questions. However, if they did not play games with their family, they were asked why not and what could be done to change this. In the end, all participants were asked about tabletop gaming habits and other pastime activities they had (either alone or with family).

[1] https://osf.io/tgfzh/

Answers to multiple-choice questions were subject to a descriptive statistical analysis. Written responses were interpreted following an inductive thematic analysis, as proposed by Braun and Clarke [10]. Me and another member of the research team were mainly involved in this process, first repeatedly reading and annotating low-level concepts that were recurring and/or relevant. Following initial discussions, I started a more formal coding process, eventually reaching a first set of codes, which were then discussed with the team and iterated (e.g., added, grouped, merged). We proceeded to search for relationships between codes and coded segments, resulting in a set of themes. These were discussed among the researchers in various sessions, defined and named accordingly.

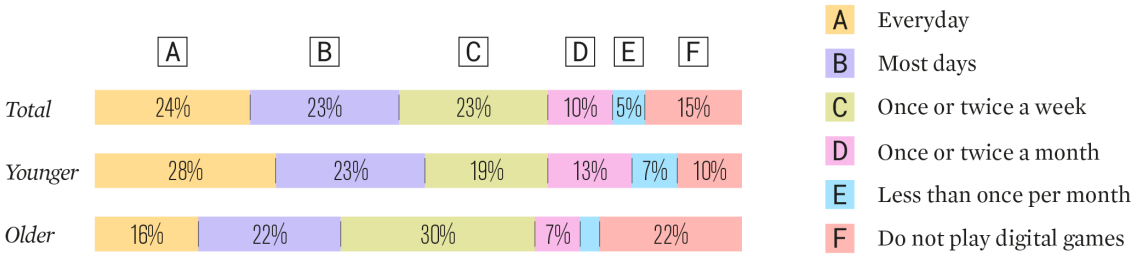

Figure 3.1: Gaming frequency of gamers

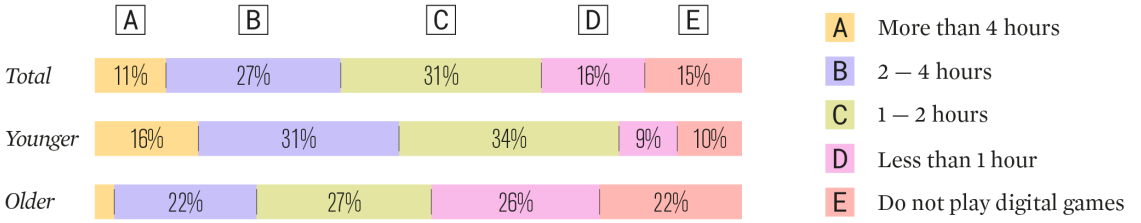

Figure 3.2: Gaming session length of gamers

3.2 Results

The survey had 402 respondents in total, but as the data sample size outside of Portugal was too small to be relevant, a decision was made to cut respondents that did not reside in Portugal. This left us with 376 respondents (146 F, 229 M, 1 preferred not to say), ages 12-69 (Mean = 28.7; SD = 12.2).

We consider 'gamers' as participants who reported playing digital games, at least occasionally; 'family gamers' as participants who reported playing digital games with

their families, at least occasionally. We also consider 'non-gamers' as participants who reported not playing digital games at all.

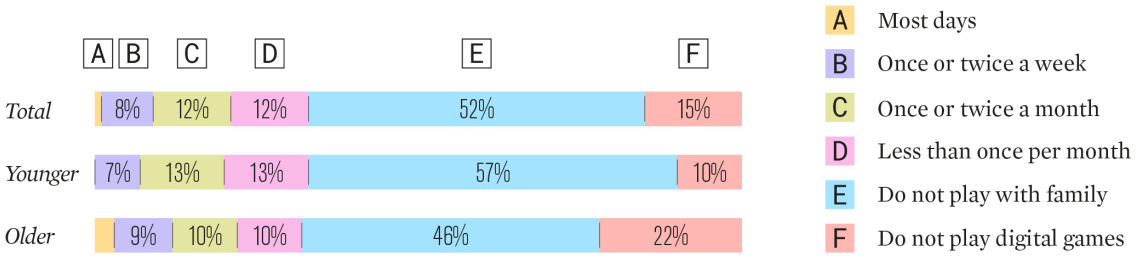

Figure 3.3: Gaming frequency of family gamers playing with their family

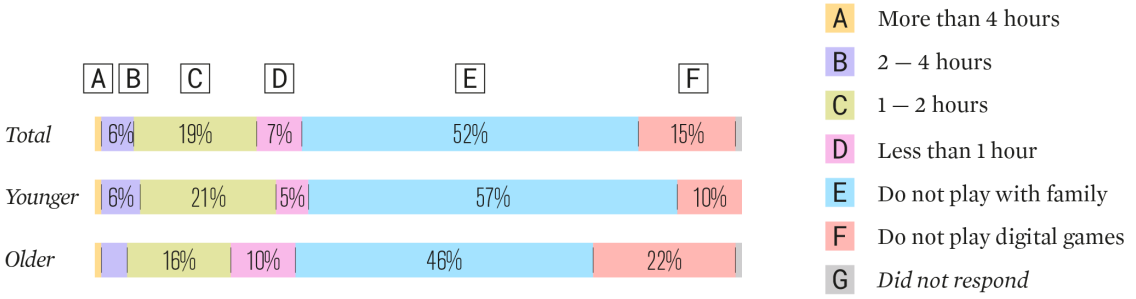

Figure 3.4: Gaming session length of family gamers playing with their family

The majority of respondents in our sample were 'gamers', playing digital games, at least occasionally (N=319, 85%), and 'family gamers', playing digital games with their families, at least occasionally (N=178, 56%). 'Gamers' were mostly playing "Everyday" (N=88, 27.5%), "Most days"(N=86, 26.88%), or "Once or twice a week" (N=87, 27.19%) [Figure 3.1], in sessions that averaged from "1 to 2 hours" (N=118, 36.88%) to "2 to 4 hours" (N=102, 31.88%) [Figure 3.2]. Playing with the family is expectedly less frequent, as most were doing it "Once or twice a week" (N=29, 23.58%), "Once or twice a month" (N=44, 35.77%) or even "Less than once per month" (N=45, 36.59%) [Figure 3.3], with session length averaging "1 to 2 hours" (N=71, 57.72%) [Figure 3.4]. Below, we describe the themes we found, illustrated with quantitative data and representative experiences shared by participants.

3.2.1 Family Bonding

Family gamers report feeling more engaged (N=52, 42.28%) and connected (N=63, 51.22%) with their families when playing with them [Figure 3.5]. When asked about positive experiences playing with the family, some respondents highlighted how games improve

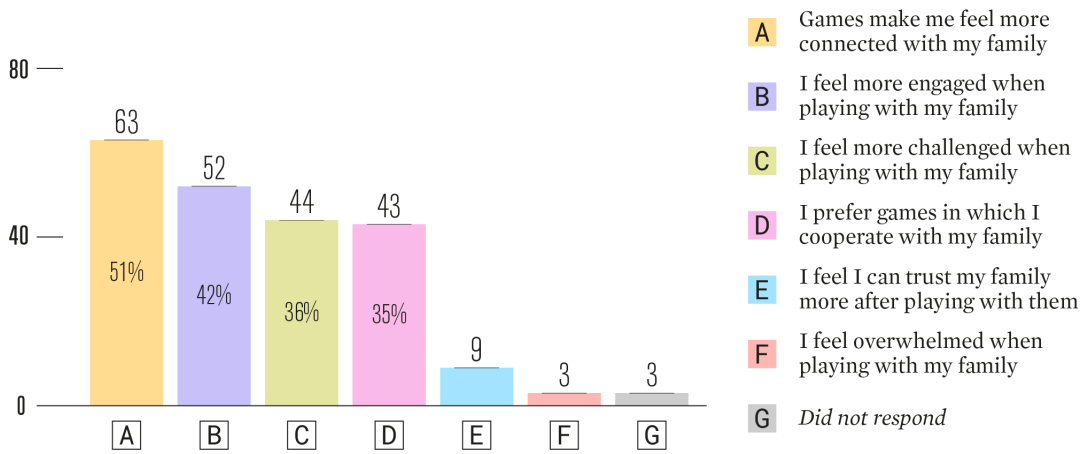

Figure 3.5: Responses to the multiple-choice question about participants' perceptions on playing with their families

connectedness and closeness: *"I feel it's an incredibly bonding experience"* (R32); *"[Games] gave us an opportunity to connect on vacation"* (R322); *"[...] moments of fun and closeness"* (R344); *"We always laugh a lot and she [sister] feels like she spends quality time with me"* (R341). Respondents mentioned gaming in family provides a space to interact and communicate, prompting outside conversations: *"A greater ease to talk about other subjects comes up while we play"* (R140); *"It's usually funnier because there's a connection and jokes made that wouldn't happen with other players"* (R16). These benefits were also highlighted by one respondent, in the current context of social isolation: *"In pandemic times, even though we are not together, when playing online together, it was like we were"* (R176). One participant highlighted the opportunity for others to be included in the experience, even when they are not actually playing: *"Although we were not all playing, even the older ones were entertained and commenting on the game"* (R163).

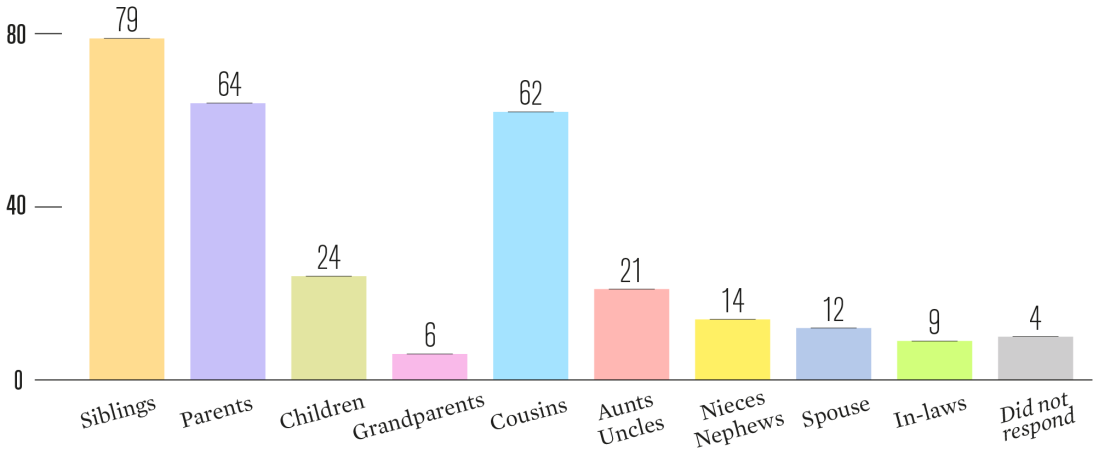

Figure 3.6: Family members with whom participants have played before

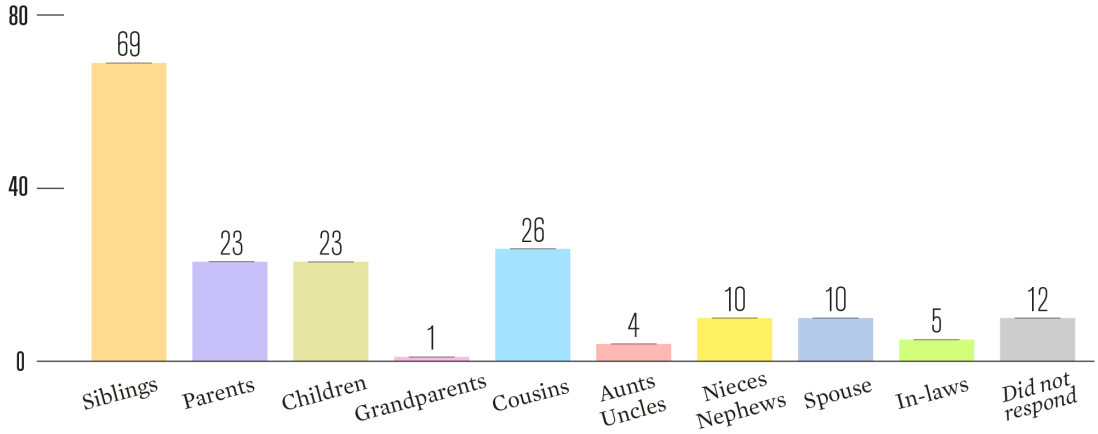

Figure 3.7: Family members with whom participants play often

3.2.2 Lack of time and circumstance

Non-gamers mostly mention lack of time (N=33, 58.93%) and "games are boring" (N=14, 25.00%) as motives for not playing games [Figure 3.8]. Gamers who do not play with their family mainly state their family "does not want to play digital games" (N=80, 40.61%), "the option was never brought up" (N=72, 36.55%), and "lack of time" (N=48, 24.37%) [Figure 3.9]. When respondents who do not play with their families were openly asked why and what would open doors for it, lack of time and circumstance was also highlighted: "*being more time together*" (R252); "*compatible schedules among everyone to dedicate to digital games, as it is the main barrier*" (R43). In this context, games that involve short sessions may be a solution: "*a game that is easy to set up [...] and has short rounds*" (R98). Some stated these experiences never happened, simply because "*the option never came up*" (R332). This was associated with a "*lack of will*"(R327) on the part of the family and not "*finding the right game*" (R37) to captivate the whole family. As many participants highlighted not finding the "right game", some delved into describing desired characteristics for family play: "*a game that would interest several generations, with a friendly look to attract people who are not interested in playing*" (R257).

3.2.3 Entry Barriers

For most respondents, finding a digital game that everyone would enjoy is a challenge. For instance, R364 has never played digital games with the family, despite doing a variety of family activities, including travelling, sports, and tabletop games: "*We play a lot of board games. It just never happened to play digitally. Having an amazing game to try out would be a way to get us to do it*". Curiously, tabletop games were often pictured as more appropriate when it came to family play. While it was explained the format "*is more personal*"(R133), it was also commonly pointed out the difficulties encountered by players in the family, when trying to access the digital medium for the first time. Respondents state digital games are typically hard to understand and controls can require complex

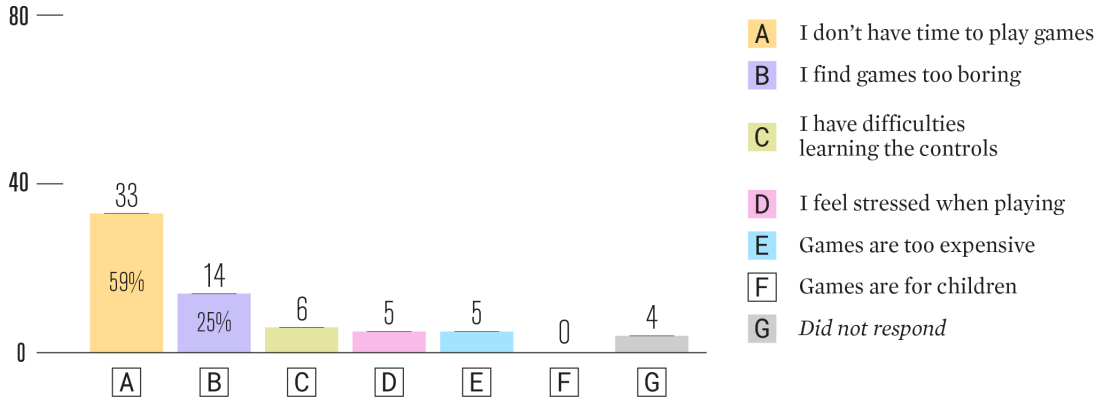

Figure 3.8: Motives reported by non-gamers to not playing digital games

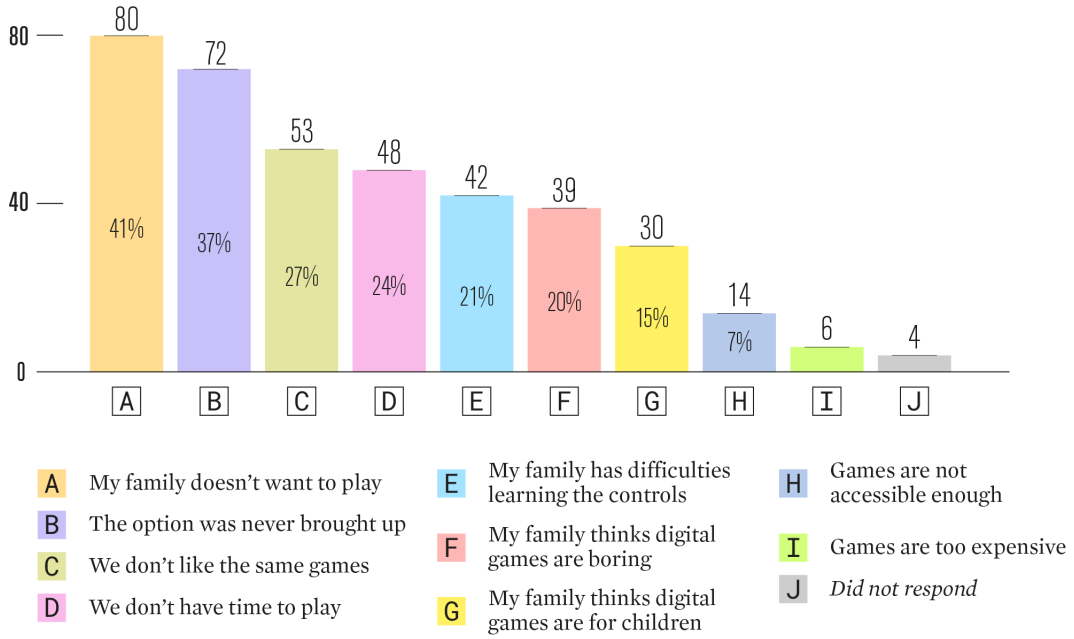

Figure 3.9: Motives reported by gamers to not playing digital games with their families

mental maps. As such, there was a general desire for a game *"that is easy for everyone to learn"* (R87) and *"that does not involve a long learning process, so that everyone feels motivated to play"* (R89). "Hard controls" is a barrier reported by gamers who do not play with their families (N=42, 21.32%). R83 gives an interesting perspective in this regard, explaining how some games rely on prior acquaintance and experimentation with the controls, making it more complex for novice players: *"Many games assume that players already have a prior knowledge of certain mechanics, which is often not explained, and only players with expertise will ask 'can I do this?', 'can I do it another way?', while less experienced players think 'if the game does not explain me, it does not work"'.*

3.2.4 Unbalanced Experiences

Respondents also had the opportunity to freely write about negative experiences when playing with their families. In this question, the vast majority of respondents mentioned the frustrating feeling of losing and how excessive competitiveness usually leads to discomfort and conflict: *"Being too competitive in a casual environment while playing, and making people uncomfortable"* (R31); *"[...] it can generate a little friction"* (R344). In some cases, this can be linked to an unbalanced experience, particularly in intergenerational scenarios, where some players cannot competitively keep up with others: *"Younger kids get angry if they are losing, and then there is someone older [...] complaining we should not have played so seriously with the younger ones"* (R163). Some respondents who play with their family report feeling more challenged, when playing with them (N=44, 35.77%). This was also evidenced in collaborative experiences, and associated with differences in expertise — *"My mother becomes sad as she thinks she has nothing to contribute because I have been playing for longer"* (R94) — and skill — *"The fact that he [his nephew] is still a kid and does not have the same cognitive ability means that in the most difficult parts of the game, it is almost like I am playing alone"* (R57).

3.2.5 Learning and breaking expectations

While this unbalance in gaming expertise and skills may originate unwanted frustration and discord, some perspectives suggest it may also give rise to positive experiences. In particular, it may emphasize a sense of shared achievement: *"My brother helped me with the Minecraft platinum trophy, given he has more expertise in the game, and we created more connection after that"* (R170). Some games also provide a space for learning, as participants mention how they often assist and instruct co-players how to play: *"I love playing with my little brother, he does not understand English so I can translate the games and help him overcome whatever the game presents"* (R10); *"I play Don't Starve Together with my nephew and he quickly learns what I teach him, proving to be a good helper"* (R57); *"In Animal Crossing, I teach my mom tricks I already knew"* (R94). When players who do not regularly play are involved, such experience may give rise to a feeling of surprise, when expectations are broken: *"It is funny that my children think that their mother, after all [not being a regular gamer], plays well"* (R130); *"During a play session of Tetris Online with my friends, they insisted that I invite my father to play with us [...] Although I was initially reticent [...], it turned out to be very positive [...] My father was very involved and competitive with the game, always keeping a playful posture, which allowed for a lot of fun moments"* (R135)

3.2.6 Discussion

Apart from interactions encouraged by the gameplay, games offer a space where non-game-related conversations occur among family. Playing together generates varying interactions and emotions, as players talk about their shared achievements and learning

outcomes. For families, it may turn into a topic to talk about routinely [52]. In our participants' perspectives, we find different types of learning exchanges, such as teaching aspects related to the game, sharing tips, learning new skills (e.g., language), but also experiences where they learn new things about one another, breaking preconceived expectations. Still, while our participants' perspectives support the recognized social potential of digital games, they also highlight some of the barriers for family play, most of them also discussed in previous work.

3.2.6.1 Time as a barrier

Families often do not have enough time to play together [56]. Older generations tend to have less time to play, as they have to deal with more responsibilities, while younger generations have more time to dedicate to games. This unbalance in available time for gaming can be reduced with games that require less time to finish or longer games that can be played in successive short sessions. However, some players might want to be able to play longer, and they won't have their needs met with such games. These differences can be designed into a game using asymmetry in investment on the multiplayer interaction. One can imagine a game where one player can spend more time playing the game (younger ones, with more time to play) while another player, with more responsibilities, can invest less time but still play the game and participate in its activities in a meaningful way. While this can happen naturally with some multiplayer games, it can also be embraced and inspired by design.

Families can also have difficulty finding a time slot to play together. While younger generations tend to have time for themselves after school, parents generally have many more responsibilities, sometimes at uncertain times, making finding a good time to play hard. Designing a game with asynchrony in mind can meet these different necessities. This way, both players can play the game whenever they find it convenient. This is usually seen in social media games such as Facebook's Farmville [19], where players do not need to be online at the same time to engage socially [37, 12, 48]. This type of gameplay can be a tool for family members to track each other's routines. The problem with this approach is that the player-to-player interaction can be neglected, getting closer to a single player experience while allowing for limited social interactions.

3.2.6.2 Gateway games

Low setup times and easy to learn games were mentioned as gateway game characteristics (games that serve as an entry point to the medium for new players). These characteristics can be important in intergenerational games, potentially with novice players by lowering the entry barrier or by cutting on the necessary time for learning how the game works before the gameplay actually begins. This is important not only for game tutorials and interface design but also the platform or devices used to play the game. A mobile game,

for example, can be an advantage, providing an ubiquitous access point to the game. Simple controls and a soft learning curve can further reduce the entry cost. One respondent pointed out how most games assume players are familiar with commonplaces in gaming (e.g., A is for jumping), and how that may compromise the accessibility of the medium for newcomers. Participants also noted the "right game" would have to captivate the whole family in some way, which would certainly vary with different families. This goes in line with one of the design recommendations highlighted by Kow et al. [37], a "widely appealing theme". Although, again, this is a subjective aspect, it may be advisable to avoid dark or mature themes, and strive for challenges somehow linked to real-life activities [37]. For example, farming is depicted as a captivating and relaxing theme in the context of family play [37].

3.2.6.3 Spectating as part of the experience

Respondents also suggested that games can be fun to spectators, instead of participating in gameplay. Even though they are not directly playing the game, spectators can participate by commentating and giving ideas on how to overcome a certain obstacle - another talking point games offer. Spectators integrate the social experience around a game and, in some cases they might have a significant influence on the gameplay and performance of the players (e.g., backseat gaming) [39, 9]. Previous studies explore game design that blurs the line between players and audience, by allowing online streaming audiences to take part in the gameplay by typing on the chat [51, 54, 22] and leveraging spectators' gaze as an input on co-located settings [40]. This opens new possibilities of designs to explore, finding ways to integrate spectators in the gameplay.

3.2.6.4 Difference in skills

Families naturally have different levels of skills and abilities. This can introduce more difficulties in designing balanced multiplayer experiences. Participants shared experiences where players (usually younger or less-experienced gamers) felt frustrated for not being able to play on par with others. In a competitive scenario, this might mean some players remain unbeatable while others get demotivated; in a collaborative scenario some players might feel their contribution is pointless while others are over-challenged. Previous work [16, 11] explores player balancing strategies where in-game advantages (e.g., aim assistance) are leveraged to compensate for skill differences. Their results suggest there is an opportunity for these strategies to be incorporated in game design, without harming player experience. The design of asymmetric roles is also a recognized balancing strategy [21, 25, 16]. By investigating gaming practices among young siblings, Go et al. [23] found how, not only aspects of game design, but also inherent siblings' behavior and dynamics affect how they dealt with skill-unbalanced experiences. While some siblings had a natural competitive behavior that resulted in antagonism and frustrating experiences, others were supportive and scaffolding of the younger part. Accordingly, in

some of our participants' perspectives, unbalance can also lead to positive experiences of shared achievement and learning exchanges, which supports past research [59, 52, 2].

4

Designing Asymmetric Games for Families

Figure 4.1: Adventurer's HUD: A – health bar; B – Items collected; C – Map of already explored rooms; D – List of power-ups collected; E – Power-up to collect at the Altar.

During our first study, we were able to assert that the main barrier felt by our respondents was a **difference in time available to dedicate to gaming**, which is reflected in **limited opportunities for shared play**, but also **differing expertise and preferences regarding game type and playstyle**. We designed and developed a proof-of-concept digital game, conceived from the ground-up to address these barriers. The game, which we entitled "Koala Boutique", is available for download for Windows[1] and for Android smartphones[2]. Below, we describe the game and its design process.

[1] https://techpeople.itch.io/koala-boutique
[2] https://play.google.com/store/apps/details?id=com.techpeople.familyPlay

4.1 Design Process

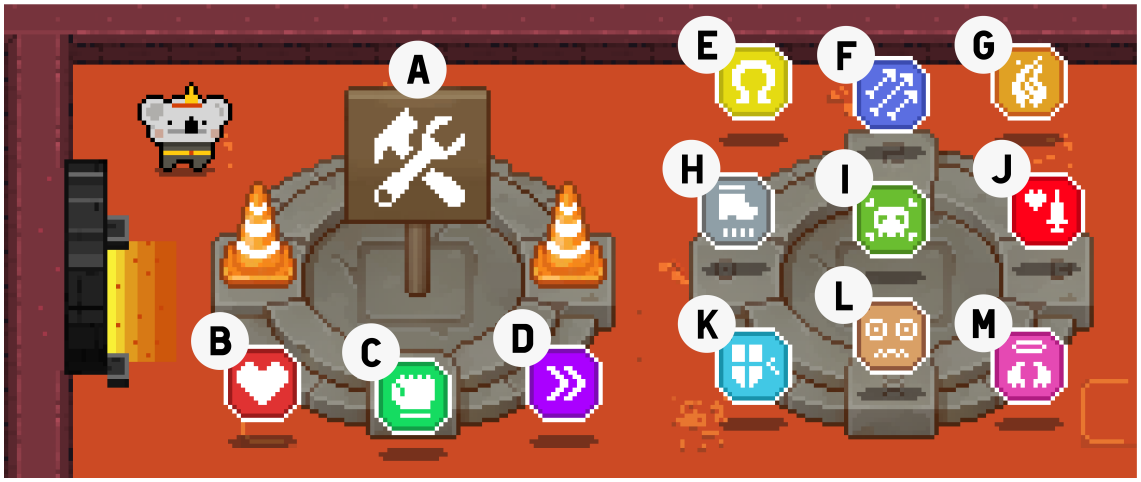

Figure 4.2: The Power-ups in the game. Descriptions can be seen in table A.1. A – Before the Altar is unlocked; B – More health; C – More attack damage; D – More movement speed; E – Lucky charm; F – Spread; G – Torch (removed from the game); H – Iron boots; I – Poison; J – Life steal; K – Deflecting armor; L – Afraid; M – Blessing

Considering the barriers found on the adults, we defined a fictitious group persona, with determined needs and barriers when it comes to playing digital games together. The fictitious scenario consists of a parent and their child who, despite wanting to spend time together through digital gaming, one of them (who we assume to be the parent) has constraints to their leisure time, resulting in limited opportunities for synchronous co-located play.

In order to bring families closer together, one of the main concerns was to build dynamics that would connect the players, without being restrained by the time factor. For this, we opted for a collaborative game, where players are interdependent (i.e they cannot progress without each other's actions). Interdependence between players was shown before to foster feelings of closeness and connectedness [29, 15]. Following the framework proposed by Harris et al. [30], we designed player interdependencies that fit the asynchronous timing interaction, where one player performs an action that allows the other to progress, but the specifics of 'when' are irrelevant. Players do not need to play at the same time or in the same place.

With this in mind, we looked for games that had systems we could draw inspiration from. The main games we drew inspiration from were:

- AdVenture Capitalist [3], an idle game where the player can sell items that are automatically produced, buy upgrades with the collected money to produce more items faster.

- Moonlighter [42], a game with two distinct phases. One where the player explores dungeons, defeating enemies and collecting loot to bring back. And another where

the player sells the loot collected in the dungeon, managing the supply and demand to get a higher profit.

With the adult being more restricted in terms of time they can dedicate to gaming, we designed the roles to be asymmetric in terms of the time investment required from players. So, the adult's role provides the opportunity to play whenever they are willing and available to. As such, we decided this role was to be played in a smartphone, which is readily available to be played on the go and in short bursts. The child's role, however, does not have this time restriction and can be played for longer play sessions, if the player so desires. In this case, the gameplay would happen on a computer and would resemble a simple action game, with dexterity challenges, typically-found in mainstream gaming (e.g., platformer, shooter). We were concerned with the child losing interest if the game was too repetitive or boring, so we implemented variety in the form of randomly generated maps (explained further below). In the same sense, when designing our mechanics and as the two players could possibly play at different times, we leveraged asymmetry of information and interdependence between roles to foster communication outside of gameplay.

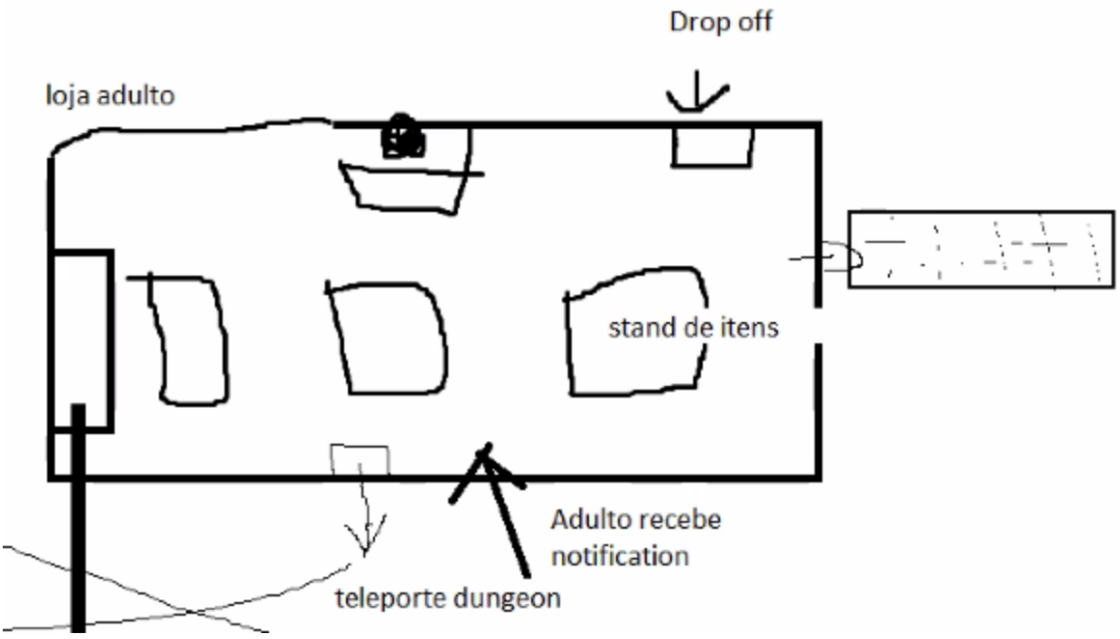

Figure 4.3: First draft of the Adventurer's menu

To reach a design for the game, we created a Game Design Document, which we iterated over the course of a month, meeting remotely, at least once per week, to discuss the mechanics of the two roles and how they could fit together. During this stage we sought to achieve a basic design structure for the game (a draft of the Adventurer's menu can be seen on figure 4.3), drawing inspiration from the previously mentioned games.

During the following three months, the design was further refined while the game was being developed. In this time, when it was possible to visualize some of the gameplay, we

started designing the collaborative tasks, focusing on promoting communication between the players. In this stage, some of the initially designed mechanics were cut from the game, as they were not necessary for the study and would increase the development time.

Figure 4.4: Current (Left side) and old (Right side) versions of the Market Sale mini-game

In the last weeks of the development process, we gave selected playtesters (mostly research colleagues) access to earlier versions of the game to iterate with feedback and ensure usability. One example is the feedback we got about the Market Sale mini-game (seen in figure 4.4), where the interface was not clear enough for players to understand what to do.

Figure 4.5: Adventurer's home screen, representing the shop. A – Class select window; B – Door (to start a mission); C – Logbook (with information on collaborative tasks)

4.2 Koala Boutique

The game happens in the Koala Kingdom where the players are the owners of a shop closing in on bankruptcy and they have to work together in order to save its future. Each

player has their specific role in this game. The Adventurer explores the dungeons to bring loot back to the shop while the Trader processes and sells this loot to unlock more content.

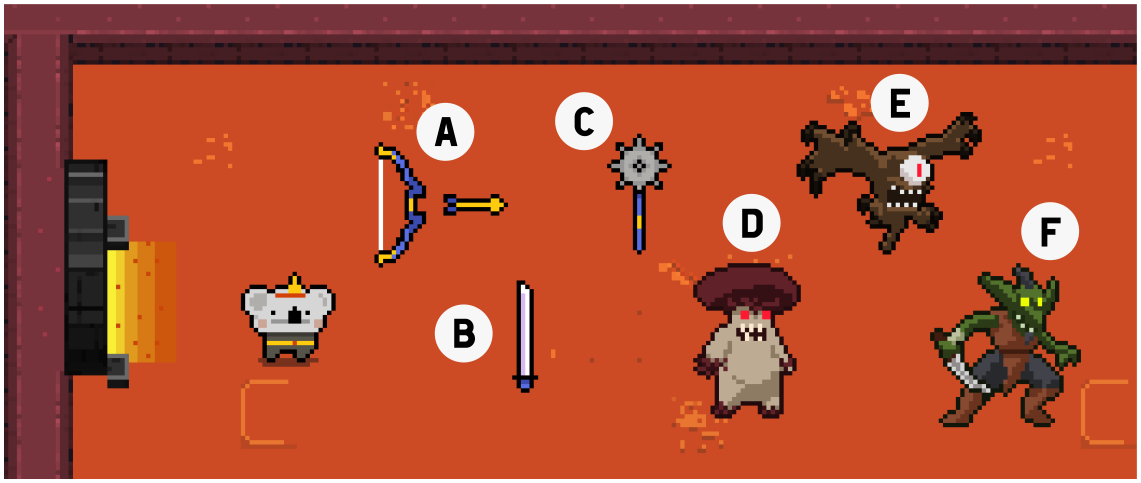

Figure 4.6: **Weapons** in the game: A – Bow (Starting weapon); B – Sword (Rogue class weapon); C – Mace (Warrior class weapon); and **Enemies**, all of them follow the Adventurer and, when close enough, attack: D – Mush Enemy (slow movement, high damage and health); E – Bat enemy (fast movement, low damage and health); F – Goblin enemy (average movement, damage and health).

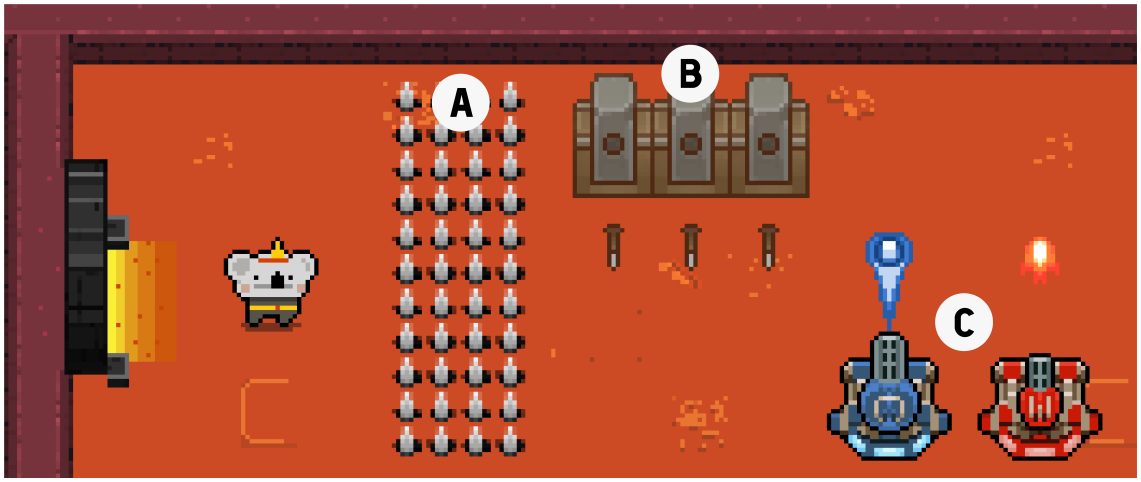

Figure 4.7: Traps in the game: A – Spike trap - spikes come out periodically, hurting the player; B – Arrow trap - shoots deadly arrows at a reasonable speed; C – Turret - periodically shoots at the player and can be destroyed.

The **Adventurer**, which we designed to be controlled by the child, has a gameplay akin to top-down, roguelike dungeon-crawler games, such as The Binding of Isaac [50], where the player sees their character in a top-down perspective and is able to move it freely and attack with their weapon, moving through a randomly generated map in which they explore rooms to avoid traps [Figure 4.7], defeat enemies [Figure 4.6] and collect their loot as well as any mushrooms they find [Figure 4.8], bringing them back to the shop.

Figure 4.8: Resources available in the game: A – Coal (removed from the game); B – Iron; C – Gold; D – Wood; E – Meat; F – Fish; G – Berries; H – Mushrooms

The Adventurer only has one class initially, the Ranger, which uses bows and arrows as their weapons, but two more classes can be unlocked later, the Warrior, which uses a mace for a weapon, and the Rogue, which uses a sword for a weapon. In the dungeons it is possible to find power-ups [Figure 4.2] (which have to be unlocked by the Trader first), increasing the adventurer's power or giving them new abilities (see table A). The first power-up can be found in the starting room, while the other ones appear on other points of the map.

The **Trader**, designed to be controlled by the adult, manages the loot the Adventurer brings to the shop, selling and processing it to unlock more content. Their gameplay resembles that of an idle or clicker game (i.e. games where the players don't have to invest much time to play), such as AdVenture Capitalist [3]. The Trader has the ability to make use of the loot the Adventurer brings back from their exploitations in some ways. One way is to sell the loot, receiving coins, which are important for unlocking new content. Another way is to process the loot (e.g., turning Iron Ore into Iron Ingots), this makes the loot usable for unlocks as well as making it more valuable (i.e. sold for a higher price).

4.3 Game Systems

For developing the game, we used Unity [55] along with Google's Firebase Realtime Database [20] as well as some additional assets, namely the Top-Down Engine [33] and Odin [45]. All graphics were either designed from scratch or adapted from free-licensed assets (found in opengameart.com [47] and itch.io [17]). Sound effects were collected from various free-licensed sound libraries and post-edited. Below we describe the game's systems.

Table 4.1: Room types summary. *Regular* rooms are the only ones that appear in rooms that are not dead-ends

Type	Description
Regular	The most common room, contains enemies and traps
Loot	A room with a single chest, where the Adventurer can get gems
Healing	A room with a statue that heals the player character when they touch it
Power-up	Power-ups can be found in these rooms, once the Altar unlock is obtained
Exit	The exit of the dungeon
Start	The starting room of the dungeon
Secret	The room behind the Secret Door, has two chests with gems and four mushrooms to collect
Oracle	The room where the Oracle can be found

4.3.1 Map Generation

A dungeon consists of several rooms, connected by their exits, randomly selected from a list created in development time. The rooms can have 8 types, which can be consulted on table 4.1. The game creates a minimum number of rooms and, once that minimum number is reached, it will start populating the remaining room exits with dead-end rooms. Only in these dead-end rooms can room types other than Regular be found.

4.3.1.1 Adaptive Difficulty

Besides creating a minimum number of rooms, the game also takes into account its difficulty. Rooms were designed to be Easy, Medium or Hard, depending on their layout, number of enemies and number of traps. These difficulties are identified as numbers (i.e. Medium is 1 and Hard is 2) which, when the map is being generated, will be added up to reach the desired difficulty level. Rooms with a difficulty higher than Easy will only be found on the second layer of rooms (i.e. two rooms away from the starting room). While picking what rooms to make part of the map, the game will first pick a Medium room and then pick one Hard room for each two Medium rooms, until the desired difficulty level is reached. In the case that picking a Hard room would surpass the desired difficulty level, the game picks a Medium room instead. The Trader has the option to override the current difficulty in the Home menu.

4.3.1.2 Altar

In the dungeons, it is possible to find Altars with Power-ups to collect. Before the Altar is unlocked, however, a "Under Construction" sign will appear instead (see figure 4.2 A). Once it is unlocked by the Trader, the Power-ups appear floating on them (see figure 4.1 (E)). The power-ups can affect the game in many different ways, from a simple increase

in attack damage, to new effects on their attacks (Poison, for example) or being immune to certain traps.

4.3.2 Unlocks

An unlockable (see table A.1) can have requirements (an unlockable that needs to be unlocked before), costs (items that need to be consumed for unlocking) and rewards, which are what the player will receive after unlocking. These rewards can range from simple upgrades to new mechanics to find in the Adventurer's playthroughs.

4.3.3 Processing

The Trader can process some items. For example, they can process Iron Ore to create Iron Ingots, which is necessary for some Unlocks and is sold at a higher value. After the Trader begins processing an item, a new entry appears in the Processing menu, with a progression bar showing how much has been processed, as well as a timer, showing how long until the process is done. The Trader can also press the "Boost" button to decrease how long they have to wait until the process is done, akin to the gameplay of idle games. This button can only be pressed once every 5 seconds.

4.3.4 Market and Fluctuating Prices

Every 3 hours, the values of the items change, going up or down by applying a modifier randomly selected from a predetermined range. This gives the Trader an opportunity to optimize their profits, if they so desire. The Trader can sell items in two ways, in retail, by selling the items at their value at that time. Or in the market, where they have to "negotiate" the price by playing a timing game, where if the "SELL" button is pressed when the cursor is in the green area items will be sold at a higher value, increasing the cursor's speed, but if the cursor is in the red area, the items will be sold at an inferior price, possibly even for free, and the cursor's speed will be reduced.

4.3.5 Abundant Mushroom

To help better control what the Adventurer can collect in the dungeons, the Trader can select what type of mushroom appears more often. They can do this through a button in the Home menu, which opens a screen allowing them to choose one of the unlocked mushrooms as the abundant one. Together with the fluctuating price market and the disease mushroom mechanic (see below) this allowed the trader to optimize loot drops.

4.3.6 Collaborative Tasks

- **Daily Quests** Each of the roles has a daily quest they can complete to receive rewards. The catch is that each role is only shown the other role's quest, forcing the players to share this information between them, if they want to get the rewards.

Table 4.2: Collaboration tasks summary.

Name	Description	Adventurer	Trader
Trading Daily Quest	The Trader has to sell a specific combination of items (changes daily), giving the Adventurer more attack damage if they do	The Adventurer **sees** the combination at the end of a successful mission and needs to **share** it with the Trader	The Trader has to **sell** the **combination** of items
Gathering Daily Quest	The Adventurer has to sell a specific combination of items (changes daily), unlocking a new type of mushroom if they do	The Trader **sees** the combination after selling an item and needs to **share** it with the Adventurer	The Adventurer has to **gather** the exact amount of mushrooms in the combination
Oracle	A character in the dungeon tells the Adventurer when an item is sold at a higher price	The Adventurer **interacts** with the character, **sees** the time and should **tell** the Trader	The Trader can choose to **sell** the items at this time for higher profit
Secret Door	Inserting the correct code in the Secret Door lets the Adventurer enter a room with more loot (code resets every 2 days)	The Adventurer **interacts** with a door they cannot enter and gets **prompted** for a code. They have to **insert** the correct code to enter,	The Trader has to **process** the key, **tap** the secret code button to see the code and **share** it with the Adventurer
King's Offering	Players lose money if they fail to offer a randomly generated combination of mushrooms in time or offer the wrong combination (new offering every 2 days)	The Adventurer **sees** the combination at the end of a successful mission and needs to **share** it with the Trader	The Trader **sees** a button he has to **interact** with to **give the offering**
Diseased Mushroom	If the Adventurer brings a diseased mushroom to the shop, they lose coins for each diseased mushroom (diseased mushroom changes every 8 hours)	The Adventurer must **not bring to the shop** the diseased mushrooms	The Trader **sees** the diseased mushroom in the Mission tab and **shares** this information with the Adventurer

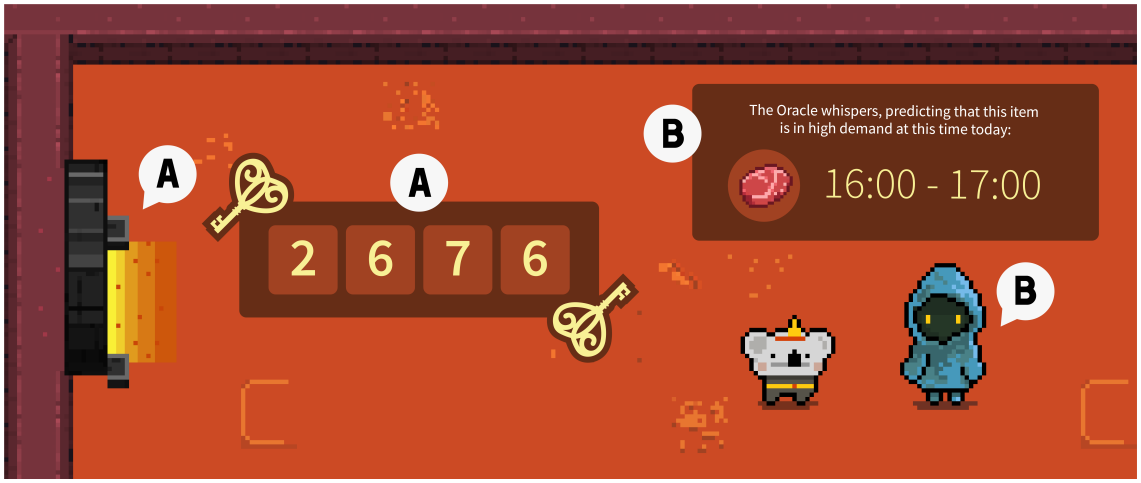

Figure 4.9: Representation of the Secret Door code prompt (A), which appears when the player interacts with the Secret Door, and the Oracle (B), which shows this message to the player once they get close enough to it

- **King's Offering** Daily, when the Adventurer finishes a playthrough successfully - by reaching the exit - they receive a notification saying the King expects an offering, along with a combination of 4 items. At the same time, a new button appears on the Trader's part of the game which opens a new screen where they can select which items they want to give the King as an offering. If the Trader offers the correct combination of items, the King is pleased and leaves. Otherwise, or if they don't offer anything at all, the King will not be pleased and will take away some coins from the shop. Whatever the resolution happens to be, the button disappears until a new offering is requested.

- **Secret Door** In the Adventurer's dungeon there is a hidden room with more loot than usual, hidden behind a locked door. This door requires a code to unlock. The Adventurer first notices this when interacting with the locked door, which prompts the player for a code to open. They are shown nothing else. On the Trader's side of things, a new item appears called "Encrypted Key" which can be processed. If it is, a new button appears (next to the King Offering's button) leading to a screen with a 4 digit code, without saying anything else. This is the code that the Adventurer inserts to unlock the Secret Door, leading to the loot. One of the players has to take the initiative and mention the locked door or secret code to the other, otherwise no information is shared.

- **Diseased Mushroom** One kind of mushroom is sick (which kind of mushroom is sick is randomised every 8 hours) and if it is brought back, it will cause the shop to lose some coins for each diseased mushroom. The Adventurer has no idea of this. They can play their part without ever knowing that they're causing the shop to lose money (potentially even leading to negative values). The Trader is able to see this

information on the "Mission" tab. They can choose to tell this to the Adventurer and ask them not to bring those kinds of mushrooms to the shop, to avoid loss.

- **Oracle** There's a special room in the Adventurer's dungeons with a mysterious character in blue robes. When the Adventurer interacts with it (by approaching it), it shows a tool-tip telling the player at which time interval a certain item will be at its higher value, in the next 24 hours.

4.3.7 Logging

Every game action (e.g. selling, processing, attacking, etc) or event (e.g. traps hitting players or enemies, enemies performing attacks) is labeled (see table B) and stored, along with a timestamp, for later analysis.

4.4 Game Presentation

The game is drastically different for each part (the Adventurer plays with keyboard and mouse while the Trader plays on a smartphone's touch screen, for example). Here we discuss their interface's appearance, as well as how they play the game.

The Adventurer begins the game by being shown an image of the shop where they can interact by clicking on some of the objects in the image, they can also select one of the three classes (starting with only the Ranger unlocked) through a window on the bottom-right corner of the screen (see figure 4.5). They can interact with the logbook to check new things the Trader has unlocked and information related to the collaborative tasks (see below). They can also interact with the door to enter a dungeon and start playing. This door began with having a simple opening animation. However, we felt that there was no sense of progression for the Adventurer. So, we decided to add a simple counter showing the current level (representing the number of gathering missions completed) and difficulty. These do not change anything mechanically. On another note, we initially decided that the player had to click a chest which would show the class selection window (as if they were picking up their equipment from the chest). However, later we decided that having this window always on the screen would be beneficial, as it would give the Adventurer some sense of objective (unlocking the two other classes).

In the dungeon, the Adventurer is right away presented with a representation of their controls and a different interface (see figure 4.1). On the bottom of the screen, the player has the list of collected items and, to the right, a minimap showing the player's position and the already explored rooms. On the top-left are an image of the player's character, its health bar and, below this, the symbols that represent the collected (currently active) power-ups.

The Trader has a less demanding gameplay in terms of dexterity, to lower the entry barrier. In this case, they are presented with a game interface that contains six submenus (see figures 4.10 and 4.11):

Figure 4.10: Trader's interface Part 1. A – Home menu; B – Mission menu; C – Unlock menu.

- Home menu, where they may consult the status and progress of the shop (e.g., money gained and new resources collected since last starting the game);
- Mission menu, where they can control which mushroom has higher changes to appear on the dungeon ("Abundant Item"), check which kind of mushroom is diseased (explained below), control the difficulty and check the Adventurer's Daily Quest;
- Unlock menu, where they can filter and browse through the available unlocks and spend resources and coins to unlock them;
- Inventory menu, where they can check the resources in stock and process raw materials;
- Processing menu, where they can see the state of materials being processed, and boost the speed of the operation by simply pressing a button.
- Market menu, where they can sell resources to gain coins in two ways, they can sell items at the retail shop, choosing how many items to sell at the current market price, or by bargaining at the market, which is represented by a timing game. This mini-game appears as a window that contains a slider with a gradient from red to green and then to red again (with the green at the center) and a cursor that is constantly moving from one end to the other. If the player presses the "SELL" button when the cursor is on the green area, items are sold at a higher value, increasing the cursor's speed, whereas if the cursor is in the red area, the items are sold at an inferior price, possibly even for free, and the cursor's speed is reduced.

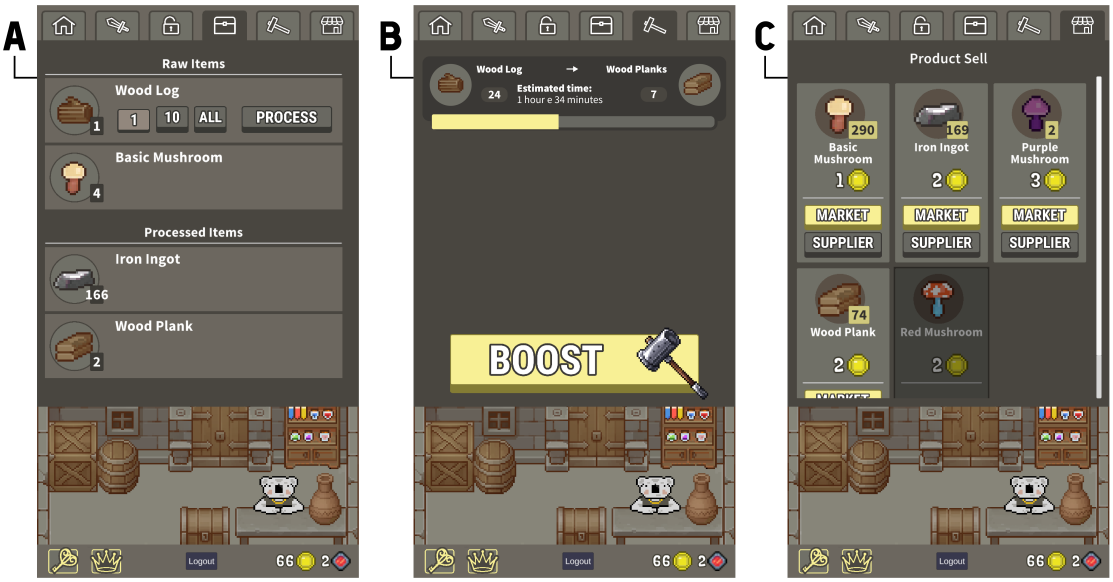

Figure 4.11: Trader's interface Part 2. A – Inventory menu; B – Processing menu; C – Market menu.

5

Game Evaluation with Intergenerational Pairs

We conducted a remote user study with adult-child pairs. Our goal was to understand the potential of the approach in creating a meaningful and balanced gaming experience that would minimize the differences (specifically in available time) between the players. Furthermore, we wanted to understand how asymmetry could meet the different requirements brought up by the first study and what types of asymmetry better cater to these differences. Participants were given the opportunity to play the game for a week and were able to leave feedback through personal contacts (email, phone) or in a form in Google Forms[1] where they were free to write about their perceptions in a text-field or send a file (for example, with a photograph of a piece of paper or a voice recording). The study was approved by the Ethics Committee of Faculdade de Ciências da Universidade de Lisboa.

5.1 Participants

Table 5.1: Participants summary of gender, age, gaming frequency and how close they feel to their study partner, according to the IOS scale [4].
M - Male; F - Female
R - Rarely; O - Occasionally; Fr - Frequently

	A1	**C1**	**A2**	**C2**	**A3**	**C3**	**A4**	**C4**	**A5**	**C5**	**A6**	**C6**
Gender	M	F	M	F	F	M	F	F	F	M	M	M
Age	44	11	45	13	48	10	31	9	25	13	25	14
Gaming	R	Fr	Fr	O	R	Fr	Fr	Fr	R	Fr	Fr	Fr
Closeness	7	7	6	6	7	7	7	7	6	7	4	6

We recruited 12 participants, 6 pairs, from Portugal, 4 parent-child pairs, one sister-brother pair and one brother-brother pair. Adults (A1-A6) were aged 25-48, while children (C1-C6) were aged 9-14 [Table 5.1]. We published a call on social networks and other websites related to gaming communities namely the Family Video Game Database

[1] https://osf.io/m3dbx/

[18], Reddit, Facebook and Discord groups, game streaming communities and shared the study through personal connections. We accepted pairs who had an adult (over 25 years old) who participated with a child (ages between 7 and 14 years old). The participants applied through a form on Google Forms, where they were asked about their demographic information (i.e. age, country of residence) and their familial relationship to their other pair element. Three Adults played video games on a daily basis and, in these pairs, both elements played together often. The other three adults played only occasionally. Most children played frequently. With the exception of the adult in pair 6, who reported an average closeness, all pairs reported high scores of closeness in the Inclusion of Other in Self scale [4]. A summary of this information is available on table 5.1.

Our main motivation for seeking family pair groups lies in enabling families with differing time requirements to enjoy gaming together. As such, and with the differences found in the first study in mind (namely, adults having less time available to dedicate to gaming), we decided to recruit adult-child pairs.

Pairs were compensated for their time with a 20€ voucher.

5.2 Procedure

After filling out the participant form, pairs were contacted via email with instructions and the link to both parts of the game (Google Play Store for Android smartphone[2] and itch.io for Windows computer[3]). For the computer game, an installation setup file was provided, to streamline the process for the child. Participants were asked to make an effort to play the game at least daily for one week. They were able to send us feedback throughout the experience through a form in Google Forms for this effect. Participants were also contacted at the middle of the week, to make sure that no problems came up with the game. At the end of the week, participants were contacted to schedule a semi-structured group interview (script is available for inspection[4]) with one researcher and both participants present, where they were asked about their perceptions on the experience, specifically about the collaborative tasks (i.e. if they were understood, useful or not) and about any feedback or suggestions they might have for future work.

Game sessions of each pair were logged in a database, which was useful to understand the context of their perceptions. As pairs were identified through an ID, logs could be associated with them. We recorded when the participants started or closed the game, collaborative tasks (e.g. completing a daily task), player actions (e.g. performing an attack) and interactions with the game (e.g. unlocking a new power-up). Logs were always recorded with a timestamp associated so we could recreate the experience later, for analysis. A full list of the types of logs can be found at the tables B.1 and B.2

[2] https://techpeople.itch.io/koala-boutique
[3] https://play.google.com/store/apps/details?id=com.techpeople.familyPlay
[4] https://osf.io/e4myd/

5.3 Data Analysis

Video recordings resulting from the interviews were transcribed, ensuring that interventions in the dialogue, such as hesitations and laughter, were captured. We performed an inductive thematic analysis over interview transcriptions and perspectives given through the diary forms. The coding scheme was developed iteratively. I started by repeatedly reading the data, annotating recurring ideas and concepts relevant for our approach. When a first draft of the coding scheme was reached, it was shared with a second researcher, who thoroughly read the data with the annotations of these first codes. In subsequent meetings, we discussed together the coding scheme, adding new codes for relevant ideas that were not yet captured, merging and removing the ones that were redundant or irrelevant, and grouping them to account for hierarchical relationships. Coders then met with the co-supervisor to discuss the code book, which resulted in a final iteration. After this, I coded data in full using the final code book[5]. Finally, the three researchers involved in this process met in order to identify relationships between codes, and rationalize the overarching themes[6] we present below.

5.4 Limitations

The study was conducted in a fully remote fashion, communicating asynchronously with participants. Because of this, aspects such as Internet connectivity, devices used, etc. could not be controlled. As this is a prototype game, developed as a proof of concept, with limited time and resources, it might not be at a state that the participants are used to playing. Progression halts once all the unlocks are obtained. Most participants had an engaging experience, but some tasks were mentioned as tedious and repetitive.

Also, in spite of the recruiting efforts, it proved hard to find a significant number of participants. Therefore, our results do not cover the wide range of perspectives that could have emerged from different families, with different backgrounds, relationships and preferences. For instance, we realized most pairs come from families with close relationships (reflected in the Inclusion of Other in Self scale). However, with only six pairs we were faced with a rich variety of different experiences and perceptions towards the game. While the study is not centered on a large number of individual perspectives, we scrutinize and minutely compare the different experiences that our twelve participants kindly shared with us.

5.5 Findings

Throughout their week of participation, Adventurers played an average of 2.14 sessions per day, with each session averaging 17.78 minutes. The Traders played more regularly,

[5] https://osf.io/e2954/
[6] https://osf.io/5d39t/

Table 5.2: Participants gameplay data summary.

Participant	Days played	Sessions/day	Minutes/session
A1	7	3.43	6.724
C1	5	2.2	18.203
A2	5	1.6	9.69
C2	6	2.17	13.39
A3	4	1.75	5.49
C3	2	1	18.66
A4	5	6	3.38
C4	5	2.2	31.31
A5	3	8	7.98
C5	3	9	13.47
A6	1	6	18.3
C6	1	9	11.62

Table 5.3: Participants progression data summary.

Participants	Unlocks obtained	Classes unlocked
A1 & C1	41	Warrior
A2 & C2	36	Rogue
A3 & C3	22	
A4 & C4	48	Warrior; Rogue
A5 & C5	29	
A6 & C6	48	Warrior; Rogue

averaging 3.03 sessions per day, but with a shorter average session duration of 8.59 minutes. More detailed information on each participant's gameplay data can be found on table 5.2

All pairs were able to unlock at least one class, except for pairs 3 and 5. We realized A3 and C3 had difficulties in understanding the flow of the game, with A3 repeatedly highlighting her lack of expertise with gaming and how the game was mostly not intuitive for her: *"The experience was not very productive precisely for that reason, because I do not have much experience in games like this. [...] I think it lacks a tutorial to say what steps we should take"*. Despite this, the pair was still able to obtain 22 unlocks. Pairs 4 and 6 were able to obtain every unlock available. When it came to collaborative tasks, participants were mostly unable to successfully complete them. The only collaborative tasks that were completed successfully at least once were the Secret Door and the Trader's Daily Task. The pair A6 and C6 were the only ones able to successfully complete all the collaborative tasks, except the Oracle. This pair also completed the game in one sitting. A detailed look at each pair's progression and collaboration tasks can be found on tables 5.3, 5.4 and 5.5.

Some participants seemed to have markedly enjoyed the experience, highlighting what aspects they liked the most: *"I enjoyed walking, exploring, finding new things [...] always happy when I found power-ups [...]"* (C2); *"I liked it, I liked it a lot. [...] It is a game that makes us communicate, in which it is really necessary to communicate"* (A4). C1 and C2

expressed how they appreciated the visuals. Participants also highlighted the feeling of novelty: *"never even heard of a game like this"* (C2); *"the first time I played something like this"* (A2); *"a different experience"* (A4). Some wished the game had more content and variety, suggesting different looks for the dungeons: *"Something that defines the differentiation of the levels, maybe. A color."* (A1); *"There's always the same enemy in the same place. I think it could vary"* (C1). Children also wished for a way of customizing the playable character: *"we could collect clothes or something in some levels and we could change some things on the koala"* (C3); *"there could be more avatars for the character"* (C1); *"being able to transform the character into something more, another animal, even into a person or another character"* (C4); *"skins for koala and the weapons"* (C6).

Each following subsection corresponds to one theme resulting from the thematic analysis, where we further distinguish how the experience went for each pair and discuss participants' perceptions more in-depth.

5.5.1 Routine Integration

When asked about how the game fit their day-to-day, both child and adult participants explained they were able to play in short sessions, avoiding the need for weighty time commitments. Adults highlighted how they could access the game for a few minutes and complete their tasks.

> *"It did not take much of my time. It is something we can do and, knowing what we are doing, what we need to do. In just a few minutes we do it. And he can continue his part"* – A3

> *"The tasks I had to do, in the time I had to do, it was perfectly fine [...] you can always take 10, 15 minutes, even when you go to bed, you play a bit and turn off and go to sleep"* – A2

> *"For example, break after lunch, between work, as I work for myself sometimes I have a break and I play [the game]."* – A5

Child participants also reported they did engage with the game in relatively short sessions. This can be observed on the logs, as, on average, child participants played for 20.39 minutes and completed (or failed) 4.04 missions per session. Some pairs shared how they chose to integrate the game in their daily routine. For instance, C2 explained that she would play after arriving home from school and that for most days she was able to reconcile with her homework and studies. In turn, her father, A2, played at different times during the day, in the short periods of time he had available time.

> *"When I got home. [...] Like a little bit before dinner or after dinner. I also happened to play one day at work, during my lunch"* – A2

"For the most part I had time to play, more than my dad, because he never had time - only when... after dinner or when he even got home" – C2

For this pair, the fact the game was played asynchronously was essential as they reported having differing availability and moments of the day to dedicate to the game. In this context, the choice of the smartphone for the role of the adult was also effective as a way to play on the go, on small chunks of available time (e.g., at work during lunch, at bed before going to sleep). Some adults recognized these aspects can be essential to families, where it is often a challenge to schedule play sessions, given the different responsibilities of each generation.

"Since nowadays it is almost impossible to have parents and children with time, on the same day and at the same time, to play together, the game allows both to play the same game in their own time" – A4

"It is great for bringing families together. Each one with their part, their task, being able to play at any time of the day, depending on their availability, I think this is excellent." – A3

5.5.2 Communicating and Learning Together

The game was successful in encouraging pairs to interact outside the game and even established new moments in the family dynamic for shared conversations. For A2 and C2, this interaction mainly occurred during dinner time, when they were both home. This was reflected in the pair exchanging information on a daily basis, with the child telling the adult what they collected during the day and the adult requesting specific resources to unlock new abilities.

"In the afternoon, she came home from school and I was working. When I arrived — "So, did you play today?"[...] and she was studying or doing something and I would take the smartphone, and start looking — [referring to their daughter] 'look, I've got you this, and this, and this'" – A2

A2 mentioned that, while the game seemed confusing in the first days, they were able to learn how the game worked together and soon reached a common understanding of the collaboration dynamics.

"Until we managed to get into the rhythm, it seemed a bit confused, but then it started to be... like, we already knew what we had to do [...] I would notify her 'look, you have to catch me x gems, x mushrooms, x of this'" – A2

The exchanges between adults and children were mainly promoted by the interdependence existing in the core mechanics, as adults required their child partner to gather resources to unlock new content. Yet, while the Trader had the responsibility of unlocking new content for the Adventurer to enjoy, some adults described how they would discuss together what would be preferable to unlock. One pair in particular (C4 and A4) mentioned how they would come up with a strategy, depending on the best unlocks to assist the child on next missions.

> *"Initially, it was about what was obtainable. Then, we started to see there was this... there were items that could help the game progress. [...] The spikes not affecting us and others. There was a strategy. Trying to understand what was better for her, so she could progress in the game."* – A4

In some instances (particularly in the case of A4 and C4), part of the interaction occurred when playing in the same space, at the same time. These participants described how they would communicate in real time what they needed from the partner and even see for themselves. To give an example, A4 described how she approached her daughter when playing and searched her screen to seek any information about the resources needed to give an appropriate offer to the King:

> *"I tried to understand, when she was playing, if it appeared something that explained what he [the King] wanted"* – A4

Similarly, C3 described how, one day, when his mother was cooking dinner, he ended up taking her smartphone and started to explore her part of the game, trying to get a better understanding of how the collaboration worked:

> *"I was seeing how mom's things worked and I saw some things there... I was looking at the things to sell and all that, and I also found the codes"* – C3

We realized this moment, as described by C3, was less of an interaction between participants (in contrast with A4 and C4, where they purposefully opted to share the experience and learn together), but a way to circumvent the communication needed, presumably in face of the difficulties A3 had in understanding her part of the game. Yet, with the exception of this pair, participants vividly described moments of interaction, and highlighted the potential of the game to bring families closer together, by motivating conversations. Curiously, A4 discussed how these interactions persisted during the week, making a comparison with other multiplayer games, where, typically, communication only spans over a match:

> *"There are very few games where there is this interaction where the person actually has to talk. In other words, we play Fortnite but that is in the moment*

and.. [...] Basically there is a goal which is to kill and win, that is it. And in this case, there is also a goal, but it is something that lasts over time and people can keep talking." – A4

5.5.3 Prompting Collaboration

Table 5.4: Participants collaboration data summary (Part 1).

Participants	Secret door Total|Correct|Incorrect	King's offering Total|Success|Failed	Oracle Total
A1 & C1	9 | 3 | 9	3 | 0 | 4	8
A2 & C2	6 | 0 | 7	3 | 0 | 3	8
A3 & C3	5 | 0 | 5	1 | 0 | 1	2
A4 & C4	9 | 2 | 7	3 | 0 | 7	15
A5 & C5	11 | 2 | 9	2 | 0 | 5	11
A6 & C6	2 | 1 | 1	1 | 1 | 1	16

Table 5.5: Participants collaboration data summary (Part 2).

Participants	Daily task (Adventurer) Total|Success	Daily task (Trader) Total|Success	Diseased mushroom Collected|Diseased
A1 & C1	6 | 0	5 | 2	473 | 52
A2 & C2	5 | 0	5 | 0	322 | 38
A3 & C3	2 | 0	1 | 1	111 | 0
A4 & C4	5 | 0	5 | 1	459 | 83
A5 & C5	2 | 0	3 | 0	309 | 8
A6 & C6	1 | 1	1 | 1	387 | 48

While interactions around the core mechanics of the game were recurrent, we realized, by analyzing the logs and by questioning pairs in the interviews, that the collaborative tasks were mostly disregarded or not understood. In this context, participants felt that if they had communicated more consistently, it would have helped understand these tasks and further progress in the game.

"I think we lacked, to be honest, a bit of more communication between the two for the game to have evolved further. For instance, in the King's Offering, as I said before, I was never able to do one. She [the child] never told me 'look, in the end it shows me what is needed to offer the king'. [child mumbles something indiscernible] Ah! Right, I'm telepathic [laughter]" – A2

In particular, A1, A2, and A4 mentioned they tried more than once to give an offer to the King but they were never able to get the correct combination, only realizing during

the interview that they had to communicate with their child to succeed. The way this mechanic was presented to both roles was not sufficient to prompt players to communicate about it. On the other hand, all pairs seemed to understand how the Secret Door worked. In this case, the way the task appeared to players was more explicit and prominent, as it blocked the child's progress on the dungeons and the adult had to act with intent to gather the information, by processing an item (secret key) and then press the corresponding button to check the code. Also, in comparison with the King's Offering, it was more identifiable, consisting of a code with four numbers.

> *"We were talking about the game and... there was a moment when she told me 'there are some keys with some numbers...' [...] and she 'ah, you have numbers and keys?'; 'of course, you could have asked longer ago!'"* – A2

When asked for suggestions to improve communication, multiple participants mentioned that notifications about other player's actions and explicit prompts telling the players to share information would have helped: *"when she gets something, it shows up to me in the game*"(C3); *"A notification could appear to do this.. 'Your partner has to do something'... or 'do this and your partner wins that'... anything like that... notifications for one and for the other, just to encourage us to continue to do something.* (A3); *"Anything that showed... that would prime each other [...] When she was playing – 'I need this' and I would get a notification on my smartphone*"(A1). Curiously, A2 made a point of stating that these types of more explicit prompts could actually subtract from the experience, as, in essence, it relies on players exploring the game together and sharing their part to reach a common understanding:

> *"Showing an indication 'Share with your player, or with your colleague, or with your team' (...) Of course, that takes away from the essence of the game, which is for us to know how to communicate and share the things with the other, without the game having to tell us, right"* – A2

5.5.4 Understanding and Visibility of Roles

The purpose of each role was seemingly understood by all participants. In fact, in the introduction video, participants were able to have a glimpse of their partner's gameplay. However, the hard separation existing in the gameplay, with players not having to play at the same time or in the same place meant that, in most cases, this was just a general awareness and not a comprehension of the specific challenges and tasks prescribed to each role. This might have made the interaction flow and the end goal of the game less clear for pairs who were less communicative. Notably, A3 shared with us that seeing their child's game could have helped understand what she had to do:

"Because I did not see how he [the child] plays yet, not even seen his layout, or anything. I only know mine, on the phone, we did not have that interaction so I could see... 'let me see what you do so I can try to understand what I need to do'" – A3

In contrast, as mentioned before, A4 and C4 reported playing in the same space several times, and this helped the pair to gain a more diligent understanding of each other's role. This pair ended up working together to understand how the collaboration was designed, by openly sharing their individual part of the game.

C4: *"[Talking to the adult] I was beside you and you were selling things and we were not understanding it. We were trying to figure out what it was [King's Offering]."*
A4: "*Yes, we spoke in this respect, me telling her that I was not understanding what it was. (...) I was watching her play and in the end I noticed and said that might be it.*"

Curiously, even though the game had two clearly separate roles with different tasks, A4 and C4 often spoke of the gameplay as a joint experience, using the "we" pronoun when referring to actions performed by any of the roles: *"there were some [rooms] **we** entered that were still under maintenance"* (A4); *"then mom found a key and **we** tried to open the door*"(C4); *"one day when **we** clicked on it [the Sell tab on the mobile game], several [resources] appeared that we could sell*". For this pair, it was apparent that the asymmetry existing in the game was practically diluted by the way participants chose to play the game.

5.5.5 Leadership & Autonomy

In the interviews we asked questions about how participants perceived the impact of each role and whether the interaction was lead by someone. Participants highlighted how the roles were balanced in a way that each player was essential to progress in the game. This perception was further developed by some participants recognizing that, even if someone was willing to take over or play, the completion of tasks in both roles were needed to ensure progression.

"She has to do her part and I have to do mine. It has to be a game in communion. It is not possible... I do not think anyone stood out more than the other [...] if someone wants to progress more or wants to do more, it reaches a point that is limited, they are unable to. – A2

This pair in particular highlighted how the collaboration was mostly balanced during the experience, with players often prompting each other to complete their tasks to

progress. For A2, this aspect actually led him to be limited in some occasions, as he depended on the child to collect resources so he could have something to do: *"When I no longer had coins and resources to spend, to unlock the items, I would say "Shoot, go play, [name of the child]!" and she did not want to [laughter]*"(A2). By design, adults were more dependent on their child pair, as they were not able to complete their main tasks (i.e. selling and processing materials, unlocking new abilities) without the resources that were gathered by the Adventurer. In contrast, children were able to play freely and complete as many missions as they were willing to. As mentioned in the previous section, this was an intended design option, given we assumed children would have more free time to play. However, the Adventurer was also limited in a way, as the missions would start to get repetitive, without the progression and new content ensured by collaborating with the Trader. A1 described a part of their experience that highlights this aspect:

> *"At some point [the child] lost her interest a bit. [...] It reached a moment where I did not have money for anything. And then she played, caught some more ores, some more mushrooms, and it started to hook her. I started unlocking some of her player abilities so she could then play at will [...] if there is no one to do this management, she will just continue to get bored* – A1

For the fourth pair, it became apparent the interaction was mostly scaffolded by the adult. As participants were physically close and played together for the most part of the experience, this might have lead to the child having less autonomy in playing her role:"*[Talking to her mother] Sometimes you controlled more. Sometimes you would say 'play alone to try to get used to it'*"(C4). Despite this, they also expressed that none of them had an actually prominent leadership role, as they discussed decisions together and, again, were not able to progress without both parts working together. However, like other adults, A4 recognized the Trader role was more limited by design, as she could not autonomously do their tasks, without prompting their child.

> *"Well, I could never move forward without communicating with her. With selling, I had a little more autonomy, and I did it according to what I thought was best. With items [unlocks] I always had to talk to her. So I think it [the Trader role] was a little more secondary role and not as important--* A4

5.5.6 Collaboration & Assistance

In some situations described by participants, difficulties posed by the game, including adversities that were not intended by design led to participants asking their partners for help. Again, this was evinced in the case of C4, who would ask her mom to play in her place, when she felt frustrated with the gameplay. While she states the game was not

particularly difficult for her, the fact she was used to playing with the arrow keys (whereas the game was controlled with the 'WASD' keys) made her struggle with the controls.

> *"At first I was upset because I was always dying and sometimes I had to be the mother who came to help me.* – C4
> *"She had this difficulty with the arrow keys. It is her own difficulty, right, it is not a difficulty that everybody has. But many times throughout the game she would tell me (...) 'I need to find a sanctuary, mom, help me'. And we managed to interact and I think that part is very amusing"* – A4

As mentioned before, A3 also had difficulties in understanding her role and tasks. As such, she described occasions where her child, who played digital games daily (in contrast with her, who rarely played) would approach her to explain certain mechanics that were confusing to her.

> *"[When talking about the market selling mechanic] A thing that has a little cursor going from one side to the other. He [the child] was the one who explained to me that I should press it when it was on the green"* – A3

In line with the perspective given by A4 on how the Trader role was somewhat secondary, A1 conveyed the role as the supportive role, motivated to help their child by managing their experience and being in charge of its progress. This participant went as far as saying that they did not feel like they were playing a game, but just doing the management of their child's game.

> *"It is a managing thing [...] if I know it will help my son or nephew or whoever is playing with me, I know it will unblock them and, in two minutes I unblock them, I see that and he can proceed. [...] For the parents, I think there is a thing that is... effectively it is not... it is not gameplay, for us it is not that thing of playing a game."* – A1

Following this rationale, A1 suggested that a welcomed addition to the game could be to have a more engaging gameplay while still maintaining the simplicity and low time requirements, as he depicted the 'clicker' gameplay as tedious sometimes: *"You could maybe try to make a bit of gameplay for the adult here, something simple [...] to spend 15 or 20 minutes there. Crosswords or something like that."* (A1)

5.5.7 Failed Collaborative Tasks

Most collaborative tasks were not successfully completed by participants [Tables 5.4 and 5.5]. The only one that was seemingly understood was the **Secret Door** where all players felt initially confused but managed to understand it through communication with their

partner. The other collaborative tasks, however, were not successful. The **Oracle** was not understood — when questioned about it, participants often described it wrongly: *"I think it gave resources at those hours. I am not really sure"* (C1); *"He would tell us that there was a resource that would appear more often at certain times*"(A4). As detailed before, the **King's Offering** was also misunderstood, with no pairs performing the offering successfully. While participants were aware that some of the collected mushrooms would be **diseased**, causing the shop to lose coins, they did not know what could be done to avoid this. One participant in particular understood that the mushrooms were already diseased when they were collected by the Adventurer, but looked for a way to fix the diseased mushrooms, instead of not collecting them altogether: *"What I thought was that indeed what she collected would come spoiled, but then I did not understand what we had to do, for it to stop being spoiled* (A4).

5.6 Discussion

The game was positively received by the participants, who saw the opportunity as a way to enjoy a playful and engaging experience with a family member, at their own pace, with small time requirements. Participants highlighted the novelty of the idea, mentioning the lack of games like this in the market.

Through the first study (in chapter 3), it was possible to assert that one of the barriers felt by family members who want to play games together, was a **lack of time** to dedicate to these experiences. To tackle this issue, we designed a cooperative asymmetric game where each role could be played independently of the availability of the other player. While roles were interdependent, they did not require synchronous play. This feature was fundamental for our study participants who repeatedly pointed out how the game was adaptable to each of their routines and play contexts.

5.6.1 Interdependence generated interaction

Although players were interdependent by design, each role gave players the ability to engage in meaningful challenges autonomously. For the child, they could play the game for as long as they wish, collecting as much resources as they wanted. For the adult, as long as resources were available in the shop there was always something to do. Participants reacted positively to this and understood the context of interdependence, drawing attention to the interactions generated by it, either by asking each other for help with the gameplay, requesting unlocks or giving information about the collaborative tasks.

For some participants, it was important that the experience and the interactions brought up by it were not over with the gameplay. In this sense, their perspectives suggest that interdependence coupled with asymmetry of information and asynchrony create an experience that can be embedded in their routine enabling interactions outside of gameplay to occur, possibly leading to other conversational topics.

5.6.2 Balancing Asymmetry of Information

We purposefully designed each role to have access to different information in order to promote a sense of discovery and a need for communication in the real world. However, we did not explicitly point out what information each role needed. This lead to some players never figuring out how to solve some of the challenges that required communication (e.g. King's Offering). There is a fine balance between guiding the player and allowing for a sense of discovery, which must be carefully considered when designing future games with asymmetry of information. For example, one can think of ways to mark features/challenges that require collaboration explicitly without providing information about how to overcome them. Similarly, since the players play at different times they do not necessarily know the impact of each other actions within the game world. We designed several mechanics to promote a sense of a shared experience but they were not enough for players to fully grasp each other's role and impact. This lead to players suggesting additional features such as prompts and notifications about other players actions, which could be part of the solution but, ideally, feedback mechanisms are embedded within the gameplay from the game design process. Future asymmetric games should also strive to include a variety of feedback mechanisms that ensure each other's actions and impact are visible despite the asymmetry of play.

5.6.3 Context of Play

At a first glance, it can seem that having a clear separation between roles, with little gameplay intersection, would create a very strict context of play. From our participants' perspectives, this does not seem to be the case. Because the game did not expect collaboration during gameplay, participants were able to adapt the experience to their needs, playing the game at the same time if they wanted to, sometimes playing the other role, in place of their partner. We were able to see the expected asynchronous gameplay but also co-located experiences with each player playing their own part, sometimes commenting on each other's gameplay. One pair even mentioned that playing apart happened less often than playing at the same time. This kind of freedom of when and where to play should be investigated further, specifically how we can design games that support and/or adapt different contexts of play.

6

Conclusion

While gaming has become a mainstream medium of entertainment, due to the differences between family members it is still hard to find an experience that they can equally enjoy together.

In a first study (Chapter 3), we gathered information on the perspectives on games and gaming habits of families. With 376 responses from Portugal, we were able to identify two prominent barriers in families that want to play together. First families tend to have differences in time available to dedicate to gaming, making it hard to find time for everyone to sit down and have a game session. Additionally, families can have different skills and expertise which can make the process of finding games that everyone can play difficult.

Embracing the differences in the players, we designed a game with two very distinct roles (Chapter 4), with the goal of creating a space where both players play in their own way and are still able to meaningfully affect the game without compromising on the sense of shared play. In this game, a parent takes on the role of the Trader in a shop, managing the loot and upgrades while the child takes on the role of the Adventurer, exploring dungeons and collecting resources to bring back to the shop.

In the end, we evaluated the games with adult-child pairs (Chapter 5) seeking to understand how the different roles were able to give a response to the prominent barriers found in the first study. The game was played during a week by 6 pairs who then met with us in a remote interview to give their perspectives. Their gameplay data was collected and analyzed in the study through logs the game would send us.

In our game, the use of interdependence generated interactions between the players, mostly in the form of making requests or passing information for other tasks. However, there is a fine balance between providing all the necessary information, aiding in understanding the game, and letting the players discover it, generating interactions between them as they try to understand the game.

Additionally, perhaps surprisingly, the strong distinction of the roles, with little gameplay intersection, did not tighten the context of play. Instead, participants were able to adapt the experience to their needs. In the same sense, asymmetry of information

combined with asynchrony allowed for the game to pervade the participants daily lives, generating new interactions outside of gameplay, which can lead to other conversational topics.

As videogames are such a diverse space, it is important to understand what factors and design spaces better foster family bonding. In this sense, we argue that, instead of trying to find ways to create an experience that pleases everyone equally, these games should embrace the differences in family members and create experiences specifically catered to them.

6.1 Future Work

This thesis approached a specific topic to explore the use of asymmetric roles in tackling barriers families encounter when looking for gaming experiences to enjoy together. We are interested in understanding how games can create inclusive experiences, promoting bonding in the context of families, friends or any other context where people interact with each other, without excluding players based on intrinsic factors. The game developed for this thesis still has much room for improvement, prompting more work to create a solid experience. With the feedback received from our participants we will improve the game to have it at a state where we can release it publicly.

As an exploratory approach, we believe we have found a new design space to explore, but there is still room for investigation. Namely, creating experiences for a wider variety of family members and/or for an undetermined number of family members. It is also possible that games can augment home life, creating a second space for families to interact in and bond over.

On another note, more work is required in order to understand collaboration mechanics, namely how to increase awareness of their existence while still maintaining communication and information sharing in the real world. Additionally, while we focused on collaboration, competitive contexts can generate other types of interactions, prompting more research.

It could also be interesting to explore how a game can be sensitive to the context of play, for example, providing a different experience when players are apart than when they are together or enabling players to drop in and out of the game, while still being part of the experience in a meaningful way when out of the game.

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A

Unlocks

Table A.1: Unlockables summary.

Name	Description
Altar	Unlocks the Altar and a few starting power-ups
Jeweler	Unlocks gold. Which can drop from defeated enemies
Groceries	Unlocks berries. Which can drop from defeated enemies
Food Market	Unlocks gold. Which can drop from defeated enemies
Dancing lessons	Increases the Adventurer's movement speed (can be obtained 5 times)
Training Dummy	Increases the Adventurer's attack damage (can be obtained 5 times)
Cooking	Increases the Adventurer's health (can be obtained 5 times)
Wood Workshop	Increases the amount of Wood Planks received from processing Wood Logs (can be obtained 5 times)
Iron Workshop	Increases the amount of Iron Ingots received from processing Iron Ore (can be obtained 5 times)
Mushroom	Can be obtained 10 times, each time unlocking a new type of mushroom that will appear in the dungeons
Poison	Unlocks **Power-up:** Adventurer's attack damage poison enemies, dealing damage over time
Spread Shot	Unlocks **Power-up:** Adventurer's attacks with the bow create three arrows instead of just one
Lucky charm	Unlocks **Power-up:** Adventurer gets double the amount of items collected
Afraid	Unlocks **Power-up:** Adventurer gets an increase in movement speed for some time when entering a new room.
Blessing	Unlocks **Power-up:** All enemies in the dungeon lose some health
Life steal	Unlocks **Power-up:** Adventurer's attacks heal them a small amount
Boots of Iron	Unlocks **Power-up:** Adventurer is invulnerable to Spike Traps
Deflecting armor	Unlocks **Power-up:** Adventurer ignores 50% of Turret shots
Rogue	Unlocks the Rogue class for the Adventurer, which uses a sword
Warrior	Unlocks the Warrior class for the Adventurer, which uses a mace

B

Logs

Table B.1: Game Logs Description (Part 1)

Log Name	Description
MissionStart	When the Adventurer starts a mission
MissionSuccess	When the Adventurer finishes a mission successfully
MissionFail	When the Adventurer fails a mission
Death	When the Adventurer is defeated.
EnemyKilled	When an enemy is defeated
DamageTaken	When anything takes damage
AttackPerformed	When the Adventurer attacks
MushroomCollected	When a mushroom is collected
DiseasedItemCollected	When a diseased mushroom is collected
LootCollected	When loot is collected
BuffCollected	When a buff is collected
RoomExplored	When the Adventurer explores a new room
RoomEntered	When the Adventurer enters a room
GotOracleInfo	When the game generates the Oracle information
OracleInteracted	When the Adventurer interacts with the Oracle
KingOfferingReceived	When a new King's Offering is received
KingOfferingChecked	When the Adventurer checks the King's Offering in the log book
KingOfferingSuccess	When the Trader offers the correct combination of mushrooms to the King
KingOfferingFail	When the Trader offers an incorrect combination of mushrooms to the King
SecretDoorInteracted	When the Adventurer interacts with the Secret Door and is prompted for the code
CorrectCodeInserted	When the Adventurer inserts the correct code in the Secret Door
WrongCodeInserted	When the Adventurer inserts the wrong code in the Secret Door
HealingReceived	When the Adventurer interacts with the healing statue
LootChestCollected	When the Adventurer collects items dropped by enemies
ItemProcessStarted	When the Trader starts processing an item

Table B.2: Game Logs Description (Part 2)

Log Name	Description
ItemProcessFinished	When an item finishes processing
ProcessBoost	When the Trader boosts existing processes
ItemSoldRetail	When the Trader sells an item in retail mode
ItemSoldMarket	When the Trader sells an item in market mode
AbundantItemSelected	When the Adventurer selects an abundant item
Unlock	When the Trader obtains a new Unlock
AdventurerQuestCreated	When the Trader receives a new Daily Task for the Adventurer
AdventurerQuestChecked	When the Trader checks the Adventurer's Daily Task
AdventurerQuestSuccess	When the Adventurer completes their Daily Task
ManagerQuestCreated	When the Adventurer receives a new Daily Task for the Manager
ManagerQuestChecked	When the Adventurer checks the Manager's Daily Task, in the log book
ManagerQuestSuccess	When the Manager completes their Daily Task
LoggedIn	When a player logs in
LoggedOut	When a player logs out
GameQuit	When the game is closed
GameStarted	When the game starts
DifficultySelected	When the Manager selects a difficulty for the Adventurer
ClassSelected	When the Adventurer selects a class
NotebookInteracted	When the Adventurer interacts with the log book
AdventurerNewsSeen	When the Adventurer sees the new unlocks from the Manager
ManagerNewsSeen	When the Manager sees the new items brought by the Adventurer
SecretCodeChecked	When the Manager checks the code for the Secret Door
MobileTabSwitched	When the Manager changes tab
UnlocksTabSwitched	When the Manager chooses a new tab in the unlocks screen
Paused	When the Adventurer pauses the game
SceneLoaded	When a new Unity scene is loaded in the game
SceneUnloaded	When a Unity scene is unloaded in the game
EncryptedKeyProcessed	When the key for the Secret Door is processed