Intergenerational Playful Experiences Based on Digital Games for Interactive Spaces

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Abstract. In this article, we first review the work carried out in the field of intergenerational digital games experiences as well as in the identification of the design factors involved. They are valued according to their applicability to put a common point to generate Intergenerational playful experiences based on digital games for interactive spaces. Starting from that point, "The Fantastic Journey", a game created to be played in an interactive space where tangible interaction on tabletops, physical interaction with real objects as well as body and gesture interaction is supported, is valued as a possible intergenerational digital game experience. Two play sessions and a workshop carried out with grandparents and their grandchildren have allowed us to elaborate the findings in the literature about the potential and the factors around intergenerational play and have served to legitimize The Fantastic Journey as a true intergenerational digital game experience.

Keywords: Intergenerational · Hybrid digital games · Interactive spaces

1 Introduction

Older people represent a growing proportion of the world population. Between 2000 and 2050, the proportion of the world's population over 60 years will double from about 11% to 22%. In our occidental societies, the older adults often suffer from social and emotional isolation, and from ageism. The term 'ageism' has emerged to refer to both the negative attitudes towards older people, and the negative attitudes that older people hold towards young people. Studies [1–5] show that video games can be a cohesion tool that enhances socialization between young and old. In fact, digital games can be individually

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beneficial for both generations. For older adults, they can improve cognitive functioning (e.g., short-term capacity, memory, attention, hand-eye coordination) [6, 7]; overcome communication problems and social isolation [8]; and encourage physical exercising and prevent falls [9, 10]. For children, collaborative digital games can improve learning, skill building, and healthy development [11]; can encourage learning, exploration, experiment, and construction of knowledge; and can develop imagination and creativity [12]. Moreover, intergenerational interactions can be mutually beneficial for both collectives: breaking with some age stereotypes or ageist attitudes [13]; developing civic engagement and contributing to an age inclusive society [14]; linking the learning and leisure needs of both generations [14] encouraging communication, solidarity, and social connectedness between generations [10, 15].

In spite of these findings, the number of projects focusing in intergenerational games is scarce, also the works that focus in their design factors. One of the factors found in the literature is the prioritization of physical, mixed reality games and multimodal interaction as well as the convenience to use shared context and meeting places to enable social interactions. From that point of view, Interactive Spaces may play a role in supporting intergenerational playing experiences. Interactive Spaces (IS) are distributed user interfaces supporting several ways of interactions in digitally augmented rooms. They combine a panoply of related interaction paradigms such as Physical Computing, Context-Aware Computing, Mixed Reality, Wearables and Tangible User Interfaces, allowing multiple users to interact, at the same time or in a distributed way. The objective of the work presented here has been to explore the potential of Interactive Spaces to support intergenerational playing experiences. To do so, two game sessions with family groups, comprised of grandparents and their grandchildren, playing in an interactive space that supports tangible, gestural and body interaction, were carried out. We wanted to compare the findings of those sessions with the ones present in the literature. Moreover, we wanted to know if grandparents and grandchildren agree with the factors stated as fundamental in the literature to generate successful intergenerational playing experiences. This is why a third experience, an intergenerational workshop, was carried out. Paper structure follows.

Section 2 introduces the state of the art in the Intergenerational Digital Gaming literature, as well as the factors to take into account when designing intergenerational experiences. In Sect. 3 a game "The Fantastic journey" is presented and analyzed from the intergenerational perspective. In Sect. 4, the intergenerational playing sessions and the workshop carried out in the ETOPIA Art and Technology Center of Zaragoza's City Council are presented and analyzed. The conclusions section summarizes the experience and discusses future work.

2 State of the Art

We will first review the digital intergenerational games present in the literature and then the factors to take into account when designing intergenerational experiences.

2.1 Intergenerational Digital Gaming

Different types of digital intergenerational games can be found in the literature; some for family environments, sharing a location or through the internet, and others in which specific educational aspects are sought to be applied to populations of different ages,

not necessarily among family members. After a general search about intergenerational games, the projects selected were those in which the target population is of extreme ages (children and the elderly, not necessarily family members) and in which any digital tool is used as an interactive medium to allow interaction whether required or not physical elements. The projects were classified according to the development technologies and predominant types of interaction (see Table 1).

Table 1. Development, technologies and predominant types of interaction

Project name	Location games with tangible interaction	Interactive physical experiences	Online Games	Games with experimental development
Curball [16]				X
Distributed Hide-and-Seek [17]			X	X
Age Invaders (Khoo et al. 2008) [18]		X	X	
Save Amaze Princess [15, 19]	X			
Atomium [9]	X			
Family Quest [20]				X
TranseCare [10]			X	
Xtreme Gardener [21]		X		
AR card game [22]	X			
Parent-Child Sexual Health Dialogue [23]	X			
Cooperative game to old powered chair users and their friends and family [24]		X		
Children's Museum [25]	X			
eBee [26]				X
Mr Robojump [27]	X			
Co-smonauts [27, 28]		X		
MeteorQuest [29]				X
SoundPlay [30]				X
Intergenerational shared action games [31]	X	X		

Looking at Table 1, we note a predominance of location games with tangible interaction; Save Amaze Princess [19], for example, essentially takes the game mechanics of Ludo and Snakes and Ladders and augments them with the use of a board projected onto a table and the use of physical tokens with animated feedback. This type of project is carried out on the hypothesis that, in general, an interactive intergenerational digital game is more successful if it takes as a reference traditional games already established, and if it also includes physical elements. It means that there is a lower learning curve of the game and a reduction in fear of technology for the elderly [25, 27].

On the other hand, Physical Interactive Experiences are preferred for exploring group interactions, typically of one to four participants. Age Invaders [18], for example, has a board in which people have to move to achieve their mission; at the same time they can interact online with other players. Xtreme Gardener [21], meanwhile, explores collaborative play to keep a garden protected from the elements and anything that can harm plants. The disposition of the game seeks that children and grandparents, through physical actions, control these elements. They are represented on a screen by their silhouettes that are tracked by a Microsoft Kinect device. Other experiences such as Cosmonauts [27] also resort to physical elements but not as controllers (tokens or symbols) but as playable pieces (parts of a rocket).

Online games are not usually predominant if we talk about intergenerational digital games, because the trend is that interactions invite people to share. However, it should be noted that Age Invaders [18], for example, adds this possibility to enrich the participatory game dynamics: grandparents and grandchildren on the one hand, and parents through the internet. Distributed Hide-and-Seek [17] may be a very interesting bet on online gameplay, since it does not have grandparents and grandchildren sitting remotely in front of a screen. Considering the impossibility, many times, of being together they propose to play a physical game such as "hide and seek" with the help of sensors so that children can hide and be found, in an entertaining way, by adults in a defined space.

Finally, Experimental development games consider the use of various technologies to verify their effectiveness. eBee [26] uses an entire previous dynamic of co-creation with weaving grandmothers to create small hexagonal pieces woven by hand with electronic components. These pieces make a board dynamic highly attractive for children due to the various colors and textures. The game pieces were made by grandmothers, manually, with crochet stitching, as a symbolic form of cohesion and identification with the activity. MeteorQuest [29], a ubiquitous game with mobiles, proposes that by means of geolocation, the family travels through certain areas in a city "hunting" the fragments of a meteorite that has fallen to the ground. This experience, enriched with creative dynamics, encourages teamwork to solve the clues required in the search and like no other, takes digital intergenerational games off the wall.

As it can be seen from the previous works, physical interaction, or at least mixed virtual/physical experiences, and co-located playing seem to be important factors for successful intergenerational games. From that point of view, Interactive Spaces (IS) [32] may be a natural place to deploy intergenerational games. Initially, ISs have been applied to explore new possibilities of collaborative work and meeting rooms but their use to support ludic experiences [24] is also rapidly growing. Nevertheless, in order to explore

their potential to support successful intergenerational games the identification of the factors to be considered in their design is needed.

2.2 Design Factors of Intergenerational Experiences

Regarding the factors to be taken into account to design intergenerational digital games, the work of De la Hera et al. [4] stands out. In their work, they make an exhaustive review of the state of the art in that moment in order to obtain, not only information about the benefits of intergenerational digital game-playing practices, but of the design factors to be taken into account. They group benefits around three important questions: strengthening of family ties, reciprocal learning and greater mutual understanding and reduction of social anxiousness. They find that the way it has proven to be most effective at narrowing the gap between generations and motivating mutual learning is through narratives used as the basis for game mechanics design. Related to the design factors, they classify them into two types of factors that are important to take into consideration: player-centric and game-centric factors. In Table 2, the factors and the related findings in the works analyzed are summarized.

The work of Kolthoff et al. [5] is also relevant. From the work of De la Hera et al. [4] and the works of Chiong [33] and Zhang and Kaufman [2], they propose 13 design factors shown in Table 3 including their applicability. Kolhoff et al. [5] contrast these theoretical factors found in previous studies with interviews among elderly and youth. Interviews confirmed the importance of five factors (weighing of different motivations young and old; need for a learning component; options for a short game; ease of use and communication and nature of social interaction) and added that the game has to be funny and save about terms of privacy.

Having detected the potential of interactive Spaces to support intergenerational gaming experiences and the most important design factors to consider, we decided to make use of a previously created Interactive Space [35] to follow that research line.

Table 2. Factors and findings in intergenerational digital games (elaborated from De la Hera et al. [4].

	Factors to consider	Findings
Player-centric	The nature of interactions between older (51–81 years old) and younger (4–22 years old)	• Users tend to carry out asymmetric interactions, where grandparents act as grandchildren "supporters". At the same time, grandchildren want to be considered as "skilled students" by their grandparents • Interactions use to build from histories inspired by the grandparents

(*continued*)

Table 2. (*continued*)

	Factors to consider	Findings
	The motivations to play digital games	• Both grandparents and grandchildren seek relaxing and having fun. Grandparents also seek social interaction and a way to escape from their reality • Children like long games, whereas old people prefer shorter games • Grandparents prefer avoiding games related to reflex movements (running, fighting…).They have more difficulties in those kinds of games and they do not enjoy them so much. They avoid violent games • Grandparents adapt to the game's content much better than young gamers do. In this way, maybe, it is interesting to design games according to young people's preferences
	The difference in habilities	• Due to their physical and cognitive difficulties, old people may have difficulties in understanding and using the games' devices depending on the technology used • Enactive interactions, which are not based on specific digital competences or mental models, are a good solution to deal with the differences in abilities • Children may also have trouble when technology is not adjusted to their age and abilities
Game-centric	Goal-related forms of interaction	• Older gamers tend to be less competitive and assume a more passive or supportive role • Better results are obtained if there is a collaborative competition: competitive games with a collaborative background promote the interaction between old and young people
	Space related forms of interaction	• Interaction mechanisms work better if they are carried out in presence of other people, participants or spectators (co-locative) • In the case of VR games, extra communication functionalities, such as sound and touch are welcome: they facilitate older participants to interact and motivate children as they can teach them how to use them

Table 3. Intergenerational games design factors and their applicability (elaborated from Kolthoff et al. [5])

Design factors	Applicability
Weighing in different motivations from both age groups	There must be motivations for both types of user to make the game attractive
Learning embedded in the game	All approaches must include some aspect related to learning
Short game sessions	Both age groups prefer games with short gaming sessions
Easy to use interface	The interface should be simple and easy to use for both groups
Collaboration games with common goals have best fit for both	Collaborative games should focus on joint goals and avoid competition between the two participants (elderly-young), but rather competition with other teams or the system
Peer-to-peer mentoring by teaching each other	The design of the system should encourage reciprocal learning
Enable social interaction, shared context and meeting places	It is important that social interaction arises with not only the participants of the game, incentivizing competition and empowering participants; to achieve this, co-locative experiences and spaces where it can be socialized outside the experience should be used
Video chat and computer mediated communication helps	In the case of experiences in different locations, communication is decisive
Asymmetrical and asynchronous play	Asymmetric learning (in which both users do not supplement the same role but are fed back) and turn-based play is more conducive to this type of game
Nature of interaction in important	Interaction must be conceptually in some common term between young and old
Enable passive watching play	Allow the person watching the game (usually the elderly) to also get satisfactory feedback
Prioritize physical, mixed-reality games and multi-modal interaction	Performing actions in the space allows multiple people to participate in the interaction at the same time
Create socially desired reward systems	This is relevant in virtual games or gamified group interactions where there are additional incentives and activities that do not necessarily involve the game

3 Playing in an Interactive Space: The Fantastic Journey

After studying the factors and recommendations to support successful intergenerational playing experiences we realized that a pervasive game, The fantastic journey, previously developed, could be a good starting point to support that kind of experiences.

3.1 Game Description

The fantastic journey is a game, initially designed to work attention, planning and social skills with ADHD children, developed by the AffectiveLab Group at the University of Zaragoza with the support of educators and therapists [34]. The game has been designed to be played in the JUGUEMOS Interactive Space [35]. It is an indoor space of around 70 m^2 that includes a real-time localization system, two Kinects (to support gesture interaction), microphones, and projectors. It also includes a set of four NikVision tangible tabletop devices which have been proved to be useful for kids to improve their cognitive, manipulative and social skills [36].

The fantastic journey is an adventure game, in which the protagonist has to progress over the story interacting with different characters and objects. It is a multiplayer game, aimed up to 16 players organized in four groups. The game is intended for use by inexperienced players that do not need to be familiar with the rules of the game neither with the controls. During the play, players have to move around the interactive space in order to find objects or to achieve the challenges proposed by the game. They also have to interact with the tangible tabletop devices and use their own body or voice. The groups have to collaborate to help the main character complete the journey, and is articulated around several missions commented next.

Magic words. Here, players have to pay attention to the lyrics of a song and then, order the words that make up the chorus. It is made with physical words put on the tabletop devices.

The sun and the moon. In this mission, players have to make up the shapes of the sun and the moon (projected on a wall) by placing themselves (localization) inside the silhouettes.

The search for the suitcase. Here, players have to find a suitcase hidden in the IS. The suitcase is closed with a padlock. The key can be obtained by playing Starloop [37], a game that were developed to improve computational thinking in kids (see Fig. 1).

Fig. 1. Intergenerational group playing Starloop.

Keyword. This mission allows working attention in both selective and global levels. Children will listen to a story in which a word is constantly repeated. Then, they will have to find the word in a word search that is projected on the tabletop devices (see Fig. 2left).

Fig. 2. Word search (left). Planet of Indians (right).

Planet of Indians. Here, players have to follow sound patterns, so successive processing and selective attention are worked. Each tabletop device represents a color and a sound (see Fig. 2right). Players have to reproduce a sound sequence by hitting the tabletop with drumsticks in the correct order.

Freeing the stars. Here, the goal is to free three stars that have been trapped in a spider web. Selective attention and simultaneous processing are the abilities to develop. The player has to select the elements required by means of gestural interaction (see Fig. 3).

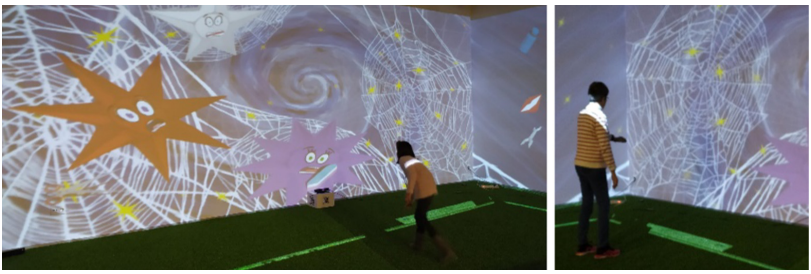

Fig. 3. Freeing the stars.

Meteorite attack. This mission is about destroying a set of meteorites. It helps to work on selective attention and planning of time-space paths. The meteorites get destroyed by shooting them with spaceships on the tabletops (see Fig. 4left).

Butterflies. In this game, players must stay quiet so that the butterflies that are projected on the walls are placed on the flowers and can be counted. The idea is to work on the inhibition of impulsive behaviors and on self-control.

Fig. 4. Meteorite attack (left). Encounter with the Comet of laughs (right).

Encounter with the Comet of laughs. The last phase of the game consists of a projection of the last scene, in which the protagonist meets the Comet of laughs (see Fig. 4right), and of the playing of the song of the game, which will be sung and danced by the players to celebrate the success of the mission.

3.2 The Fantastic Journey as an Intergenerational Experience.

The game fulfills several of the factors presented in previous section (see Table 3) to be important to support intergenerational playing experiences. In particular:

- Learning embedded in the game: each activity/mission has been defined to work one or more competences (such as language, learn to learn, social skills, digital competence and competence of initiative).
- Short game sessions: the game has been structured around short missions that are solved and allow it to continue in the game; nevertheless, a common and engaging narrative drives the experience which will better fit expectations from the younger gamers (see also Table 2).
- Easy to use interfaces: natural interaction based on manipulating objects using the tangible tabletops (magic words, keyword, planet of indians, meteorite attack activities), seeking of objects within the space (search of the suitcase activity), or using the own body (the sun and the moon activity) or hands (freeing the stars activity) avoiding the interaction through specialized or complex devices.
- Collaboration games with common goals have best fit for both: although teams are formed to play, they have to collaborate: all the teams have to achieve the goal so that they can all continue to the next activity; this promotes interaction not only within a team but among teams.
- Enable social interaction, shared context and meeting places: the Interactive Space acts as a meeting place that allows co-located play.
- Prioritize physical, mixed-reality games and multi-modal interaction: the game supports tangible, gestural and bodily interaction.

To increase both groups' motivation and engagement with the narrative (in our game not originated from elderly stories) we decided to include a greeting from Pipo's grandma video to welcome the families when they entered the Interactive Space (see Fig. 5).

Moreover, in order to assure easy to use for all, and taking advantage of the fact that during play, the game is controlled by a mediator, it was decided to allow the mediator to choose for each mission the level of difficulty (each mission has been designed with different levels of difficulty) that better fit.

Fig. 5. Getting to know Pipo's grandma (left) and Pipo main character (right)

In the next section, the intergenerational experiences carried out based on the fantastic journey game are presented.

4 Intergenerational Experiences

The JUGUEMOS interactive space is located in the ETOPIA Art and Technology Center of Zaragoza's City Council where families are engaged all year long in different artistic/technological activities. We decided to organize game sessions where children with their grandparents could play The Fantastic Journey together. The objective of the sessions was to assess the potential of the game to support intergenerational play, getting direct feedback from users, and to observe the dynamics of the intergenerational groups in the interactive space to compare them with the findings in the literature. Two sessions were carried out. After them, it was decided to organize an intergenerational workshop to deepen with the families in the intergenerational games design factors. All the precedent mission figures were taken during those experiences.

4.1 Intergenerational Game Sessions

Two intergenerational game sessions were organised, one in December 2018 and the other June 2019. They were announced through the municipal web and family groups formed by one or two grandparents and one or two grandchildren aging from 7 to 12 could sign up. In the first group there were 18 people so two families were put together in one of the tabletops. In the second group, there was just a family in each tabletop. One researcher took observation notes and two others helped players with the different missions. The families played the game for around one hour. Afterwards, players were divided into two age groups: grandparents filled a questionnaire and children just talked about the experience. The family groups were able to get through all the missions without

special difficulties. Compared to usual children-only groups, children were observed to be more quiet and careful when playing. Following main observations are commented.

With regard to participation:

In general, they all helped and facilitated that all of them could see what was happening and could participate in the missions. They all celebrated their achievements. Especially grandparents celebrated them, singing Pipo's song after the missions.

In terms of leadership:

Children made proposals and grandparents observed or helped. In general, the grandparents were much more prudent than children, acting slowly, leaving the children to make decisions and act. When children failed to perform activities, then grandparents began to act and to make decisions.

Regarding mediation:

Grandparents provided the children with the materials needed for the missions. They gave instructions and advice when children got stacked. Some grandparents organized turns among their grandchildren and encouraged them to help other teams after having accomplished their own missions. In some activities, interaction was quite intensive:

- In the Starloop mission, some grandparents participated quite actively, giving advice about the best strategies. They also expressed curiosity asking the children to explain how they had succeeded in completing the activities ("Why have you put this tab here?")
- In the suitcase mission, the suitcase was a quite old-fashion one and the grandparents had to explain to the children how to open it.
- In the word search, grandparents got involved much more actively giving precise instructions.

During the small talk with the children after playing, many of them said that even though they spend quite a lot of time with their grandparents they do not play with them ("It has been the first time my grandfather has been playing with me"). They all thought that their grandparents would not be able to finish the game without their help. Nevertheless, they admitted that in some missions, such as the word search, their grandparents had been better than them.

In the questionnaire, grandparents were asked about their feelings playing with their grandchildren and the difficulties encountered by both of them. The answers were very positive showing a general very positive experience. Anyway, two issues arose. Surprisingly, they felt they had not helped their grandchildren as they had seen them very good at playing, which was not always the fact. This may indicate the necessity of pointing out the value of the supporting role of the elderly during the game play. Besides, regarding the feelings they had felt during the play, although the most common terms were happy/very happy, the words slow and stupid arose. This points out the necessity of carefully tuning all the activities to the abilities of all the participants, which represent a big challenge as they may be very different even among individuals of the same age, as it is also the case among children.

Regarding the observations if we compare them with De la Hera et al. [10] findings (see Table 1), we find some agreements but also disagreements:

– "Users generally tend to carry out asymmetric interactions, where grandparents act as supporters for grandchildren". This was observed during the whole game. In fact, the game mediator had to encourage the elderly to take a more active role in the missions.
– "Grandparents adapt to the game's content much better than young gamers. In this way, maybe, it is interesting to design games according to young people's preferences." It is true that elderly adapt well to all types of games or missions (for example to tangible tabletop activities) but also the children to "more adult" missions (the word search). In addition, we realize that using a game based on a familiar activity for the elder allows them to show themselves as "masters", what they love, and, as the children saw them as experts, it helps to break down usual age stereotypes. On the contrary, those activities in which the elderly see that children are more used (using a Kinect in the Freeing the stars mission) make them assume a more passive role (the mediator had to encourage the elderly and just one of them took part).

The experience was very positively considered in both age groups. They all agreed they had had a good time and thanked the opportunity of playing together. We realize that, although we split the age groups to comment on the experience, they were very interested in commenting on the experience with the other age group. In fact, we realize that talking about the game experience itself could be a new good conversation topic for them and could also foster intergenerational interaction. We wanted also to discuss with them the most important factors too take into account when designing intergenerational games. Therefore, in the next experience, we decided to shorten the play experience and to add other intergenerational activities, as explained in the next section.

4.2 Intergenerational Workshop

In this second type of experience, four family groups participated, made up of one or two grandparents (over 60 years old) and one or two grandchildren (under 12 years old) without cognitive or motor difficulties. The experience consisted of three parts. First, they played a simplified version of the game with only three activities: Meteors attack, Starloop and Freeing the star. They were used because they combined fun (Meteors attack) and learning (Starloop) and tangible (Meteors attack and Starloop) and gesture (Freeing the stars) types of interaction. The design factors brainstorming (part 2) and the games modifications proposals (part 3) are explained next.

Design Factors Brainstorming
The aim of this part was to talk with grandparents and their grandchildren about the most important factors to design intergenerational games to see if they agree with the ones mentioned in the literature.

The activity consisted of interpreting, taking into account the clues, a message in Japanese, given by a grandmother, who was also a game designer (see Fig. 6 left). This activity also sought to intensify intergenerational participation and to took advantage of the previous gaming experience to decipher four aspects to take into account when designing games to play by grandparents with their grandchildren.

Fig. 6. Message form the grandma designer in Japanese (left). Brainstorm written in a flip chart (right)

The four aspects the Japanese grandmother argues to consider, are:

A. The game might allow both my grandchildren and me to have fun.
B. It has to be useful for something, and above all, so that my grandchildren and I are left wanting to spend more time together, playing.
C. What game proposes, even if it is a challenge, must also be something with the possibility of doing it together, and in turn, it must be as easy for my grandchildren as it is for me.
D. Both they and me, indistinctly, can have control of what happens in the game, without the game requiring personal resources that exceed one or the other.

In fact, the four proposed aspects are related to the model proposed by Cheng [38] that integrates the technology acceptance model (TAM) and the theory of planned behavior (TPB).

The technology acceptance model (TAM) [39] considers that:

– Perceived ease-of-use refers to the extent to which an individual believes that using a particular system is free of effort.
– Perceived usefulness refers to the extent to which an individual believes that using a particular system would improve work performance.

The theory of planned behavior (TPB) [40] considers that:

– Attitudes toward the behavior refers to an individual's favorable or unfavorable response to a particular behavior. It should be noted that the original model [41], in addition to the aspects considered by Davis (utility and ease of use), also included the Self- Esteem and the Subjective norms (individual's reaction to social preferences on performing a particular behavior).
– These authors also consider the importance of the Perceived behavioral control, key element in relation to intergenerational games.

To build the four aspects that the supposed Japanese designer takes into account, the three variables of the integrated model (TAM+TPB) of Cheng [45] that were of special interest for this workshop were considered: The perceived usefulness (A & B aspect proposed by the designer), perceived ease-of-use (C aspect) and perceived behavioral control (D aspect). Furthermore, the four aspects are related to most of the design factors proposed by Kolhtoff et al. [5], as can be seen in Table 4, except those that include online aspects not applicable to this experience.

Table 4. Kolthoff et al. [5] design factors with the four factors worked in the workshop

Design factors	Aspects related with…
Weighing in different motivations from both age groups	A,B, C and D
Learning embedded in the game	B
Peer-to-peer mentoring by teaching each other	B
Enable social interaction, shared context and meeting places	B
Create socially desired reward systems	B
Collaboration games with common goals have best fit for both	C
Prioritize physical, mixed-reality games and multi-modal interaction	C
Easy to use interface	C, D
Nature of interaction in important	C, D

A brainstorm was carried out and the ideas were written in a flip chart (see Fig. 6 right). It should be noted that the group arrived to principles very similar to those of the Japanese designer, highlighting the fun, learning (utility), participation of all (something easy to do together) and control over the game.

Games Modification Proposals

In the third activity, the Starloop and Freeing Stars games were evaluated, based on the four principles derived from the previous activity (see Fig. 7). The participants were divided into two intergenerational groups and each one analyzed one of the games, and then, shared what to keep, what to eliminate, what to change, and what to add.

Fig. 7. Presenting the proposed game modifications (Starloop)

The improvement proposals, above all, were aimed at suggesting small changes in the experience, without proposing significant changes in any way. The key proposals focused in particular on "utility" (B) and "ease of use" (C). This coincides with the two points that have special relevance for the TAM model and for the items of the selected model of Kolthoff et al. (in Table 4 most of the elements have a connection to B and C).

Suggestions to improve the experience affected the following aspects:

- Changing colors (more squeaky colors in the stars to make them more fun;
- Simplification of processes (introduce the possibility that the tours to the stars of the star game Starloop, could also be programmed diagonally);
- Inclusion of learning elements (related to science, the universe, the stars, incorporating the incidence of gravity in the Meteorites attack mission);
- Increase of the level of complexity of the task so that the games offer more possibilities (including some more galactic stars to the game Freeing the stars).

Regarding the game in general, a child literally expressed: "Make it longer and more complex, with more tests". This goes in the same direction stated by De la Hera et al. [10]: younger gamers like longer and more challenging experiences. This question has to be carefully considered as making the experience longer or more difficult could affect the elderly experience. The use of physical controls ("I have always liked video games with physical controls" expressed one of the elderly) and bodily interaction ("movement in the air") were also welcomed.

5 Conclusions and Future Work

Intergenerational ludic experiences may have important benefits for both collectives and can contribute to increase mutual understanding, but are still scarce in the literature. Physical interaction and co-located play appear in the literature as two important factors for successful intergenerational interactions. Both aspects can successfully be supported in Interactive Spaces where groups of different ages may interact and have fun and learn together.

A game designed to be played in a public interactive space supporting physical, tangible, gesture and body interaction has been used to carry out two play sessions and a workshop with grandparents and their grandchildren. The experiences have been analyzed and have confirmed the suitability of the designed games to support intergenerational play and have also helped us to fine tune the design factors and recommendations found in the literature.

In spite of the positive results, the experiences have brought to light some questions:

- the necessity of strengthening the learning potential of the ludic experiences;
- the utility of the game experience as a new conversation topic that may facilitate the dialog between generations.
- the potential of such experiences to overcome prejudices between generations showing different roles and abilities;
- the challenge of fine tuning the game to the cognitive and physical abilities of all participants;

– the lack of tools to assess those intergenerational experiences and their impact.

Future work will focus on those issues, in particular, on how to potentiate dialog between generations and on the design of specific assessment methods to evaluate the short, mid and long term impact of the experiences.

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