InterPlayces: Results of an Intergenerational Games Study

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Abstract. Our submission describes the conceptualization and the results of an intergenerational games study composed of various games held in the Welios Science Center. We aim to identify design criteria (game mechanics, goals, etc.) for intergenerational digital games with haptic elements in a museum context that are not only fun, but also foster the communication between old and young players. In order to reach our goal, we confronted players with several different commercially available games as well as a specifically developed game prototype. To address the physical context (museum) in our methods and our game design we also carried out observations of existing installations plus interviews with museum guides. Results show that cooperative intergenerational games in a museum should include haptic elements, consist of several phases, with the possibility of reruns and should not be too complex, both technically and conceptually.

Keywords: Intergenerational play · Game design · Cooperative play

1 Introduction

According to the WHO[1] the number of elderly persons (60+) in western countries will increase considerably in the following years. These demographic developments have led to societal, political and technological challenges. Consequently, several initiatives were launched with the goal to increase the well-being of seniors through information and communication technologies (ICTs). One very relevant factor that contributes to the well-being of elderly people is a frequent face-to-face contact with the family and close friends (especially young and old). Based on these facts, the question arises: how can the social exchange and the relationship between the generations being fostered via ICTs?

[1] http://www.who.int/mediacentre/news/releases/2015/older-persons-day/en/.

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A very promising solution to this issue can be identified in the field of computer games (in this case: intergenerational games as a social medium). Intergenerational games offer the benefit of connecting different age groups while playing as these games increase positive interactions that lead to improved self-esteem and provide talking points for conversations [18]. Several studies revealed that there is a preference towards designing cooperative compared to competitive intergenerational games [14]. This cooperative aspect is especially relevant for grandparents to get in contact with their grandchildren [8].

Regarding the player behavior and preferences it was shown that older adults tend to engage cooperatively, seek more agreement and confirmation of actions from other players compared to children [10], as well as have a higher tendency to help, rather than compete against other players [2]. Another interesting aspect that was found out is the fact that younger people report that social interaction is one of the strongest motivators to play video games [12]. Furthermore, in contrast to the older generations, younger players show proactive behavior during gameplay [21]. Although the beneficial impact of intergenerational games is indicated in various publications, fairly little is known how older and younger adults play video games together and how the cooperative elements should be designed.

One of the few attempts can be found in the work of [14]. The researchers identified several design factors that should be addressed when creating intergenerational games: role differentiation and interdependence (collective versus individual roles of the players, balance of building positive interdependencies between players to contribute towards shared goals), gameplay assistance (addressing imbalance in skill levels both within and between the age groups), focal points (mutual exchange of ideas and information), physical engagement (physical attributes of the game), and instructional support (quality of game instructions). Although these factors may help designers to create intergenerational games, the authors note that the game-type used in the evaluation, and differences in gaming expertise must be acknowledged as influential factors. We want to address this issue by employing and evaluating various games (that share the recommended characteristics of intergenerational games such as cooperation and co-creation). We deem that the proposed study format is a powerful tool to design and evaluate intergenerational games as it follows a human-centered research procedure and brings together players of different ages and game researchers with expertise related to the design and evaluation of such games [9].

2 Our Contribution

In our submission we describe the results of an intergenerational games study composed of various games held in a science center (museum context). The proposed research is part of a bigger project, where it is the main aim to design and create an intergenerational game installation for the Welios Science Center[2]. Based on the current literature in the field we want to identify design criteria

[2] http://www.welios.at/.

for intergenerational games (game mechanics, goals, etc.) that not only are fun, but also foster the communication between old and young players.

In order to reach our goal, we organized and carried out a study where we confronted players with several different available commercial games as well as our own game prototype, called Mr. Robojump, that is based on existing game design guidelines and recommendations. Furthermore, we address the physical context (museum) in our methods and our game design via literature research (e.g. [3]), observations of existing installations plus interviews with the museum guides of the center. Through our approach we can identify possible design solutions and methods regarding intergenerational games for the application context (games that fit into the existing portfolio of the science center). The results of the study and the preliminary activities should aid both designers and researchers to create intergenerational games in a museum context that are fun to play and foster the communicative processes among the players. In the following information on the preliminary investigations (observations and interviews), the structure of the game study, and the employed games is given.

2.1 Preliminary Investigations

In order to set up the intergenerational games study, data about the interaction context was gathered. This was done by carrying out preliminary investigations focusing on existing exhibitions (how to integrate intergenerational playful experiences), target groups (age, gender, behavior), and interviewing relevant stakeholders (e.g. interview museum guides to find out which exhibition pieces are well received by both young and old people). On the 23rd of March 2016, an observation was carried out at the Welios Science Center to get a detailed picture of the facility and the exhibits. The Welios Science Center is Austria's first science center on a surface of 3,000 m^2, and is conceptualized as an Join-in-Museum with more than 120 interactive exhibits. It addresses aspects of natural science in a playful way by focusing on a funny transfer of scientific topics, learning by awaking all senses, and learning by doing. The goal of observations were to provide a grasp on how old and young museum visitors experience and appreciate the existing exhibits. The observation included all floors of the science center and lasted about four hours, wherein observations were limited to those exhibits people interacted with. In addition to the systematic observation of visitor behavior, we conducted a guided interview with an experienced museum visitors' guide.

Observations. The Welios Science Center has a couple of bigger exhibits on which it is required (or at least highly useful) to be a group of people when interacting with them, such as the Marble Run, the Hydroelectric Plant, or the Pellet Conveyor. The Marble Run exhibit, for instance, is one of the most cherished by visitors old and young. The task is to lay plastic pipes on a vertical magnetic wall to transport balls from one end of the installation to the other. In between a crank has to be operated to carry the balls from one pipe to another. Especially young children (aged 5 to 7) enjoy playing on this exhibit with their

grandparents. The grandparent is needed to help, plan, and coordinate where pipes should go, because of the vastness of the magnetic wall. Sometimes the children are not physically strong or tall enough to move the pipes where they are needed, hence they require the support of a grandparent. In these cases, the children are mostly concerned with handling the crank, applying the balls, or providing the pipe pieces for the grown-up. If the children are equipped to handle the exhibit by themselves, grown-ups enjoy sitting on the bench opposite of it to watch the children play. In these cases, the children regularly enforce attention and appreciation of the adults in the audience. The exhibit is highly cooperative and consists of different haptic elements. People usually spend quite a long amount of time with this exhibit.

Interview: Museum Guide. According to the Welios museum guide, the visitor groups consisting of children with their grandparents particularly enjoy the above mentioned multi-person exhibits, as well as some of the other cooperative stations. After looking at the mentioned favorite exhibits, we concluded that important for an intergenerational game was to involve haptic elements (like for example pipes, bricks, gadgets, cranks, levers) and cooperation between participants. Regarding technical obstacles, the guide pointed out that grandparents usually let the children interact with technical equipment at first and take the role of observer and planner. Furthermore, it is important to have a short and understandable game description in an easy to read font and a huge enough font size on screens, because the grandparents often have to read the instructions for the children. It was specifically stressed that a vital component for grandparents is to have sitting accommodations near or in front of the exhibits.

Outcome of Preliminary Activities. In conclusion, children engage exhibits pro-actively, prefer haptic interactions with components, and enjoy being watched by an audience. Grown-ups, specifically grandparents, are more cautious and diffident toward an exhibit and let the children interact with it first before actively engaging themselves. While adults read instructions first, the children just get started with a game or installation, but usually not before the adult is at least watching. If adults do not engage with an installation directly, they almost always serve as a source of information or at least as an audience for the children. It was evident that both, young and old, have a preference for haptic elements and cooperative activities. However, cooperation could mean different things: first, grown-ups have to help if physical strength is needed, or a bit more elaborate planning, than is manageable by the children. Second, the game needs at least a second participant to engage in the game. Finally, third, the children need or demand a grown-up, especially a grandparent, to be an active audience by appreciating the child's game effort.

2.2 Intergenerational Games Study

Based on a literature research on game preferences of younger and older users and on experiences with intergenerational games (e.g., [1,5–7,17,20]), we formulated

evaluation criteria for the selection of games and the design of our own game prototype for the design study. These evaluation criteria were paired with the insights from the preliminary investigations. Following a human-centered research procedure [19] we involved users at an early stage in the development and design process and conducted a study to test six gaming concepts based on our evaluation criteria. We developed questionnaires suitable for older and younger users and supplemented these with systematic observations by game station supervisors. The study provided valuable information on gaming preferences and technological challenges of our target user groups. The study took place at the Welios Science Center on the 15th of July, 2016. The overall goal was to evaluate gaming concepts applicability for intergenerational settings and to test the developed evaluation material.

Employed Games. Guided by our state-of-the-art research in context of intergenerational games, we evaluated six games in our study that consist of five commercially available games and also a game prototype that was created by our research group. In the following, the five commercially available games are briefly described:

- IQ-Fit is a puzzle board game developed by smart games[3] to recreate different given shapes. Various 3D-puzzle pieces have to be placed on a game board in such a way that all the parts fit together without any holes.
- The Spore Creature Creator[4] is a software published by Electronic Arts in 2008. Players can create creatures by assembling various body parts in 3d space. Like professional digital creation tools, the 3d-models can be reshaped and textured. Finally simple animations can bee added to the creature.
- Bad Piggies is a puzzle game developed and published by Rovio Entertainment[5] in 2012, and is one of the many spin-offs of Rovio's well-known game Angry Birds[6]. The player's goal is to build a functional vehicle from a large collection of parts for a minion pig and to guide the vehicle trough a map to collect various items.
- Rugged Rover is a multiplayer game developed by the games studio Preloaded[7] for the Science Museum London. Players can design their own all-terrain space rover and test it in a rugged landscape on a fictional planet.
- Box Buddies[8] is a multiplayer puzzle game developed by students form the University of Applied Sciences Upper Austria Hagenberg Campus. Two players have to work together by moving obstacles to reach the entrance to the next level.

[3] http://www.smartgames.eu/.
[4] http://www.spore.com/creatureCreator.
[5] http://www.rovio.com/.
[6] https://www.angrybirds.com/.
[7] http://preloaded.com/games/rugged-rovers/.
[8] http://boxbuddies.rohschinken.at/en/.

The sixth game that was employed in the study was developed by our research group, called Mr. Robojump (see Fig. 1), includes unique game features such as tangible objects. In the game a robot has to be built out of various elements like propellers, springs and small jet propulsion to jump as high as possible. Players place cubes of different colors onto a 6×4 grid. The cubes are tracked by a camera that is placed above the playing field and their positions are translated to the application in real time. Once players are happy with their robot they can press "Start" to enter a simple 3d-scene. While jumping, player controls are limited to rotating the robot mid-air and short additional boosts that can be used up to three times. Using these tools, the players have to dodge a number of balloons on their way to the top. Players can retry as often as they want to or simply decide to try out a new robot design. High-scores are saved over multiple tries to create an incentive for experimenting with different setups.

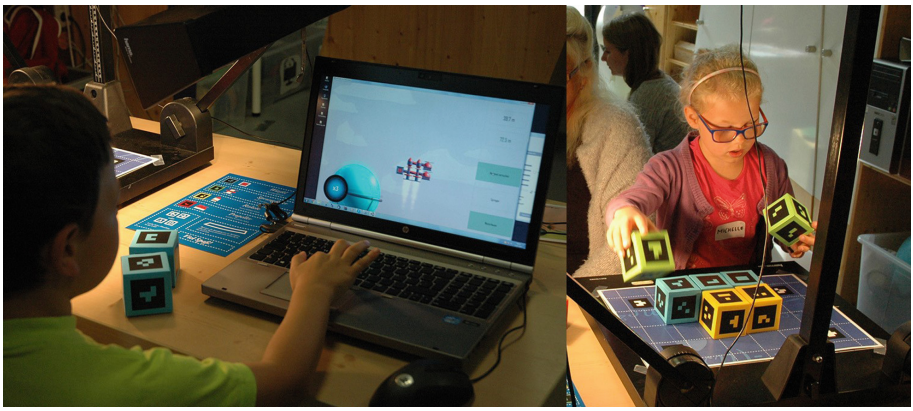

Fig. 1. Game prototype developed by our research group: Mr. Robojump; right: the player is constructing a robot via tangible objects; left: the player is playing with the newly built robot.

Participants and Procedure. Six teams took part in the study with each team consisting of a grandparent (aged 53–66 years) and a grandchild (aged 6–8 years). However, there was an exception as one team included two children (siblings). The participating teams reported doing something together on a regular basis ranging from once a week to even daily. While the gender ratio of the children was close to equal (four boys and three girls), none of the accompanying adults was male. Five of the seven children said to play computer games daily and the remaining two only very seldom. Only one adult engaged in computer games on a daily basis, the other adults reported to do this a couple times a week or less. Although the children were more accustomed to computer games, only one of the children named a computer game when asked for their favorite game. The majority of the children and all adults thought of board games.

At the beginning of the study, the participants filled out a questionnaire with demographic information and information regarding game and computer game experiences. Then the six teams were distributed into two groups and each group tested three of the six games. Each team played one game for about ten minutes and was then asked to fill in the questionnaire for the current game station (see Fig. 2). After finishing the third game, each participant was given the final questionnaire to evaluate the three games in relation to one another and the overall study experience.

Fig. 2. Old and young participants playing one of the 6 games (Spore). After each game evaluation session, subjects were asked to fill in a questionnaire.

An assistant was stationed at each game to instruct the participants on study procedure (e.g. reminding them to fill out the game station questionnaire or asking them to move on to the next game station), to support them if technical or game problems occurred, and additionally to observe the participants and answer the observer questionnaire. Following this, we divided the participants into four focus groups. Adults and children were separated and put into new groups of only children and only adults. All participants in one focus group had played the same three games (group 1: IQ-Fit, Creature Editor, Bad Piggies, and group 2: Mr. Robojump, Rugged Rover, Box Buddies). Their task was to evaluate the games they had played, note improvements or changes they would like, and decide together on how they would rate the games. The results were visualized on a poster. The children groups were supported by a study assistant who read the questions to them and helped with writing down their thoughts.

Measures. Based on the criteria derived from the literature and the outcomes of the preliminary investigations we developed a questionnaire for older and younger users. Especially, great care was put into designing a questionnaire suitable for young children. The questionnaire covered the same important aspects

regarding game immersion experience as suggested in previous studies [6,7,16] and which are at the same time driving motivators (psychological needs) for situational well-being according to Self-Determination Theory [15], namely the need for relatedness, autonomy, and competence. In the context of our study situational well-being can be understood as equivalent to an enjoyable game experience. To ensure the suitability and validity of the questionnaire for young children, adapted questions from the Game Experience Questionnaire (GEQ) [4] were used (e.g. "How much fun did you have playing the game?", "How was the game: (1) boring (5) exciting"), along with an adaption of all elements of the Fun Toolkit [13]. The Fun Toolkit is a collection of measuring tools which is often and successfully used for scientific research with children [11]. It uses a five-point scale of emojis (from a sad face to a smiling face) to indicate enjoyment and offers a structured comparison of the games played (e.g. "Of the three games you played, which one was the most difficult?"), emphasizing the use of pictures. The comparison questions were used to check if previous answers to the individual games reflected in the overall opinion. In the following focus group session the participants had the task to evaluate the played games, note improvements or changes they would like, and decide together on how they would rate the games. The questions used were self-designed. In the observer questionnaire the assistants were asked to note down problems or difficulties the participants encountered during the game, to indicate to what extent the participants were active or passive players, and to give an estimation on how the participants enjoyed or not enjoyed the game (e.g. "How did the child appear to you during the game?" with answer options to tick like "bored" and "overwhelmed").

3 Results and Discussion

The best-rated games on the fun factor were Bad Piggies and Rugged Rover, scoring 5 of 5 points (see Table 1). All participants rated both games highest in regard to fun while playing the game. Both games are proven game concepts, which have undergone game development processes already and hence are in an advanced conceptional state. Apparently, the combination of first carrying out preliminary settings on game content, before starting the actual game run-through is a diverting and favored pastime for old and young. It is important to note, that during the run-through phase, both games offered minor possibilities to influence game play and outcome, hence fostering the feeling of control and competence, as well as autonomy, because the player is not just in the role of a passive bystander and at the mercy of artificial intelligence or game algorithms. The least fun game was Box Buddies with a mean fun score of 4.2. At the same time, participants reported it to be the most difficult game and hardest to understand. However, it was voted one of the most exciting games, alongside Mr. Robojump and Creature Editor.

The Creature Editor lacked a second game phase, in which the participants could have explored how their creation worked and reacted in a virtual environment. The demo version of the game only allowed for building your creature

Table 1. Mean values for game experience of all employed games (minimum = 1, maximum = 5).

	Game	Fun	Co-play	Difficulty	Excitement	Comprehensibility	Freedom
All	IQ-Fit	4.83	5.00	2.60	4.20	4.80	5.00
	Creature Editor	4.83	5.00	1.50	4.83	4.67	4.80
	Bad Piggies	5.00	4.83	1.83	4.50	4.83	4.60
	Robo Jump	4.33	4.43	2.83	4.86	4.43	5.00
	Rugged Rover	5.00	4.57	1.00	4.71	5.00	4.29
	Box Buddies	4.20	4.71	4.14	4.86	3.43	4.29
Adults	IQ-Fit	5.00	5.00	2.50	5.00	5.00	5.00
	Creature Editor	4.67	5.00	1.67	4.67	4.33	5.00
	Bad Piggies	5.00	5.00	2.00	4.33	4.67	4.50
	Robo Jump	4.00	4.33	3.33	4.67	4.33	5.00
	Rugged Rover	5.00	4.00	1.00	4.33	5.00	4.67
	Box Buddies	4.00	4.67	4.00	4.67	2.67	3.33
Children	IQ-Fit	4.67	5.00	2.67	3.67	4.67	5.00
	Creature Editor	5.00	5.00	1.33	5.00	5.00	4.67
	Bad Piggies	5.00	4.67	1.67	4.67	5.00	4.67
	Robo Jump	4.50	4.50	2.33	5.00	4.50	5.00
	Rugged Rover	5.00	5.00	1.00	5.00	5.00	4.00
	Box Buddies	4.25	4.75	4.25	5.00	4.00	5.00

without leaving the confined space of the editor. A child participant noted that the creature should have been able to move beyond the circle of the design interface, and the station assistant reported that especially the children always tried to move their creature beyond the circle to explore their creation in the world beyond. Nevertheless, the Creature Editor is the only game of which all participants, young and old alike, answered "yes" when asked if they wanted to play it again. Evidently, creative tasks with exploration possibilities seem highly enjoyable to both age groups.

All six games scored high on whether participants enjoyed playing it with their team partner or not, with mean scores ranging from 4.43 (Mr. Robojump) to a straight 5.00 (IQ-Fit, Creature Editor). It seemed to be not too important if participants were always very actively involved in the game to report high enjoyment because some grown-ups reported wanting to "just watch" the other (namely the child) play, as was the case for Creature Editor and Mr. Robojump. Moreover, grown-ups reported having only watched during playing Bad Piggies and Rugged Rover but still say they would want to play the game again, as well as graded the games with 5 of 5 points on fun and enjoyment. For children "just watching" was a total no-go. Overall, grown-ups reported to not want to play any of the games alone, while children reported that they would like to play alone, especially on the Creature Editor. According to the observer questionnaires, the most prominent difficulties for the older participants occurred at the beginning of games in the form of technical obstacles (like how to correctly use the controller for playing Box Buddies or how to operate the tablet touchscreen in an effective

and meaningful way). In these cases it was necessary for the assistants to support the team, especially if the child did not take on the role of instructor. In some teams the child participant was skilled in using a tablet and, therefore, either showed the adult how to interact with the device or took over tablet control and let the adult just watch. The assistants often noted that adults seemed to enjoy watching and giving instructions from time to time while children explored and experimented. In the following focus group session, the participants evaluated each game once again in a group discussion and visualized the results on a poster. The results showed the same tendencies reported earlier on an individual level in the questionnaires. Adults, as well as children, noted that the Creature Editor lacked the opportunity to explore and watch how the creation worked in a broader virtual environment and hence the demand was to add "more level" to the game. If the game contained haptic elements, it was always positively mentioned in the evaluation. For example, although IQ Fit had been rated as very difficult by the children, the possibility to build and interact with 3D-objects resonated very positively with them. Furthermore, the most outstanding feature regarding Mr. Robojump was that real-life cubes were used to build the digital robot on the screen. A keyword often associated and mentioned with this block building principle was "creative". The term was also attributed to games like Creature Editor and Rugged Rover.

4 Conclusion

On the basis of the literature, our preliminary investigations and finally the results from the study, the following design criteria for an intergenerational collocated and collaborative game at the Welios Science Center have been identified. It proved successful if the game consisted of two phases, with the possibility of reruns. In the first phase, the player designs the primary game content with which she/he then plays and interacts in the second phase of the game. The first phase of the game offers ample chance to be as creative as one wishes but should include a rather basic set-up to soon start the second phase. To provide a sense of autonomy and control, it is advised to provide interaction and adjustment opportunities in the second phase, which can be minor or major depending on the participant.

In this way, cognitive overload can be prevented and success or failure can be improved respectively redeemed in a consecutive playthrough. This iterative learning process makes the game less frustrating and at the same time more challenging. Furthermore, with iterative loops the duration to play is variable and can be chosen individually by players, offering flexibility and autonomy. Consequently, an iteration should be rather short, but the overall playing time can be as long as the player chooses. Hence, it should incorporate possibilities of upgrades, improvements or further levels that can be reached to ensure engagement and enjoyment.

A game should not be too complex, technically and conceptually. Young and old participants evaluated the co-operative concept and control of Box Buddies as

rather difficult on a technical, executive, and conceptual level. As a consequence, the enjoyment ratings of the game were rather low in comparison to the other games, despite the fact that players reported experiencing the game as exciting. To deal with this, tasks and responsibilities can be appointed to a specific player, for example technically more demanding tasks are the younger player's responsibility or cognitive tasks are appointed to the older player. This accommodates the preferences of older players to act as observers rather than active players who interact with the interface, whereas the younger players demand active roles. Additionally, different roles acknowledge different levels of experience and help to appoint the player with the appropriate level of difficulty and challenge.

Incorporating haptic, tangible objects into the game was positively evaluated by old and young. Despite manifold digital game opportunities offered recently, children still value interaction and engagement with actual objects they can touch and feel. Furthermore, the combination of tangible objects and their digital representation can be seen as a synthesis of traditional (haptic board games) and digital games, and their use might ease older people into the game experience.

In general, we argue that our approach supports the identification of design criteria (game mechanics, goals, etc.) for intergenerational games in a museum context that are not only fun, but also foster the communication between old and young players. We are aware of the limitations of the study due to the small sample size, but we conducted the study with due diligence and report the results as what they are without the pretense of inferential statistics. Our findings highlight that the inclusion of cooperative behavior, haptic elements, and several phases with the possibility of reruns is beneficial for the experience of intergenerational games. For future work, based on the study findings and the Mr. Robojump-concept we plan to create a more elaborate game prototype. This prototype should be evaluated over a longer period of time at the Welios Science Center to identify additional mechanics that contribute to the relation between the generations.

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