Setting Up and Conducting the Co-design of an Intergenerational Digital Game: A State-of-the-Art Literature Review

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Abstract. In our ageing society, health and social problems of older people are on the rise. A possible way to deal with these issues is to ensure older people remain actively engaged in society by stimulating social interaction with other generations, such as (grand) children. Playing intergenerational digital games could be a way to achieve this kind of social interaction. The present state-of-the-art literature review aims to provide insight into the factors to take into consideration for setting up and conducting the *co*-design (involving younger and older adults interacting both with one another and with game designers) for an intergenerational digital game. Finally, this paper offers recommendations for the co-design of such games.

Keywords: State-of-the-art literature review · Intergenerational digital games · Co-design · Design recommendations

1 Introduction

Older people are at risk of health issues (e.g., due to mental and physical decline) as well as social problems (e.g., loneliness) (http://www.who.int/about/mission/en/). As the world's population is ageing rapidly, with the number of older people estimated to double to 1.6 billion globally between 2025 and 2050 (U.S. Census Bureau, 2016), this is an important social issue. The ageing of the population is a megatrend that will impact on global society for decades to come. Yet another megatrend that is swiftly changing the world is that of the digitization of society. The number of users of digital media in Western countries has soared over the past few years across all age groups, from young to old (http://www.pewinternet.org/2017/05/17/tech-adoption-climbs-among-older-adults/ and https://ec.europa.eu/eurostat/statistics-explained/index.php/people_in_the_EU_-_statistics_on_an_ageing_society).

Remaining actively engaged in society, for example, through social interaction with other generations, such as (grand) children, could offer a way to deal with the health issues and social problems confronting older adults. Studies have clearly shown that fostering intergenerational contact can serve as a valuable instrument to achieve such active engagement [1–3]. As play is a necessary human activity (see Huizinga [4] on the "homo ludens"), and playing digital games in our everyday life has become as common as watching television for many of us [5, 6], intergenerational digital games could provide a useful tool in getting or keeping older people involved in our society.

Literature reviews [7, 8] explored the possibilities of intergenerational digital gaming in a broad sense, and examined various characteristics of intergenerational digital games. They did not, however, analyze in detail the process of designing intergenerational digital games. Another literature review [9] provided insight into the attraction of intergenerational digital games and the factors that need to be taken into consideration when setting up and designing digital games targeted at mixed-aged players. But to our knowledge, no state-of the-art literature review has yet focused on how *co*-design can be used to set up and conduct an intergenerational digital game to enable seniors to become or remain involved in society. This is somewhat remarkable, as involving the future players – in this case, members of both older and younger generations - in the design process is a logical condition to foster meaningful play; gaming is a shared play activity for which the players need each other.

The present state-of-the art literature review, therefore, aims to provide insight into the characteristics and dynamics of setting up and conducting the co-design of an intergenerational digital game. We are aware of the fact that other terms have also been proposed for this type of design, such as player-centered game, participatory design, human-centered game design, and user-centered game design, each of which, however, carries a slightly different meaning. In this article, we use the term co-design to refer to a process in which involving users from the very beginning to the end is crucial. According to Stewart et al. [10], such an approach blurs "the boundary between game player and traditional 'creator'" (p. 20). Following [11–14] we define the co-design of an intergenerational digital game as: A process involving younger and older adults both with one another and with game designers) in the design of a digital game through a participatory approach to enhance meaningful play. And we follow [15] who, after first having argued that "meaningful play in a game emerges from the relationship between player and system outcome" (p. 34), later added in a section about Games as Social Play that for such games, it is not enough to focus only "on the relationship between an individual player and a game, but also on the social experiences that occur when more than one player participates in the same game." (p. 462). We also follow [16] who state that "a thorough understanding of seniors, their expectations, their likes and dislikes, social relationships, etc. is essential to designing meaningful play for elderly citizens". It goes without saying that, in the case of intergenerational digital game design, this applies to younger citizens, as well.

The co-design process is an iterative, cyclic one that consists of the following four phases: analysis, design, development and evaluation [17]. Several techniques may be used during each phase. The analysis phase, for example, may involve performing contextual inquiries and participatory design. Contextual inquiries are observations of persons in their natural environments to understand how people usually behave [17].

Participatory design is a technique that is used to collect qualitative data about the proposed user, As the focus of participatory design is less on game concepts, and more on the user, it is not only part of the design and development phase, but also of the analysis phase [17]. Evaluations are preferably carried out after every phase, to ensure that feedback is received in time to allow modifications to be made to the game. In earlier stages, these user tests might be performed using low-fidelity prototypes, which are low-cost preliminary versions of the game with only limited functionality [17].

As our definition of the co-design of intergenerational digital games makes clear, the creation process should have a participatory character. This implies that game designers should involve the target groups in an active way, i.e., ensuring the full participation of older and younger people in the design process, from the very beginning to the end.

In the present state-of-the-art literature review, we will examine empirical studies to gain insight into factors to take into consideration for the set up and co-design of intergenerational digital games.

2   The Importance of Intergenerational Games

Intergenerational play can serve different purposes, such as fun (leisure), seriousness (learning) or serious fun (see [7, 18]). According to Davis et al. [1] intergenerational play could be instrumental in enhancing intergenerational contact, which could be mutually beneficial to grandparents and grandchildren. De la Hera et al. [19] argue that this kind of social interaction, "must be stimulated, as not only do the generations hold negative age stereotypes about each other, age differences also contribute to a lack of mutual understanding, which may serve to inhibit interactions between the generations [20]".

In our opinion, intergenerational gaming is significant, because it can contribute to an important societal issue: enhancing intergenerational relations. [1] state that "it is well documented that ongoing social connection between the young and the elderly increase the sense of wellbeing of both parties" (p. 191), and [3] argue that: "Intergenerational contact can reduce the prevalence of ageism, and significantly help improve the mental and physical health amongst the elderly [2]. Similarly, within the family, strong intergenerational relationships have been found to increase self-esteem for the young, and provide positive long-term psychological benefits for children as they move into adulthood [21]." (p. 368)." So, intergenerational contact has the potential to reduce the prevalence of ageism, and significantly improve the mental and physical health of younger and older persons. Costa and Veloso [7] and Zhang and Kaufman [8] have pointed out the potential benefits at the cognitive level (e.g. the exchange of information, knowledge and skills [2], attitudinal level (e.g. reducing ageist ideas, e.g. [7]; and the social level (companionship, e.g. [22]). Finally, [2] underlined the importance of family contexts, especially grandparent-grandchild relationships, in this regard (see also [1, 22–25]).

3   The Importance of Co-design

It is important to involve game players in game design, especially when it comes to non-traditional player groups [13, 26]. The following statement, though, made by Vetere et al. [25] in 2005, still applies today:

"One of the crucial critiques of the current state of game development is the apparent lack of originality in design solutions: games are designed to appeal to a rather narrow, already existing player demographic. As long as the design of new games is based on the traditional model of individual game author or small team designing games based on their personal likings and vision, rather than on understanding derived from their potential new audiences, this is unlikely to change" (p. 1).

Game designers are typically young male adults with little understanding of the needs that older adults have [11] Or, as Oudshoorn et al. [27, p. 41]) (citing Akrich ([28], see also [16, 29]) phrases it, the pitfall of I-methodology should be avoided: "The I-methodology refers to a design practice in which designers consider themselves as representative of the users [28]. Akrich [28] describes the I-methodology as the "reliance on personal experience, whereby the designer replaces his professional that by that of the layman" [p. x]."

This is often an unconscious process: the designer is not aware of the fact that the user representation he or she is using resembles himself or herself. In contrast to the images created by designers and what people expect, implicit methods are often more powerful than explicit methods in shaping the design (p. 41).

Co-design in an intergenerational context implies the involvement of two different user groups (younger and older adult), who interact both with one another and with game designers. As we saw in Sect. 1, involving younger and older adults - the future players - in the design process is a logical condition to foster meaningful play, as gaming is a shared play activity for which the players need each other. It follows, therefore, that a co-design process is essential to developing a digital game that fits the motivations and abilities of both older and younger players.

It is also important to be aware of the fact that the motivations to play digital games differ between older and younger individuals. This finding led De la Hera et al. [19] to argue that older players (1) tend to reject reflex-oriented games such as fighting or racing games, as they find such games more difficult, less interesting and therefore less enjoyable to play [30], (2) avoid action and violent games, (3) prefer games with intellectual challenges [30–33], (4) like playing games because of social aspects, in particular when playing with family members, when the social aspect is more important than the game itself [33, 34], and (5) tend to be less competitive and inclined to assume more passive and supportive roles [30, 31, 33, 35]. Common ground should therefore continuously be sought: the need for fun and relaxation, to escape reality and for social interaction and connectedness is shared by both generations [11].

De la Hera et al. [19] also argue that, as older players are generally less competitive than younger adults and children, digital games designed for intergenerational play should preferably take the form of collaborative games or digital games implementing cooperative competition (e.g. Khoo's digital game *Age Invaders*) rather than competitive games [35–37].

Finally, we should keep in mind that there are age-related differences between younger and older players. Loos [11] points to a number of problems confronting senior players, such as age-related decline in vision (difficulties with reading texts on screens and with detecting items in the periphery of the screen), hearing (problems hearing certain sounds), cognition (difficulties with speed) and visual-motor coordination (problems with mouse and key board controls, selecting and scrolling pages on the screen); see also [23, 37–40].

To accommodate these age-related differences, De la Herra et al. [19] have suggested taking the following points into account when co-designing intergenerational digital games regarding:

- older players:
  (1) strive to develop in-game adjustable speeds instead of time restricted games [31];
  (2) allow for the possibility to play according to the players' own abilities (see the digital game *Age Invaders* [23, 24];
- younger players:
   tailor the game technology to their age and abilities [25, 41];
- older and younger players:
  (1) include easy to master physical and tactile controls, because they elicit higher degrees of involvement for both generations, tend to be shorter (attractive for older players) and feature lighthearted themes and characters (attractive for younger players) [36];
  (2) make use of enactive interaction that avoids relying on specific knowledge of how to operate digital games [36, 37].

After having presented the characteristics of intergenerational relations, play and gaming, including implications for game designers, in the next sections we move on to the central theme of our article: the *co*-design of intergenerational digital games.

4   Method State-of-the-Art Literature Review

As our goal is to review empirical studies to get insight into the dynamics of setting up and conducting the co-design of an intergenerational digital game. The focus is on intergenerational game activities in which *game designers collaborated with younger and older players to get insight into their experiences of gaming* together to optimize the design process. So, the goal is not to provide a basis for evidence-informed policymaking and practice, and for this reason we decided against conducting a systematic literature review, opting instead for state-of-the art literature review, including full papers of empirical studies published until the end of 2017, with this focus. We started with the review by Costa and Veloso ([7], and using the snowball method [42], we finally included eight empirical studies.

Please note that we did not include Knudtzon et al. [43] in our state-of-the art literature review as the term 'intergenerational' in their title 'Starting an intergenerational technology design team: a case study', referred to children and game designers and not to older players. Neither did we include Van den Abeele and De Schutter [44] as this publication was not a full paper but a one page description of a design research project based on a framework (called P-III) to facilitate intergenerational play between grandparents and grandchildren (see also a comparable research project, called e-Treasureproject by the same researchers, aiming at developing a digital game by means of a player-centered design process, including seniors and youngsters from the beginning until the end - https://iiw.kuleuven.be/onderzoek/emedia/projects/etreasure).

4.1 The Included Empirical Studies

As explained in Sect. 4, eight articles on the co-design of intergenerational digital games were retrieved from the literature (see Table 1), and discussed in terms of study design, aims and populations, theoretical/methodological approach or design rationales, and the recommendations given for the co-design of intergenerational digital games (see Table 1).

Table 1. Co-designing intergenerational digital games

Article	Study design	Study aim(s)	Study population	Theoretical/methodological approach or design rationales	Recommendations for the co-design of intergenerational digital games
1. Al Mahmud et al. [45]	3 case studies: ! : designing and testing with children, 2: designing and testing with older adults, 3. testing both digital games with both user groups	"(…) we investigated various options for enhancing the gaming experience through augmented tabletop games for children and older adults" (p. 147)	Children aged 7–11 and older adults aged 65–73. Both groups were studied separately and together.	Qualitative and quantitative user test of the digital game Tangible (social) interaction was the starting point for the development of the digital game. Augmented tabletop gaming was found to be suitable by the researchers	• Maximize social interaction. For instance, by including guessing, cooperation, and competition • Create uncertainty within the digital game, such as hidden resources, to introduce new challenges • Theme and game elements should attract children • Maintain a balance between social interaction and immersion • Make sure the digital game is easily followed by both user groups, for instance by gradually introducing technology and use simple game rules • Game rules must encourage cooperation • Keep in mind the preferences of children, rather than the elderly

Table 1. (*continued*)

Article	Study design	Study aim(s)	Study population	Theoretical/methodological approach or design rationales	Recommendations for the co-design of intergenerational digital games
2. Derboven et al. [46]	Case study: User tests of an intergenerational digital game	"(…) explore how direct video communication in an inter-generational game influences game experience" (p. 57)	15 couples of one senior (60 or older) and his/her (grand)-child (15 or older) participated in user tests	Qualitative and quantitative user test of the digital game (i.e. evaluation/proto-typing) Observations of older people to understand the kind of digital games usually played (i.e. contextual inquiry) Starting point was that the digital game had to include a social aspect/social interaction	• Use video chat functionality • Moving through game phases should occur simultaneously for all players • Include an exercise mode, preferably in such a way that older and younger players can explore the digital game together • All players should have to opportunity to 'take the lead' • Digital games should have the possibility to play both with and without extra communication functionality
3. Khoo et al. [23]	Case study: a description of the digital game (design) and user tests	"[Highlighting] the general methodologies for designing computer games for the elderly." (p. 15)	5 university employees aged 45–60, and 5 students aged 16–20	"General methodologies followed for designing computer related games for elderly [were followed]." (p. 5) (e.g. assessing how well elderly understand modern technologies, finding out which digital games are currently available, and conducting user studies with target population) Starting points for the digital game included four different aspects: social gaming, physical gaming, a cognitive aspect, and a psychological aspect	• Recommendations for the *Age Invaders* game only
4. Khoo et al. [24]	Case study: a description of the digital game (design)	"This paper presents steps for designing an inter-generational family entertainment system which focuses on physical and social inter-actions using a mixed reality floor system." (p. 76)	User studies: 49 students and 20 persons from the target groups (10 persons 60-80 and 10 children 10–12)	A User-Centered design approach was followed, including: - problem identification - problem exploration (e.g. observation of or focus groups with target groups) - setting design goals - identifying design requirements for prototype of the digital game, including identification of financial resource, time constraints and user needs, and researching the context/setting of use - design idea generation (e.g. brainstorm sessions) - usability studies Design goals: (physical and tangible interaction) Social interaction	• Recommendations for the *Age Invaders* game only

(*continued*)

Table 1. (*continued*)

Article	Study design	Study aim(s)	Study population	Theoretical/methodological approach or design rationales	Recommendations for the co-design of intergenerational digital games
5. Rice et al. [47]	Case study on the co-design of an intergenerational digital game	To explore interests, motivations, and design ideas for digital game applications among young, old, and game designers	50 participants aged 15–21 and 55–74	Three design workshops with 2 to 4 persons within own and mixed age groups performing several activities (e.g. "100 pictures") A co-design approach was applied. Co-design methods and activities were borrowed from [42], among others	• Take advantage of differences in ability between older adults and young persons (e.g. life-skills and experiences, physiological abilities) • Use relevant user group expertise (comparable to previous recommendation); e.g., children/younger adults could support older adults in understanding the digital game, older adults could pass on positive life experiences • Make sure there is long-term motivational interest in the digital game: intergenerational digital games require both complexity and challenge • Explore opportunities within public spaces for community engagement • Recognize local challenges and opportunities for intergenerational digital games
6. Romero and Ouellet [13]	Intergenerational digital game design workshops	Analyzing "the scaffolding process of inter-generational game design activities as a s an instructional learning strategy." (p. 74)	34 18 to 80 years old participants	Participatory activities involving older and younger participants to scaffold a digital game creation process (by using a storyboard and the visual programming tool Scratch (http://scratch.mit.edu). Approach characterized by the fact that "… the final game product is not the objective, but an intergen-erational facilitator." (p. 80)	• "A highly guided approach to scaffold the intergenerational game creation workshop was a key element for its successful development." (p. 80)
7. Vanden Abeele and De Schutter [37]	Case study on the design and user evaluation of existing digital games and user evaluation of the developed mini-game	To verify the design rationales and test the inter-generational digital game	User-evaluation of existing mini-games: 5 pairs of a senior and a younger adult (3 of the pairs had a grand-parent-grandchild relationship, 2 pairs were acquaintances) User-evaluation of developed mini-game: 7 seniors (and one 45-year-old stand-in) and 8 younger adults	Qualitative user test of the developed digital game (i.e. evaluation/proto-typing) and comparable existing digital games Ethnographically inspired research The digital game was developed applying a player-centered design process, but the authors report that "the discussion of the entire player-centered design process is beyond the scope of this paper" (p. 426) Three design rationales were reported. These were produced by the design team and supported by theory	• No general recommendations for co-design of intergenerational digital games mentioned

Table 1. (*continued*)

Article	Study design	Study aim(s)	Study population	Theoretical/methodological approach or design rationales	Recommendations for the co-design of intergenerational digital games
8. Xie et al. [48]	Case study on the design and user evaluation of existing digital games and user evaluation of the developed mini-game	To understand how older adults and children can work together to co-design technology and to determine what (new) co-design methods are needed	6 older adults aged 68–81 and 7 children aged 6–9 who did not know each other	Co-design activities took place in several stages and included among other, distributed design sessions, sticky note ideas, and brainstorming. One of the methods was called "co-design of co-design" (p. 16) by the authors. A co-design approach was applied. One of the study aims was to "revise and improve methods with co-design partners." (p. 415)	• Children and older adults need time together to start the collaboration and understand each other's needs, but also time apart to advance the collaboration in a less stressful environment • Work primarily in small groups when children and older adults are together • It is important to build and elaborate upon the (shared) ideas of children and older adults • Spend time on a group discussion with older adults only so they can express their needs and wishes • Use art supplies for children • Use sticky notes for children and older adults to share ideas

4.2   Discussion of the Empirical Studies

Although the studies differed substantially as regards study design, aims and populations, all dealt with an empirical study on the co-design of (newly developed) intergenerational digital games involving users form different generations. Most authors reported on one or more case studies and focused on user tests of newly developed intergenerational digital games. Of the eight studies in our state-of the-art literature review, Rice et al. [47] and Xie et al. [48] were the ones that focused most on the co-design process of intergenerational digital games.

Xie et al. [48] explicitly aimed to explore co-design methods that could be employed to involve older adults and children in the use of technologies in intergenerational interaction. This study was specifically set up to develop co-design methods for technology use in an intergenerational context. The authors call one particular activity within their design process 'co-design of the co-design methods', through which important insights were gained as regards setting up and conducting the co-design of an intergenerational digital game. The most pivotal recommendation in this study was that intergenerational collaboration, according to these authors, could best take place in a distributed fashion. Co-located collaboration is not essential; instead, older and younger adults should spend time together (to understand the needs and preferences of each other) as well as apart (to elaborate on ideas). Other recommendations for co-design were to work in small groups, to use art supplies with children, and to make use of sticky notes for both target groups (i.e. older adults and children) to share ideas. An important point to keep in mind about this study is that the older adults and children had never met before taking part in the study. Hence, the extent to which

the findings can be generalized to co-design processes with older adults and their (grand) children is unclear.

Rice et al. [47] focused on "the roles games have in fostering relations with strangers, and the extent they differ to a family context" (p. 377). They conducted three workshops with 50 participants, who took part in a range of design activities intended to create an intergenerational digital game. They analyzed videotaped workshop sessions and materials (e.g. game concepts, storyboards) created by the participants. They recommended "to address possible disparities in skill sets, designers should build on the intrinsic qualities and experiences of targeted age groups (p. 376)". For a discussion of age-related differences between younger and older individuals, we refer to Sect. 3.

Although the design process was not the main focus of the other studies, these nevertheless also provided useful insights for designers aiming to set up and conduct the co-design of an intergenerational digital game. Some of the studies used a qualitative approach (#5, 6, 7 and 8), other studies used a mix of qualitative and quantitative users' tests (#1, 2, 3 and 4). The co-design characteristics most often reported were user observations and interviews with user groups, to understand the type of game they play, and user tests of prototype games that have been developed. Al Mahmud et al. [45] for instance, reported that their game design started with an observation of the target groups in their natural environment. These activities can be regarded as contextual inquiries and are obviously part of a player-centered design process [17]. The evaluation of a prototype of the game was part of the design process in several studies (#1, 2, 3, 4 and 8). This method occurs in the player-centered design process as well, preferably following each of the three design phases, i.e., after the analysis phase, design phase, and development phase) [17]. In most empirical studies the design processes were difficult to reconstruct from the information available in the articles and as a result and hard to evaluate in the light of the predetermined criteria. By contrast, [23, 24] published a series of articles on the design process of *Age Invaders*, in which low-fidelity prototypes were followed by higher fidelity prototypes. For example, [23] presented the results of a user study with a preliminary prototype, while in their later article [24], they describe the use of a more advanced prototype for this purpose.

None of the eight articles alluded to the use of theories in the co-design process, nor were any theories, such as the Self-Determination Theory [49, 50], the Uses and Gratifications Theory [51–53] and the Domestication Theory [54, 55] used as a theoretical frame work for co-design. Design methodologies were barely mentioned or only implicitly touched on. Study findings and recommendations were highly dependent on how the (co-)design had been conducted. Exploiting the differences in skills and abilities of both user groups (by studies #2, 4, 5 and 8) were recommendations for the design of intergenerational digital games that emerged a couple of times.

5   Conclusions

Our state-of-the-art literature review clearly showed that empirical studies providing insight into the dynamics of setting up and conducting the co-design of intergenerational digital games are scarce. While the eight studies we discussed critically in our state-of-the-art literature review differed with regard to study design, aims and

populations, they all focused on an empirical study on the co-design of intergenerational digital games, or on user tests of such newly developed games. The following Table shows which lessons can be drawn from our state-of-the-art literature review (Table 2).

Table 2. Recommendations for the co-design of intergenerational digital games

• Allow children and older adults to spend time together to start the collaboration and understand each other's needs, but let them also have time apart to advance the collaboration in a less stressful environment. • Work primarily in small groups when children and older adults are together. • Build and elaborate upon the (shared) ideas of children and older adults. • Use relevant user group expertise (e.g., children/younger adults could support older adults in understanding the game, older adults could pass on positive life experiences). • Make sure that the game is easily followed by both user groups (e.g. by gradually introducing technology and use simple game rules). • Moving through game phases should occur simultaneously for all players, use relevant user group expertise (e.g., children/younger adults could support older adults in understanding the game, older adults could pass on positive life experiences). • Make sure there is long-term motivational interest: intergenerational digital games require both complexity and challenge.

We conclude that for setting up and conducting the co-design of intergenerational digital games distributed collaboration is important: children and older adults should spend time together to start the collaboration and to understand one another's needs, but also time apart to advance the collaboration in a less stressful environment, work in small groups, and pay attention to and make use of differences in their skills (including age-related differences). To sum up, we recommend "designing with, rather than for participants …" ([47], p. 369).

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