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Creating Wheelchair-Controlled Video Games: Challenges and Opportunities when Involving Young People with Mobility Impairments and Game Design Experts

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Abstract

Although participatory design (PD) is currently the most acceptable and respectful process we have for designing technology, recent discussions suggest that there may be two barriers to the successful application of PD to the design of digital games: First, the involvement of audiences with special needs can introduce new practical and ethical challenges to the design process. Second, the use of non-experts in game design roles has been criticised in that participants lack skills necessary to create games of appropriate quality. To explore how domain knowledge and user involvement influence game design, we present results from two projects that addressed the creation of movement-based wheelchair-controlled video games from different perspectives. The first project was carried out together with a local school that provides education for young people with special needs, where we invited students who use wheelchairs to take part in design sessions. The second project involved university students on a game development course, who do not use wheelchairs, taking on the role of expert designers. They were asked to design concepts for wheelchair-controlled games as part of a final-year course on game design. Our results show that concepts developed by both groups were generally suitable examples of wheelchair-controlled motion-based video games, but we observed differences regarding level of detail of game concepts, and ideas of disability. Additionally, our results show that the design exercise exposed vulnerabilities in both groups, outlining that the risk of practical and emotional vulnerability needs to be considered when working with the target audience as well as expert designers.

Highlights

- First participatory study designing games for young people using wheelchairs.
- Reflection on relative contribution of game design expertise and experience.
- Explores representation of mobility disability by participants in design process.
- Reflection on how vulnerability of participants exposed through design process.

1. Introduction

Creating interactive technologies for people with disabilities can be challenging for designers: apart from ensuring accessibility, a crucial point in the design process is to anticipate needs and preferences of the target audience to create engaging experiences. To address this issue, research in Human-Computer Interaction (HCI) commonly applies participatory design (PD) as a means of directly involving end-users in the development process (Muller and Druin, 2009). Although PD has been widely adopted in the HCI community, and has been successfully applied to design assistive technology (Williams et al., 2014), recent discussions suggest that there may be two barriers to the successful application of PD to the design of digital games (Khaled et al., 2014).

First, the involvement of audiences with special needs can introduce new practical and ethical challenges to the design process. Because games must provide challenges to players in order to engender player motivation (Sweetser and Wyeth, 2005), designers of games for vulnerable user groups must gain an understanding of the types of activities that provide acceptable and interesting challenges to that group. Player abilities must be explored in order to create engaging experiences. However, when working with young people with disabilities, this may mean there is a necessity to explore attitudes around their disability, together with their sense of embodied self, potentially exposing vulnerability (Gerling and Linehan, 2014; Flintoff et al., 2008; Waddington et al., 2015). Yet, a lack of involvement of the target audience may lead to the development of technologies that do not meet their needs and preferences (Newell et al., 2011). Therefore, despite the risks it may introduce into the design process (Gerling et al. 2015), PD is currently the most acceptable and respectful process we have for designing technology (Wright and McCarthy, 2008).

Second, there has been much criticism of the direct involvement of non-game design experts in game design roles (Khaled et al., 2014; Wyeth et al., 2014). For example, the relative lack of success of educational games has often been attributed to the reliance on pedagogical rather than game design expertise in designing those games (Bruckman 1999; Habgood, 2011). Products and services that have been augmented with game-like features (Deterding, 2011), by designers who have no expertise in designing games, have been similarly criticized in the literature (i.e., Hamari 2014). However, when working with game design experts on projects intended for people with disabilities, many will have limited experience of working with those groups (Porter and Kientz, 2013), increasing the risk of introducing implicit biases about disability into the design process (Foley and Ferri, 2012). In order to develop empowering experiences for this audience, it is important to not only understand players' perspectives on video games, but also to explore their perceived embodied identities, and how these relate to their wheelchair.

To explore how domain knowledge and user involvement influence game design, we present results from two projects that addressed the creation of movement-based wheelchair-controlled video games from different perspectives. The first project was carried out together with a local school that provides education for young people with special needs, where we invited students who use wheelchairs to take part in design sessions exploring their self-perception, views on wheelchairs, and gaming preferences. The second project involved game development university students who were asked to design concepts for wheelchair-controlled games as part of a final-year course on game design. None of these students used wheelchairs. Through a comparison of both projects, we explore perspectives on disability, the suitability of resulting game concepts for the target audience, and whether the design process exposed instances of vulnerability. Our paper makes the following three main contributions: (1) We provide the first qualitative enquiry into design processes addressing the development of games for audiences with special needs that compares outcomes achieved by potential players – young people who use wheelchairs – and game design experts. Our results show that concepts developed by both groups were generally appropriate and feasible examples of wheelchair-controlled motion-based video games. (2) We explore

the representation of mobility disability in games from the perspective of game developers, and that of players with mobility impairment who use wheelchairs on a daily basis, providing insights into future avenues for game developers and games research. (3) We reflect upon how vulnerability of both the target users and the game development experts was exposed throughout the development process, providing insights into the emotional risks of participatory game design when working with and for audiences with special needs.

Developing empowering and engaging playful experiences for young people with disabilities is an important step toward a more inclusive game development community. Our work provides insights into the involvement of young people with disabilities and non-disabled experts in the process of game design, and contributes to a better understanding of PD for audiences with special needs.

2. Related Work

This section summarizes perspective on participatory design in Human-Computer Interaction, participatory approaches when working with people with disabilities, and the involvement of players in the design of video games.

2.1 Participatory Design in Human-Computer Interaction

An increasing number of projects in HCI introduce participatory design as a means of directly involving end-users in the development process (Muller and Druin, 2009). This is in contrast to user-centred design (UCD), the dominant contemporary approach to design, which defines a set of practices that places the end user as the focus of all design work, but often the end users are engaged in a way that is held separate from the creative design work. For example, users may be studied from an ethnographic perspective, or interviewed, or asked to evaluate various iterations of prototype solutions, or all of the above. Participatory design is a type of user-centred design that involves end users directly in the creative process of generating design solutions. Aside from being an effective method for meeting the needs of those users (Wright and McCarthy, 2008), the participatory process is intended to be an inherently empowering experience (Stewart and Bhagwanjee, 1999), especially for marginalized audiences such as children with special needs (Malinverni et al., 2014), who otherwise struggle to have their voices and stories heard. Indeed, past research has demonstrated the importance of the involvement of people with disabilities in the technology design process (Williams et al., 2014).

2.2 Involving People with Disabilities in Design

Newell et al. (2011) have suggested the adoption of *User-Sensitive Inclusive Design* in order to create technology that is not only accessible, but also useful. To this end, they outline the importance of improving empathy among designers to ensure resulting systems represent the interests of the intended target audience. Guha et al. (2008) propose a more differentiated view on user involvement when working with children with special needs, outlining that depending on the severity of disability, different levels of involvement (e.g., designing, or testing) need to be considered. Along these lines, Holone and Herstad (2013) reflect upon inclusion and participatory design, and identify challenges regarding user involvement and time constraints, participants' potential lack of experience of taking on an active role in the design process, and communication barriers that may be the result of complex needs.

While issues around communicating with persons with complex needs have been addressed through the development of alternative methods, e.g., facilitating participation and design through interaction (Larsen and Hedvall, 2012; O'Connor et al., 2006), other challenges such as empowering individuals to take an active role in the development process remain.

2.3 Participatory Game Design

Various attempts have been made to establish participatory design processes in the context of serious games (Khaled et al., 2014). For example, Khaled and Vasalou (2014) report on the design of Village Voices, a game for conflict resolution that was created with children as co-designers. In their work, the authors propose novel approaches to PD to facilitate the participation of young people, and demonstrate that children's input was most valuable during the middle stages of the development. Particularly addressing the design of interactive applications for young people with special needs, Anthony et al. (2012) explore the value of participatory design workshops to engage young people with learning difficulties. Findings highlight the importance of considering how participants communicate with one another, being aware of participants' individual backgrounds, and fostering inclusion through choice of accessible workshop materials. Along these lines, work by Benton et al. (2012) on participatory design with children with autism demonstrated that the design process as such can be a positive experience for participants, but that contextual factors such as children's willingness to collaborate need to be kept in mind. Additionally, Benton and Johnson (2013) argue that adult participants (e.g., carers or researchers) have to carefully define their own role to enable children with special needs to participate in PD in an empowering way. Exploring participatory design with children with physical disabilities, Brederode et al. (2005) comment that extensive involvement in the design process may be difficult to achieve due to physical and cognitive demands, which might create stressful situations for participants. In this context, major challenges in PD for game design evolve around the involvement of people without game design expertise in the development process (Wyeth et al., 2014), the potential of participatory design to expose vulnerability among participants, especially when working with persons with special needs (Gerling and Linehan, 2014; Gerling et al., 2015; Waddington et al., 2015). Additionally, when designing for people with disabilities, the impact that implicit biases about disability among non-disabled researchers and designers may have on the design of technology needs to be considered (Foley and Ferri, 2012).These examples demonstrate that careful consideration is necessary when involving young people with disabilities in the design of video games. In our work, we aim to expand on these findings by specifically exploring the contribution of game design expertise and experience.

3. Designing Wheelchair-Controlled Video Games

In our paper, we compare outcomes of a participatory design process with young people who use wheelchairs and results of wheelchair-themed class projects of non-disabled students to explore implications of both approaches in terms of game design and views on disability. The goal of both design processes was to develop wheelchair-based movement-based games building on the KINECT^{Wheels} toolkit (Gerling et al., 2013) that allows the integration of basic wheelchair movement (back and forth, turning to the sides) as part of a game control interface.

3.1 Research Questions

Our work was guided by the following three research questions around wheelchair-based game design, and concerns associated with participatory design processes when designing for audiences with special needs.

(1) **Perception of mobility impairment.** How do young people using wheelchairs see themselves, and how do non-disabled young people describe them through personas? What view on disability is communicated by each group?

(2) **Suitability of game concepts.** Are there any differences between game concepts developed by the two groups regarding themes, gameplay, and technical feasibility? What is the general suitability of game concepts for the intended target audience? How is disability represented in game concepts?

(3) **Instances of vulnerability.** Were there, among both groups, instances where the design process exposed vulnerability, either through focus on mobility impairment among people who use wheelchairs, or by exploring attitudes regarding disability among non-disabled persons?

3.2 Participants

Group 1: Young people who use wheelchairs

We worked with St. Francis School in Lincoln, UK, which provides education for young people with special needs. Nine young people participated in the project; they had a wide range of physical and cognitive abilities. Participants were aged 13 to 22 (3 female). All of them used powered wheelchairs with two occasionally using manual wheelchairs; medical conditions ranged from spinal cord injury as the result of accident to progressive neurodegenerative diseases and developmental conditions such as Cerebral Palsy. While most participants could express themselves through speech, one participant was non-verbal and required the assistance of staff, and another participant applied assistive technology (iPad application generating speech) to communicate. All but one participant had previous experience playing video games, with preferences ranging from triple-A first-person shooting (FPS) games such as Call of Duty to casual and social games. Participants generally preferred console and mobile games due to the availability and accessibility of these platforms (i.e., some found it easier to interact with touchscreens while other participants voiced preferences for gamepad input); one participant mentioned that his parents monitored types of games he was allowed to play. Participants had no experience with movement-based games, two participants had watched others play Nintendo Wii and Microsoft Kinect games in the past.

Group 2: Game design experts

The second group consisted of 22 final year undergraduate students enrolled in a game development programme at the University of Lincoln, UK. Participants were in their early 20s (all male). None of them self-identified as having impairments that would require the use of a mobility aid. We class the students as experts in game design, since, at this point in their programme, they have demonstrated expertise through completion of several years of full-time study centred around game studies, game design, and games programming including topics such as accessibility, and human-computer interaction. All participants in this group reported extensive previous experience playing video games. Preferences spanned a wide range of genres (e.g., FPS games, strategy, and sports), production styles (triple-A and indie), and platforms (different consoles, PC, and mobile). Participants had previous experience playing movement-based games including the Nintendo Wii and Sony PlayStation Move controllers, and Microsoft's Kinect sensor.

3.3 Design Process

The design process followed a different format at each research sites:

Group 1: Young people who use wheelchairs

At the school, we worked with two groups of teenagers and young adults over the course of four months, during which we held a total of nine design sessions, exploring participants' self-perception, views on wheelchairs, and gaming preferences. The design process included a total of four sessions with distinct themes: At the beginning, we worked with each group of participants to explore their personal gaming history and preferences without giving them any guidance on the games that we were looking to create, and asked participants to brainstorm game themes they would be interested in. Building on this initial session, we then explored how they viewed themselves, how they would like to be represented in the games we were going to build, and their perception of wheelchairs as input devices for video games. In this context, we explained the technical capabilities of KINECT^{Wheels}, and the range of input options it would offer. In the final session, we worked with participants to

refine initial game themes, design basic game mechanics, and consolidate them with technical constraints of the toolkit we chose for wheelchair input.

Group 2: Game design experts

The design process was integrated into the structure of a 12 week course on advanced game design. Students attended one lecture and one workshop a week, with lectures covering contemporary design topics such as user-centred design, diversity in games, and game accessibility. In parallel, students were asked to design a concept for a wheelchair-controlled game. As part of this, they were instructed to develop personas and create a game design document detailing specifics of their game in respect to theme, gameplay and mechanics, and graphical design. At the end of the course, students were invited to participate in a structured group interview to explore their perceptions of the design process.

The research was approved by the University of Lincoln College of Science Ethics Board. Our consent procedure at St. Francis included informed consent from parents which was obtained through the school, paired with assent from study participants that was renewed at each session. University game design students gave written consent to the analysis of their design artefacts.

3.4 Data Collection and Analysis

We collected the following data: when working with groups of young people using wheelchairs, design sessions were audio recorded and transcribed later on. Game concepts were created together with the students during these design sessions, leading to five game concepts. Game design experts made design artefacts available in PDF or Word format; a total of two datasets per participant were included in analysis. The final group interview was audio recorded and transcribed.

Qualitative data were analysed according to the three research questions, perception of mobility impairment (RQ1), suitability of game concepts (RQ2), and instances of vulnerability (RQ3).

Table 1. Dimensions and items of the Attitudes to Disability Scale (Power et al., 2010).

Inclusion	People with a disability find it harder than others to make new friends
	People with a disability have problems getting involved in society
	People with a disability are a burden on society
	People with a disability are a burden on their family
Discrimination	People often make fun of disabilities
	People with a disability are easier to take advantage of (exploit or treat badly) compared with other people
	People tend to become impatient with those with a disability
	People tend to treat those with a disability as if they have no feelings
Gains	Having a disability can make someone a stronger person
	Having a disability can make someone a wiser person
	Some people achieve more because of their disability (e.g. they are more successful)
	People with a disability are more determined than others to reach their goals
Prospects	Sex should not be discussed with people with disabilities
	People should not expect too much from those with a disability
	People with a disability should not be optimistic (hopeful) about their future
	People with a disability have less to look forward to than others

RQ1 was addressed using Deductive Thematic Analysis (Fereday and Muir-Cochrane, 2006). Analysis of interview transcripts and personas was guided by the Attitudes to Disability Scale (ADS, Table 1) by Power et al. (2010), which provides a formalized, validated theory of how people think and communicate about disability. Following the method outlined by Braun and Clarke (2006), the data was first read thoroughly a number of times by one researcher. Transcripts were then coded using the concepts from the ADS scale. The researcher noted where a concept was mentioned, and whether it was expressed as a positive or a negative. This was an important distinction, as many of the concepts are expressed in negative language in the scale (see Table 1).

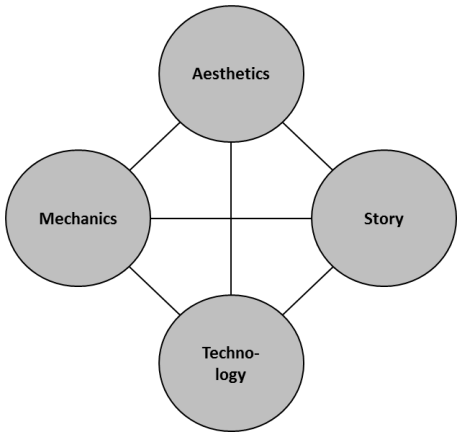


Figure 1. Schell's Four Basic Elements of Games [0].

Data relevant to RQ2 was analysed based on the Four Main Elements of Games by Schell (2008) (Figure 1). This framework of games focuses on *Mechanics* (procedures, rules and goals that govern games), *Story* (game themes and sequence of events), *Aesthetics* (visuals, sound, smell and taste, and feel of a game), and *Technology* (the medium through which a game is experienced). This framework allowed us to explore the completeness of game concepts.

RQ3 was explored through Inductive Thematic Analysis (Braun and Clarke, 2006) of interview transcripts as this analysis approach allowed us to explore general instances of vulnerability that may have emerged throughout the research process. Following a process of inductive thematic analysis, transcripts for all sessions were coded by a single researcher focusing on emotional responses that may indicate personal vulnerability. Across all transcripts, 32 individual codes were identified. In an iterative process the codes were collapsed and merged into a structured tree of themes, for each group, related to issues of vulnerability in design.

4. Results

In the following sections, we present our results addressing each of the research questions. We report findings from both design processes with a focus on differences and similarities between young people using wheelchairs at St. Francis (Group 1), and game design experts at the University of Lincoln (Group 2).

4.1 Research Question 1: Perception of Mobility Impairment

RQ1 asked how young people using wheelchairs see themselves, and how non-disabled young people describe people using wheelchairs through personas. In our analysis, participants rarely expressed the largely negative concepts on the ADS (Power et al., 2008). Both groups of participants, in their design work, demonstrated empathy towards people with disabilities, and the group of people who used wheelchairs did not communicate

negative concepts, such as being a burden or not having emotions. The following sections give a detailed overview of the results.

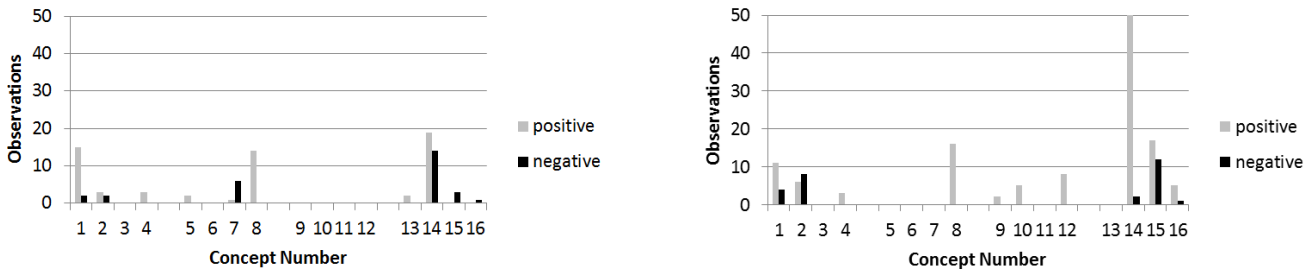


Figure 2. Number of observations of ADS concepts among young people using wheelchairs (group 1, left) and game design experts (group 2, right).

4.1.1 Inclusion

The first concept, that "people with a disability find it harder than others to make new friends" was mentioned by both groups. Young people using wheelchairs (Group 1) often communicated disagreement with that statement, *"Definitely a team player, aren't you, Matthew?" "he knows me all too well"*, although there was some agreement, *"I'm mostly on my own most of the time."* Game design experts (Group 2) often expressed opinions that disagreed with the statement, *"enjoys socialising with her friends, and doesn't consider herself to be any less than others due to her disability,"*, and *"In his free time he likes to go out and see his friends"*.

The second concept concerned involvement in society. Group 1 expressed some positive attitudes, *"It's no good winning if you're the only one there and nobody can see your victory,"* but most of the discussion was more complex, noting that the idea of social involvement was appealing but generally not on offer, *"it would be nice if they could do things maybe a bit in competition, but teamwork as well where they can help each other."* There was also some negative sentiment about social interaction *"you do tend to get a lot of unwanted interaction."* Game design experts in group 2 also expressed a lot of negative sentiment regarding the social interaction of people with disabilities, *"She is quite a lonely person who is struggling to adapt to her life after the incident," "her main form of socialising is through the medical therapy she undergoes,"* although there were some positive comments *"He enjoys going to school where he can socialise with people his own age."*

There was very little mention, by either group, of concepts three or four, which concern people with disabilities being a burden on society, or on their families. Discussion of family by both groups was generally positive, as demonstrated by statements such as *"I know you racing around with your dad in your chair, don't ya?"* (Group 1). Overall, both groups, through very different design activities, raised similar issues and demonstrated a similar balance of perspectives.

4.1.2 Discrimination

The four concepts addressing discrimination were mentioned comparatively little in either of the data sets. The game design experts expressed no opinions regarding people making fun of, taking advantage of, or becoming impatient with, people with disabilities. These issues were simply never raised in any of the personas. Group 1 discussed being made fun of, but in a playful and positive sense, where they were being made fun of as people, rather than for having disabilities, *"My mum's idea of a joke she bought me a top that simply just reads 'dork' over the front."* Impatience was a theme that was evident in the interview transcripts that was not present in the personas. This was manifested in the impatience of participants towards each other, *"he spent about 20 minutes one morning just deciding what shoes to put on because he was determined to defy the laws of parents,"* and

towards facilitators and researchers, *"I can tell. I am very intelligent,"* and in the impatience of those adults towards the participants, *"Although it's very nice to hear all about your rabbit and how it likes to come out for cuddles. But why do you like playing on the videogames?"*

In contrast with some previous findings, in our study the emotions of people with disabilities were considered with great depth and empathy. Group 1 demonstrated great insight, *"certainly a lot of the autistic kids, I think they do also get a lot of the emotional enjoyment," "we don't want it to be … too upsetting when one child beats another child,"* The game design experts (Group 2) also demonstrated sensitivity to other peoples' emotions in their personas, *"He doesn't like it when people take pity on him,", "He is a playful soul and loves playing games with his friends and family"*. There weren't any instances where our participants treated people with disabilities as if they had no emotions, nor were there instances where people mentioned being treated as if they have no emotions.

4.1.3 Gains

There was a marked difference in the way that the groups talked about possible gains derived from the use of wheelchairs. The game design expert group mentioned how people with disabilities can be stronger, *"She fights such challenges head-on,"* wiser, *"Chris has grown to be open to more things,"* and more determined, *"She is a very demanding individual who fights vigorously for accessibility and equality", "determined to continue with her sporting lifestyle."* In contrast, young people using wheelchairs expressed nothing that could be classified under these statements.

4.1.4 Prospects

In terms of the Prospects dimension, the most frequently coded statement was that "people should not expect too much from those with a disability." Both groups produced much communication that disagreed with this statement. For example, game design experts (Group 2) demonstrated very high expectations for the abilities of wheelchair users *"he was inspired to achieve something that others would say is impossible," "she works to promote accessibility and equality,"* sometimes bordering on the ridiculous *"carries on interest in sports by working as wheelchair stuntman (beginner)."* Group 1 also expressed positive expectations, *"You quite like to be stylish," "I live a very active life," "I beat a guy that was like prestige four and I was pretty new,"* but unlike group 2, they expressed almost as many negative expectations, *"I would like to but I can't use my hand…. it takes a lot of strength," "they don't tend to play the games that have like the platform levels ….. because of the concentration element."*

The final two statements are quite similar to each other, addressing optimism and looking forward. Game design experts demonstrated a balance between positive *"She is a very optimistic person," "aspiring to become a music producer,"* and negative statements *"He is incredibly bitter," "he has grown into a very morose individual"*, while young people using wheelchairs primarily communicated a lack of optimism *"they probably wouldn't get a chance to do in reality," "You like music but you can't do it."*

4.2 Research Question 2: Suitability of Game Concepts

Both design approaches resulted in game concepts that provide valuable insights into the design of wheelchair-based video games. In the following sections, we present detail regarding the completeness of game concepts based on Schell's (2008) Four Basic Elements of Games, and give an overview of game settings, genres and representations of disability suggested by both groups.

4.2.1 Mechanics

The area of mechanics was addressed by both groups, and was integrated in all game concepts (5/5 concepts developed with young people using wheelchairs, and 22/22 concepts developed with game design experts. While group 1 provided high-level considerations touching upon the procedures of games (e.g., suggesting the development of a downhill skiing games), concepts did not provide depth in terms of the implications of the general game idea, and only implicitly touched upon what the overall goal of the game would be. In contrast, the experienced game designers in group 2 addressed all aspects of mechanics in great detail, clearly establishing relationships between procedures, rules, and goals of the suggested games.

4.2.2 Story

Both groups addressed the concept of story in their game concepts (5/5 concepts developed by group 1, and 22/22 concepts developed by group 2). Game concepts developed by group 2 show that game themes were often developed with the available technology and resulting mechanics as a starting point, i.e., participants explored the technical capabilities of the KINECT^{Wheels} toolkit, how these translated into mechanics, and what themes they could be mapped onto, resulting in 10/22 game concepts suggesting the use of wheelchair input to control vehicles ranging from motorcycles to space ships, and 9/22 game concepts using wheelchair input to control movement of human-like avatars. In contrast, interview results suggest that participants in group 1 were eager to identify general areas of interest, and proceeded to develop game themes on that basis, not considering implications of wheelchair input at that point.

4.2.3 Aesthetics

The element of aesthetics was addressed by both groups. All concepts developed by group 2 offered some consideration regarding the graphical style of the game (offering mock-ups and examples of proposed graphical style) along with an overview of suitable sounds, and 2/5 game concepts developed by group 1 offered suggestions regarding aesthetics. Interestingly, group 1 was less concerned with the graphical style of games unless it was an integral part of gameplay, e.g., when designing a game that would offer a sensory experience rather than engaging the player through challenge. On a general level, the focus of both groups was on graphics and sound; none of the concepts addressed aesthetics beyond graphics and sound, i.e., by exploring haptic dimensions of wheelchair-controlled play.

4.2.4 Technology

While all game concepts developed by game design experts in group 2 addressed the use of technology to track wheelchair input, none of the game concepts developed by the young people using wheelchairs touched upon potential technical restraints. Interestingly, only one concept developed by game design experts addressed the use of technology beyond KINECT^{Wheels}, and suggested the integration of the Oculus Rift as immersive output device.

4.2.5 Setting and Genre

In addition to the general completeness of game concepts created by both groups, we explored proposed settings and genres to investigate potential differences regarding gaming preferences.

Game concepts developed by young people using wheelchairs in group 1 had a strong focus on real-world experiences with 3/5 concepts directly relating to sports. In contrast, design results of group 2 demonstrate a mixed choice of setting with 8 game concepts set in the real-world, 8 fantasy games, and 5 games that are set in a science fiction environment. In terms of genres, 3/5 games proposed by group 1 focused on the experience of sports, one game was classified as a casual puzzle game, and one game concept addressed the idea of offering sensory experiences for players (i.e., an interactive environment responding to any kind of player input through visual and auditory feedback) to enable persons with severe impairment to participate in play. Game concepts

developed by experts in group 2 showed a strong focus on combat games with 9/22 games (2 first-person shooting games, 7 sea/space/medieval battle games), followed by 6/22 games focusing on real-world experiences (3 racing games, 3 other sports games), 5 puzzle games, one adventure game, and one exergame to support physical activity. Generally, concepts developed by both groups strongly reflected the idea of casual games – games that can be played in short sessions, are easily accessible, intuitive, and offer background stories that appeal to wide audiences (Kuittinen et al., 2007) – with all concepts developed by group 1, and 20/22 of game concepts developed by group 2 outlining features such as easy accessibility that are in line with this definition.

4.2.6 Representation of Disability

In a final step, we explored the representation of disability in the proposed game concepts. Out of the 22 game ideas developed by game design experts, only one game concept explicitly included an avatar that used a wheelchair, and one other centred on training people to use wheelchairs. Other game concepts developed by this group included non-disabled avatars (with two explicitly pointing out that the avatar had the ability of walking), and focused on activities that might not be accessible in the daily lives of people using wheelchairs (e.g., driving a car). Likewise, none of the game concepts developed by group 1 – young people who use wheelchairs on a daily basis – explicitly addressed the representation of disability within the games. Follow-up questions revealed that participants did not consider the inclusion of avatars using wheelchairs in their games because those were not commonly included in commercially available games, and that they would not appreciate the inclusion of wheelchairs within games if those introduced limitations similar to those in the real world, with one participant for example stating that *"[…] at least if I was able bodied [in the game] you wouldn't have to worry about not having the same range of movement"*. However, participants were interested in avatars using wheelchairs if those were presented in an empowering way, suggesting approaches such as implementing *"[…] a really basic chair that could then turn into something like the bat mobile or something really high powered and cool"*.

4.3 Research Question 3: Instances of Vulnerability

Since both groups were working on designing games specifically for players with mobility impairments, both groups were obliged to take a reflective stance on the issues surrounding this design space. Given this, we were interested to understand how the design process may expose vulnerability on behalf of both designers and users. Although the design exercise exposed some kind of vulnerabilities in both groups, the vulnerabilities associated with group 1 were oriented on pragmatic concerns, while the vulnerabilities expressed by group 2 were of emotional nature. In general, when talking about design constraints, practical concerns of young people using wheelchairs (Group 1) were created by their motor impairments. This vulnerability tended to be expressed as frustration with particular control mechanisms that make games too difficult, that in turn leads to specific actionable requirements for developers – "*[I] would like to [use controllers] but can't use my hand*", "*it takes a lot of strength*", "*if there is a simplified control option, I will tend to go for that*". Participants did express dismay that games they found appealing (e.g. music games, games with too many flashing images) were often unplayable for them.

There was a preference shown for playing together in a social situation, but this discussion exposed vulnerabilities amongst the group around differing abilities. In particular, the experience of co-players becoming emotionally upset when losing, either due to physical ability or competitive natures. Participants were especially concerned over the potential for poor balancing to create friction between the group – "*we don't want it to be too upsetting when one [person] beats another…, but we don't want it to be too boring either*". Generally, group members felt video games provided positive experiences. When prompted, group members did identify that games provide a good way to experience activities that they "*probably wouldn't get a chance to do in reality*", such as skiing and rock climbing.

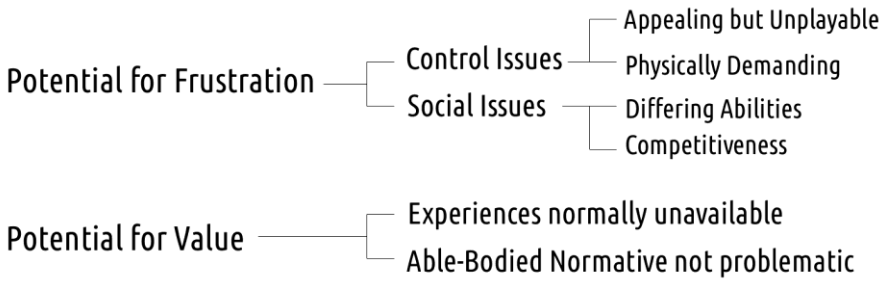


Figure 3. Themes of vulnerability emerging from young people who use wheelchairs (group 1).

In contrast to group 1, game design experts in group 2 expressed a range of vulnerabilities, both for themselves and the perceived reaction of users with mobility impairments. Chief among these was the overwhelming concern about unintentionally designing a game that caused the player distress or upset. This topic came up frequently in the discussion and exposed a real worry on behalf of the game designers, who were quick to imagine specific circumstances that might trigger upset in the player – "*say a car crash game, when they could have ended up in a wheelchair because of a car crash*", "*my first idea was actually a racing game and I sat there and went 'oh, that might not be a good idea just in case'*". In addition, a key worry was "*accidentally patronising them*", for example by "*Having controls for a wheelchair game might... offend them. Here's a game for you to use...because you can't play normal games.*".



Figure 4. Themes of vulnerability emerging from game design experts (group 2).

In a personal sense, these experienced game designers found the task exposed a lack of knowledge that undermined their abilities. Players felt it was "*very daunting*" and despite between 3 and 4 years of full time education and practical experience with game design, participants expressed lack of confidence - "*I've never done anything like this before. Where do I start?*" They were "*never taught to think like that*". When issued the task, participants reported an immediate defensive reaction to a feeling of restriction harming their ability to complete the task - "*it felt very restrictive*", "*it's very limiting*", "*trying to make a game with limited controls is hard*", however they felt this gave way once development was underway - "*yeah, initially it felt very restrictive but it actually forced you to think critically*" and found that it "*makes sense*" and "*helped focus the design efforts*".

As part of the design process, they were asked to develop a group of personae that each represented a fictionalised user of their game, to be used as reference through the development. Participants reported that they found this task difficult due to their lack of personal experience. None of them knew any friends or family with mobility impairments, so relied on envisioning personal reactions (e.g., "*I did what I think I'd be like if I'd just got put in a wheelchair*") and internet-based research to help discover more about the experiences of people who use

wheelchairs. When the researcher asked if anyone had tried to contact someone who has a wheelchair, participants again showed a lack of confidence: "*I'd be afraid to*". When asked if they felt the personae accurately reflect people in wheelchairs, the participants unanimously declared that "*Nobody has any idea*" - "*I've done research but that's not the same as actually knowing someone and knowing exactly what they are going through*".

5. Discussion

In this study, we employed participatory design practices to the design of movement-based games for young people who use wheelchairs. The goal of the study was to better understand the types of useful and insightful, as well as problematic, contributions we can expect to elicit during participatory design sessions with two different groups, each of which had a different set of insights; 1) a group who has valuable experiential insight, but no design expertise, and 2) a group who has game design expertise, but little experiential insight. In order address the stated goal, we asked three specific research questions.

Research question 1 (RQ1) asked how young people using wheelchairs talked about themselves during design sessions, and how non-disabled young people described them through personas. We were interested in whether discussions of disability were characterized by stereotyped or discriminatory language, and used an established tool, the Attitudes to Discrimination Scale (ADS; Power et al., 2010) to code interactions and personas. We found that both groups of participants demonstrated empathy towards people with disabilities, and rarely expressed negative concepts about disabilities. On the contrary, results show that game design experts who did not use wheelchairs demonstrated far more positive expectations about the abilities of wheelchair users than those people themselves, and regularly expressed opinions that disability could lead to gains in determination, wisdom and strength.

Research Question 2 (RQ2) asked whether there were any differences between game concepts developed by the two groups regarding themes, gameplay, and technical feasibility. Both design approaches resulted in game concepts that provide valuable insights into the design of wheelchair-based video games. Unsurprisingly, the group who had game design expertise provided more practical and detailed specifications for games through their design work, but the group of wheelchair users also provided insightful high-level design concepts. We were also interested in the general suitability of game concepts for the intended target audience. Interestingly, game concepts developed by both groups focused on casual games; games that can be played in short sessions, are easily accessible, intuitive, and offer background stories that appeal to wide audiences. Finally, we were interested in how disability was represented in game concepts. We found that none of the game concepts developed by wheelchair-using participants included an avatar that used a wheelchair, and only one of the twenty two concepts designed by the game design students did so. It appears that participants did not consider the inclusion of avatars using wheelchairs in their games because those were not commonly included in commercially available games.

Research Question 3 (RQ3) asked whether there were, among both groups, instances where the design process exposed vulnerability, either through focus on mobility impairment among people who use wheelchairs, or by exploring attitudes regarding disability among non-disabled persons. Although the design exercise exposed some kind of vulnerabilities in both groups, the vulnerabilities associated with group 1 were oriented much more on pragmatic concerns. In contrast, the vulnerabilities expressed by group 2 were much more emotional. These participants were challenged by the design theme worried about potentially upsetting members of the intended target audience unintentionally.

5.1 Reflections on Expert and Player Participation in Wheelchair-Based Game Design

Our work provides insights into two major challenges associated with participatory game design; correctly representing player preferences, while ensuring general feasibility of game concepts.

5.1.1 Understanding Player Needs and Preferences

Our results show that both groups – game design experts and young people using wheelchairs – were able to address basic aspects of game design that need to be considered when developing games for people using wheelchairs. Particularly, similarities between game concepts proposed by both groups (i.e., casual nature with action elements, and gameplay that invites the integration of wheelchair input) demonstrate that game design experts were able to anticipate many opportunities in wheelchair-based game design, and that their ideas are likely to resonate with young people using wheelchairs. This is in line with research on the development of games for young people with cerebral palsy (Hernandez et al., 2013), who were interested in playing action-based games similar to commercially available games. However, when exploring aspects that extend beyond game themes particularly regarding the representation of disability within games, we observed differences between groups that we discuss in section 5.3.

5.1.2 Ensuring Feasibility of Game Concepts

Beyond meeting the needs of the target audience, another challenge in participatory game design is ensuring that concepts are generally feasible in terms of technology, and that they meet the requirements of the application context. On a general level, the higher level of detail and technical consideration provided in game concepts created by game development experts suggests that there might be fewer problems in terms of implementation. In contrast, game concepts developed by young people using wheelchairs omit technical detail and only include high-level considerations regarding suitable game themes, gameplay, and core mechanics. This creates an interesting challenge in terms of implementation: they leave extensive room for interpretation when translating game themes and ideas for gameplay into actual mechanics and control schemes. This situation may put developers at risk of creating games that do not meet the needs of the target audience if detail is lost in translation. Rapid iterative development in collaboration with participants would help ameliorate this concern.

5.2 Imagining Versus Experiencing Disability

Results show that university students who did not use wheelchairs demonstrated far more positive expectations about the abilities of wheelchair users than those people themselves. They were also more optimistic about the future prospects of people using wheelchairs, and regularly expressed opinions that disability could lead to gains in determination, wisdom and strength. These overly optimistic expectations of wheelchair users, if relied upon alone, could significantly undermine the value of games for that population. Specifically, if games are designed in a manner that expects more of users than they are capable of, this could lead to disengagement and frustration (Sweetser & Wyeth, 2005), and the exposing of player vulnerabilities (Gerling, Mandryk & Linehan, 2015). This finding illustrates the problems caused by relying on designers to speculate about the implications of disability, rather than involving those with experiential insights into the design process. Indeed, fictional depictions of disability in the popular media, produced by non-disabled people, often emphasise that disability is *foreign*, or *other*, and that there is a real difference between the disabled and non-disabled (Preston, 2014). In this context, it should not be a surprise that depictions of disability produced by the game design experts in our study are similarly separated from reality. Thus, our project demonstrates that, although it is expensive, time consuming and often emotionally and cognitively challenging carrying out design work in collaboration with people with disabilities, it is entirely necessary in order to generate realistic and useful requirements.

5.3 The Impact of Representation of Disability (and Lack Thereof) in Games on Player Preferences

Despite integrating wheelchairs as input devices, an overwhelming majority of game concepts did not represent disability within the virtual environment, for example, through avatars that reflect the use of wheelchairs in their graphical design, or reflection on the use of wheelchair when designing the player's in-game abilities. Interview responses showed that young people using wheelchairs at St. Francis were used to being represented through non-

disabled commercially available games, and were apprehensive to embrace in-game representation of wheelchairs if it introduced limitations in terms of player abilities. Therefore, further research is necessary to understand how people with mobility disabilities would like to be represented in games; in this context, it is important to investigate what kinds of avatars young people with mobility disabilities would consider appropriate on a broader scale, and explore avenues of creating suitable in-game roles to ensure that aspects of disability (e.g., the use of mobility aids) are integrated in an empowering context.

5.4 Exposing Vulnerability Through Design Processes

The potential of participatory design to expose vulnerability among participants and designers has been discussed extensively in the context of Human-Computer Interaction. Our work clearly illustrates some of the core challenges in terms of vulnerability when working with audiences with special needs, e.g., pragmatic concerns that were raised by young people using wheelchairs regarding their own mobility, and we also observed instances of conflict throughout the design process that could potentially lead to vulnerability, for example, impatience was an issue that was expressed by all actors during the sessions with young people using wheelchairs. This impatience seemed to be derived from problems with communication between people engaging in unfamiliar activities with unfamiliar people. It must be acknowledged that asking participants with communication difficulties to co-design games has great potential to generate frustration and impatience in those participants. However, expert game designers also expressed frequent instances of emotional vulnerability. Particularly, the topic of disability appeared to undermine their own confidence in their skills. They were very aware of their own lack of experience, and although willing to carry out extensive research, they remained unconfident in anything they created. On a broader scale, this issue needs to be considered when involving designers in the creation of technology for audiences with special need that they have little experience with; engagement with such a design process does not only have potential of creating unsuitable solutions, but can also put designers at emotional risk.

6 Limitations and Future Work

We provide a qualitative enquiry into challenges and opportunities of participatory design of wheelchair-based video games; findings need to be interpreted in the light of the specific application context and the small number of people involved in both projects presented in this paper. Nevertheless, we believe that our work offers interesting insights into different design approaches when creating video games for audiences with special needs, and it opens up promising avenues for future work that can further contribute to a better understanding of participatory game design.

Our work shows that the involvement of design experts leads to more refined game concepts, while the involvement of end-users provides valuable insights into their preferences and needs in terms of representation of disability that extends beyond aspects anticipated by experts. Therefore, bringing both groups together throughout the design process might be an interesting opportunity for young people using wheelchairs to directly work with game designers, and for game design experts to develop a better understanding of their target audience, which might also mitigate some of the instances of vulnerability that we observed among game design experts throughout the design process. In this context, future work should further explore designers' views on disability and how it influences their approaches to game design, the representation of disability in games, and whether empathy toward and understanding of people with disabilities can be increased through co-design.

7 Conclusion

Involving diverse audiences in game design is an important yet challenging step towards tailoring games to meet players' needs and preferences. Our work explores participatory design for and with people using wheelchairs, and reflects upon challenges and opportunities that were identified when working with game design experts who

do not use wheelchairs, and young people who use wheelchairs on a daily basis. Findings show that the involvement of both groups is crucial to create engaging experiences that offer well-defined ideas of play, are technically feasible, and build on realistic perspectives on disability. In this context, our paper offers starting points for reflection on participatory design for researchers and practitioners wishing to develop interactive experiences for audiences with special needs.

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