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Designing serious games for special user groups—Design for somebody approach

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Abstract

This paper presents the Design for Somebody (DfS) philosophy targeted to iterative, user-oriented development of solutions for special user groups. In this article, the DfS is discussed using a game development context. The paper gives concrete examples how the DfS can be used in developing motivating serious games. The paper presents three games which can be adjusted according to the user's abilities. The aim is to generate personalized means to enable and motivate physical, cognitive and social skill development. The development process of the three games is described in order to clarify the DfS approach and the features which are of key importance in game development for special user groups. Authentic user experiences are also presented and discussed. The user experiences and the suitability of the games were investigated through interviews and observations in game test events. The main findings in general indicated the usefulness of the DfS principles and the great interest and positive experiences in special user groups. The findings encourage further research and development of serious games for these target groups.

Introduction

The Design for All (DfA) and other ideologies to individualize products and services have promoted making everyday life activities accessible, available and feasible for everyone by redesigning environment, products and services applicable for anyone (Blanck, 2014; Joines, 2009). However, accessibility is a far wider concept than ramps or door widths in construction and housing environments (Patomella, Kottorp, Malinowsky, & Nygård, 2011; Preston & Rajéé, 2007). In conventional industry and commerce, special user groups are often seen as marginal minor groups that are not so interesting to invest in. Fortunately, the transition from this conventional thinking towards user-oriented production development and service design is an ongoing process (Sirkka, Merilampi, & Sandelin, 2017).

Practitioner Notes

What is already known about this topic

- Serious games can be used in learning, special needs user groups are no exception in this.
- Also special needs people are interested in playing games but due to their special need may have challenges with mainstream games.
- Inclusion is topical trend, but there is lack of tools to implement this.
- Technology could help in resolving this challenge, but the special needs require specific approach in development.
- Design for all (DfA)—type approach has been beneficially added accessibility of technology solutions.
- DfA might not be possible, if users have very specific needs -> there is a need for modified approach.

What this paper adds

- The paper introduces a Design for Somebody (DfS) development method which is especially suitable in development for special needs people.
- The development approach is described with three case studies.
- The case studies provide concrete examples of serious games for special user groups. These can be used as tools for enhancing inclusion.
- The paper underlines the positive user experiences related to the games and inclusion of the target group in the development process.
- The article describes how novel technology skills and technologies (3d printing, mobile technology and sensor technology) can be applied to provide tools for special user groups.

Implications for practice and/or policy

- DfS development method can be applied in any technology development for special needs people.
- The paper is eye-opening for technology developers, since it describes how to use their skills for new purposes (special needs people) and that there is also market potential in this. One of the games described in case studies is going to be a commercial product developed by three companies together.
- The paper underlines the need and benefits of multidisciplinarity through the development.
- The paper describes how to involve special needs people as active players also in the development process.
- The paper illustrates new tools to boost inclusion.
- The paper empathizes the special user groups to enjoy (serious) gaming.
- The paper describes the potential of novel technologies and games in inclusion.

There are so many different avenues to improve accessibility and user experiences. DfS is one approach willing to challenge conventional production development models, by setting modifiability as a cornerstone. The ideology in DfS is quite similar to that employed in DfA; only the approach is different, involving the user as an active party throughout the iterative development process. The reason for developing a new approach is related to the very specific needs of small target groups. If a solution is designed for all, the same solution should serve everybody, despite

impairments. However, when dealing with very specific needs, it may not be possible to make the "DfA" solution without losing functionality and usability of the solution from other user groups' point of view. Instead, a modular structure facilitates tailor-made solutions with specified, modifiable modules that make the product or service usable even for persons with severe impairments or special needs. In these cases, DfS appears to work better as a design approach. The DfS ideology in technology and service design has demonstrated positive results in developing a variety of solutions, regarding all demographics and groups with particular needs, without need for distinctions (Finn & Loane, 2016; Koivisto, 2016; Sirkka, Merilampi, Koivisto, Tommiska, & Saarinen, 2017; Sirkka *et al.*, 2017).

The game industry has faced the need to provide accessible games, especially since the emergence of serious gaming and rehabilitation games as useful tools (Bierre *et al.*, 2005; Koivisto *et al.*, 2016). Bierre *et al.* (2005) present various issues which makes the special user group game play challenging. These are: inability to follow a storyline, to complete a puzzle or task, to determine how a game is played, to use adaptive hardware, and player's character gets killed/injured repeatedly in game which is very demotivating. These challenges can be caused by various disabilities such as mobility, auditory, visual or cognitive disabilities. It is essential to determine the cause in each case. From a game design point of view, this requires various versions of the game/game play, according to the player's challenges. It is not necessary to take all special needs into consideration at the same time, but to make the game easy to modify according to the user (user profile).

In this article, three games which are personalized for special user groups are presented. The previously mentioned challenges in special user group gaming and the generic frame were taken into special consideration in game designing, which were executed according to the DfS philosophy.

Methods

Three case studies are discussed in this article to describe the use of DfS in game development: orienteering game, activation game with special controllers and gamified walking aid. The user experiences were studied through thematic interviews, in addition to researcher and staff member observations in game test events. The structured interviews consisted of: (1) background information of the person's technology use, (2) visual design, (3) information and interaction designs, (4) functional specifications and content requirements and (5) user needs and site objectives. Each test event was designed according to the user group and the game under development. Due to a need for highly individualized needs, the test groups were intentionally kept rather small.

The Orienteering game was tested in a care home for people with learning disabilities. Participants ($N = 4$) testing the Orienteering Game were all residents of a group home. The participants were taking part in the thematic interview and their answers were verified by the nursing staff. Also, the nursing staff members ($N = 2$) were interviewed. The activation game was tested by 17 rehabilitation center clients. In addition, observations from researchers and rehabilitation members were gathered and analyzed. The game in the third case study was in its very early development phase and the user group was not yet determined clearly. However, since there is a great need for remote rehabilitation tools, the third case provides a motivation application to help the professional staff in remote rehabilitation. This is why the suitability and user experience tests were first targeted for physiotherapy students ($N = 10$) and professionals (their teacher and working life partners, $N = 2$). The students were answering a questionnaire which contained questions with scaling from 0 (poor) to 5 (excellent) and two open-ended questions. The professional staff gave only free comments. Similar methods have been used in the following previous studies (Finn & Loane, 2016; Koivisto, 2016; Sirkka, Merilampi, *et al.*, 2017).

DfS in games development

In the gaming industry, DfS particularly serves small user groups with highly individual needs. These user groups are typically seen as unattractive from a business point of view. This is also why the competition and supply is typically small in this market, although the demand is significant. The modular designing of the DfS method is the key to cover many different user groups. In addition, it makes it possible to provide new, need-based individual solutions for special user groups, as wells as reasonable business opportunities. In non-modular development, financial issues are often seen as constraints in designing individualized solutions. The DfS approach has already proved most of the development serving the needs of various user groups with only minor modifications needed to meet special user needs. DfS also pays attention to service designing, since sometimes the modification requires only the right kinds of supporting services and a personalized user interface. (Koivisto, Merilampi, & Sirkka, 2015; Merilampi, Sirkka, Leino, Koivisto, & Finn, 2014; Merilampi, Sirkka, & Iniewski, 2016).

DfS means iterative development, constant user experience research and involvement of the end-users from the very beginning. Asking the right questions is key. Instead of "what do you want," one should ask "how would you like this solution to serve you" and "what should be changed." Even after false assumptions and educated guesses to begin with, the innovative processes often ends up with positively surprising results (Koivisto *et al.*, 2015, 2016; Merilampi *et al.*, 2016). Basic usability guidelines are a good starting point in application development (Morville, 2004; Nielsen, 2012), but many other issues named in the introduction chapter need to be taken into account. The specific requirements apply for both device use and application use, affecting in the selection of the most suitable platform.

Usability means accessibility, less is more, and keep it simple are the DfS mottos (see Discussion). This is realized through minimizing required elements and equipment, achieving an appealing enough product to generate the "flow feeling" that activates and motivates use, but at the same time being "serious" enough with a clear goal and purpose. Globally known concepts, spoken instructions, repetition, familiar elements, clear illustrations and visual hints, and personalization of the user interface are very powerful motivational elements in the game design. The more adaptive and scalable the better. The following case studies are developed following the DfS principles (Díaz-Bossini & Moreno, 2014; Finn, Sirkka, Merilampi, Leino, & Koivisto, 2015; Koivisto *et al.*, 2015, 2016; Merilampi *et al.*, 2016; Merilampi, Koivisto, *et al.*, 2016; Sirkka & Koivisto, 2015; Sirkka, Merilampi, & Leino, 2014).

Case Study 1: the orienteering game

The orienteering game was based on the needs identified by the staff of the care home for disabled people. The first step of the development process was a group discussion with the care home staff members. During the discussion, the possibility of mobile devices were first shown through simple demonstrations. In the discussion, the researchers identified the key needs of the group home: activation for outdoor activities and teaching the residents everyday living skills. The researchers were also given a description on the overall characteristics of the care home residents, from which a simple paper prototype describing the basic idea of the game was generated and introduced to the care personnel for deeper ideation of the actual game. Most developmental ideas were related to simplifying the game (less graphics, easier game logic and adding familiar characters in the game).

The Orienteering Game aims to activate and motivate physical outdoor activities, add social interaction, teach situational skills, and to provide cognitive stimulation. The game is a simple sport-like course with a few control points and digital mini-game assignments. In total, nine mini-games were included in the game, with topics varying from physical activities and daily living-

Figure 1: Minigames of orienteering game are activated by touching a control point outdoors [Colour figure can be viewed at wileyonlinelibrary.com]

related tasks, to identification of facial expressions (feelings), and to completing simple mathematical tasks. The assignments were illustrated with familiar visual (photos, videos and drawn pictures) and audio elements, and designed to enhance perception and decision-making skills.

The game proceeds by reading the allocated NFC (near-field communication) tag in each checkpoint. The tags have randomly chosen mini-game assignments and the illustrated hint of the next control point. The control point was simply a laminated A4 paper with the picture of a tablet. On the other side of the A4 paper, the researchers added an NFC smart sticker. Reading the NFC sticker activated a mini-game. The NFC sticker was read with an embedded NFC reader tablet. The picture of the tablet on the A4 paper was real-size, to make it easier to put the tablet in correct place to read the tag (Figure 1). The control points (A4 papers with NFC smart stickers) were placed outside to promote going outdoors, however, the control points could also be placed inside if desired. When starting the game, a clue about the first control point with the first minigame was provided to the player as a simple puzzle on the tablet. The picture (a photo) in the puzzle revealed the first control point, which was placed outdoors in the care home's backyard. The firstplace is randomized (puzzle picture selected from previously defined photos). Placing the tablet on the tablet picture of the control point, resulted in the reading of the NFC sticker from the control point, identifying the location and opening the first mini-game. After finishing the minigame, the game provided a hint (picture) to the next control point, with the next mini-game.

Each of the minigames were first tested with the care home recidents who provided ideas on how to improve the games. Many residents asked for more sound effects. According to the researcher's observations, further simplification was also made to the games and more obvious responses were added to the games, such as sounds and visual effects while touching the screen and the game objects. The researchers also found that not all residentss were able to understand the game logic in all the games. However, this did not stop them playing but after adding responses to the games, the players just found a new logic to play. Due to this never-ending game logic, a SKIP button was added to the games, to allow continuing to the next step without finishing the game in previous control point. After these improvements, the control points were added and the entire game was tested again which led to adding repetitive spoken instructions. The user experience research was performed after adding this feature.

The target group of the game was taking an active role in the iterative game development. The care home residents (test group members) produced graphics, sounds and other elements for the game. The test group members drew game characters and acted in videoclips within the game. The photos of the surroundings of the care home and staff members voices were used in the

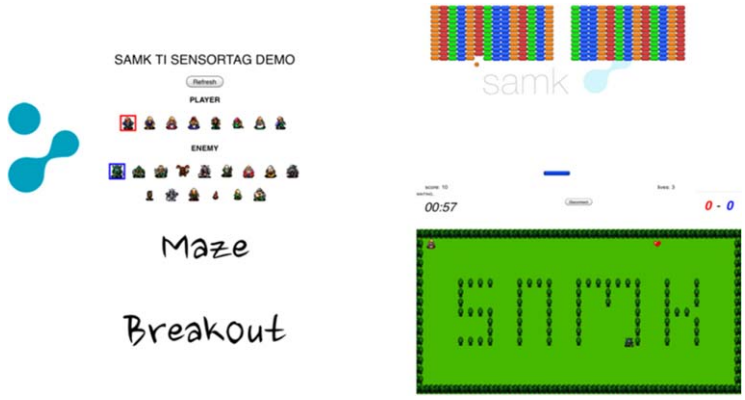

Figure 2: Self-rehabilitation games created for people with physical disabilities. Main menu on the left and game screens on the right [Colour figure can be viewed at wileyonlinelibrary.com]

game as important and motivating familiar elements. The game difficulty levels were defined by early-state user trials, during which the test group was also giving advice how they wanted to modify the game.

Case study 2: activation game with special controllers

The activation games and special game controllers were designed to motivate and intensify physical rehabilitation. Important in the game development was to generate tools for game modifications, based on the user's accessibility requirements, personal likes and rehabilitation needs (individualization and motivation). The need for a modifiable and enjoyable rehabilitation tool was identified in similar processes to the orienteering game, only the rehabilitation center's staff as participants in the group discussion. Based on the discussions, the first version only contained a character which collected items. In the first version, only one control method, tilting the tablet, was used to control the game character. The prototype was tested and opened the ideation phase in which other control methods were developed according to the user feedback in the rehabilitation center. The test persons also gave ideas about the appearance of the game. A simple appearance without too many moving elements was desired, to help perception.

Two different games were designed, a classic Breakout and a Maze (heart collection game) (Figure 2). The main idea using easily understandable game logic. During the development process, the games were tested once before the user experiences were researched. Slight modification was done after the gaming event.

In the classic breakout, a paddle controlled by the player and a ball are used to break the tiles on top of the screen. The required movements are only tilting the controller sidewise left or right. The speed of the ball was adjusted with the test players in an early-state game trial. In the Maze, a game character tries to catch as many hearts as possible in 1-minute time. The game character can be moved all directions which make it more challenging to control. In the Maze, there is an adversery which also collects hearts. To avoid player frustration, hitting the adversery does not kill the game character.

Tilting the tablet was not an optimal control method, considering the rehabilitation needs or the physical abilities of the clients. This is why special game control methods were developed. The game was controlled by tilting an accelerometer.The game controller contained two parts: a sensor (External Texas Instruments CC2650) and a jig placed into a balance board (whole body/leg

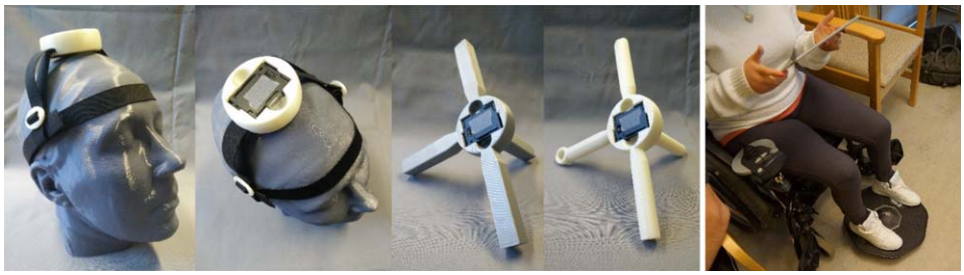

Figure 3: Game controllers: head controller, easy-grip handle (hand controller) and balance board (leg/whole-body) controller [Colour figure can be viewed at wileyonlinelibrary.com]

controller), a 3D-printed handle (hand controller) or a 3d-printed head controller (Figure 3). Different shapes of handles were used based on the players' grip abilities.

The games can thus be used by individuals with a range of physical impairments and is also suitable for anybody, since the sensor can be fixed in a variety of equipment, like a balance board. In the case of manual impairments, the controller provides various grip possibilities, and the head controller allows game play with head movements.

The breakout game was especially meant for the head controller, since it contained only side-to-side movements. The intensity and the graphics of both games were adjusted according to the advice of the rehabilitation center staff and clients in the early-state game development. Modifications were made regarding the size of the game elements (bigger elements) and the speed (slower speed of the ball, faster with the paddle in breakout; faster speed of the game character in Maze). Similarly, modifications were made to the hand controller according to findings of field testing. A small hole was added to enable the controller to be attached to the body by belt, to get extra support or to avoid controller drop in any case of dyskinersia or poor grip. This version of the game was used in the user experience research.

Case study 3: the gamified walking aid

A gamified walking aid is a hybrid of sensor technology, motivation application and walking aid. The goal of the concept is to offer tools for remote/home rehabilitation, as well as for personal development. The need was described by a rehabilitation clinic currently developing new remote services and by a company developing walking aids described the need for finding new application possibilities for their products. The process started by match-making these needs. To enable remote monitoring and motivating the rehabilitation client, ICT technology was identified as being the missing link. During the first discussions, existing sensor solutions and games were introduced to further define the needs of different stakeholders. The first version of the gamified walking aid was developed in collaboration with physiotherapy students and teachers (user proxies). This approach was taken since the stakeholder's requirements were not clearly understood, containing multiple components and clients, such as rehabilitation clients and therapists. Through user proxies, too early prototypes do not cause frustration in actual end-users, but the idea can be visualized, and the useful characteristics identified.

The main idea of the developed concept is to add a sensor to the Wheellator walking aid (Figure 4) to measure the walking distance, intensity and time. The sensor communicates with a motivation tablet application, which provides extra content as the walking aid is used. The goal is to keep the user motivated and to provide valuable data about the progress. The app is a virtual trip displayed in a tablet attached to the walking-aid. The user can insert the actual walking distance and locations into the application (for example from Pori to Helsinki; Figure 4). The app scales the virtual

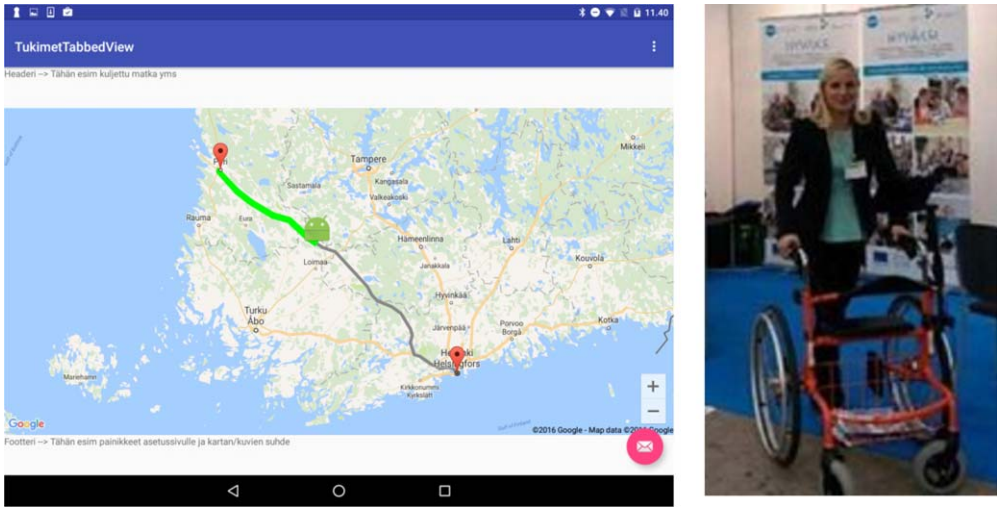

Figure 4: Screenshot of the map in the Wheeltravel app (left) and the Wheellator walking aid (right). [Colour figure can be viewed at wileyonlinelibrary.com]

trip to the actual walking distance. When the user starts to walk, the character starts the journey on the map to visualize the progress. After test findings, additional motivation elements were added, like Google street-view and uploaded photos on the location at the map.

The DfS approach was further applied by involving physiotherapy students and teachers as user proxies. The usability, suitability and further development issues were ideated from users' and rehabilitation professionals' point-of-view. In the future, the developed version can be used as technology demonstration in further identification and refining of user needs.

Results

Feedback on the orienteering game

Participants (N= 4) testing the orienteering game were all residents of a group home. . All residents were diagnosed with learning disabilities. The age varied between 34 and 60 years. Three ($n = 3$) of four were able to read; three ($n = 3$) were female. None ($n = 0$) of the residents possessed a phone, tablet or computer or was experienced in technology use. However, all ($n = 4$) were satisfied with the appearance and user logic of the application. Self-made elements in the game were giving positive experiences for the players. A photoof the care home's dog inspired the playersThe spoken instructions appeared useful. The results confirmed the game functions easy to use, the visualization appropriate, and the logic understandable. As to the difficulty levels in the game, some of the mini-game assignments appeared too difficult, despite all the simplification. Everybody enjoyed playing their own way even without understanding the content; game reacting to player's actions was enough to keep the player engaged.

A commonly rewarding result was to notice that everyone was able to use the app regardless of occasionally required instructions and encouragement to be repeated. Each resident ($n = 4$) was able to do other things with the tablet (play games, listen to music).

The right tapping style was a challenge with a tendence to push the tablet screen too hard and long. Introducing a touch screen pen resolved the situation. The residents' skills to use tablet computers surprised the staff. Encouraged by this trial, the home planned to purchase tablets for two of the residents. In fact, the use of the application was heavily dependent on the attitudes and interests of the staff. Researchers observed the social effects of the tested apps, providing the

residents and the staff with new common things to do and discuss. The location of the tablet was noticed to be an important factor affecting use. One-to-one tablet learning lessons with the residents were identified as a positive experience teaching about the resident's interests and skills.

The game was made easy to modify for different user groups. The content, difficulty level and location of the control points could be changed according to the user group. The next steps include testing the application with a larger test group and modification for other user groups. In this trial, the test group was kept intentionally small to perform a deeper analysis of the resident's likes and skills being one of the key ideas of the DfS approach.

Feedback on the activation games and special game controllers

The activation game was tested by 17 rehabilitation center clients. The test group ($N = 17$) was satisfied with the visual elements of the games. Only two ($n = 2$) commented that the games were a bit hard to learn, and one ($n = 1$) commented the game logic difficult to understand. Time limit divided the opinions in test group. As to the set time limit, seven participants ($n = 7$) saw it inspiring to play, while six (n = 6) had the opposite stance. Most of the participants ($n = 14$) expressed the game being suitable for rehabilitation purposes. All game controller types received mainly positive feedback. Five ($n = 5$) participants noted some momentary problems with the sensitivity of the controller sensor and the touch screen.

Added to game design, the games provided positive feelings and experiences. The feeling of success was especially seen by clients with major challenges in functioning. This is probably, because there are less applications available for these users. Despite different disabilities, all participants were able to play. The head controller was the most challenging controller requiring adjustments to find the correct position. . The breakout was more suitable for the head controller due to only two-dimensional controls. Projecting the game screen on the wall made the game easier to follow and the situation more social with others being able to watch, cheer and give instructions.

Some concrete advice to improve the game was also given. Further levels in the game were suggested and executed in the new version. In the additional levels, there are more adverseries, more complex mazes and collision with adversery kills the character. This new version is yet to be tested.

From the care personnels' point of view, the games and controllers were warmly welcomed addition to rehabilitation, enabling new experiences for the clients. They were mentioned easy to adjust for different user groups. One very important added value for the rehabilitation center was the social interaction the gaming event created. The games provided an excuse to be socially interactive, especially with new people. In case of severe physical impairments, the goal of the games drifted more towards providing new contents to everyday living rather than rehabilitation.

Feedback on the gamified walking aid

Due to the relatively early developmental phase of this concept, the suitability and user experience tests were targeted for user proxies: physiotherapy students ($N = 10$) and professionals (their teacher and working life partners, $N = 2$). In total, 90% of the students rated the application moderate or easy to use (3= 40%, 4 = 30% and 5 = 20%). Due to limited ability to use touch screen device, the usability must be further developed before testing with end-users. Some usability improvement suggestions mentioned were: more simple and bigger buttons and placement of the tablet stand which should be in front of the user so there is no need to bend head to see the progress. Also, cheering and guiding voice was mentioned to bring more motivation and make the use of the application more obvious. Both the visualization (3= 20%, 4 = 30% and 5 = 50%) and added audio (3= 10%, 4 = 50% and 5 = 40%) were considered important, taking into account that end-users may have different abilities and needs. The students and professionals

find recording and saving the data from the application very important. Totally, 100% (4= 30%, 5 = 70%) answered the saving to be important and useful.

In general, the students and professionals saw this kind of modern technology tool important to remote rehabilitation. The professionals and students were very interested in participating in the evaluation and development of the application. In total, 80% rated the application very suitable for remote rehabilitation (4 = 40%, 5 = 40%) and 100% for promoting physical activity (4= 30%, 5 = 70%). The application possibilities mentioned were therapist to see measured results and to have a chance to motivate, if the exercise is not performed according to plan. The application was also seen as a tool to generally motivate the clients to be physically active indoors (in hospitals or care homes). In addition to motivation, the application could be used to evaluate and measure the client's physical activity and functional capability. Another idea mentioned was to include a pedometer or pulsometer within the application.

The application could also be seen as a safety technology, if further features were added. Some additive features suggested were indoor and outdoor navigation and positioning, safety zone (memory impaired clients), a panic button, reminders and video phone call features. Entertainment features could be added, like game element (badges, scores and real-life prices), music, guided indoor tours at museums, information about places visited, etc. An interesting idea mentioned was the seasonal changes in the weather to be taken into account in street-view photos which could be a useful feature for memory-impaired users with limited chances to go out. A clock was mentioned to be a good addition. Before mentioned ideas result in further development involving different end-user groups to create a modular product. Only after testing with the end user, the most important issues and suitability can be evaluated. So far we can tell only that the DfS process produced various pathways to investigate further. The concept is further developed with three companies to make it a commercial product.

Discussion

This paper reported case studies applying the Design for Somebody (DfS) approach in mobile technology development for people with special needs. Even with a limited number of participants, the user feedback data confirmed the results in previous studies as being encouraging and undoubtedly indicated the usefulness of DfS principles. The DfS process is useful when considering special user groups. On the other hand, it is not cost effective, if the user group is very heterogenous as to predefined characteristics. High client involvement and deep analysis may not produce results that help the designer to develop significantly better game experience compared to the resources spent on the analysis. This paper concentrated on special user groups and presented three very different case studies in which the DfS principles were used.

The DfS process contains steps analogous to those in any product development project: (1) emphatizing and understanding user needs, context and existing solutions, (2) ideating, defining and designing possible solutions (requirements analysis), (3) prototyping and testing, and (4) release and "after sales"/maintenance. As in all iterative processes, these phases repeated many times. Due to the impaired perception and sensation skills in the target groups, the game design paid particular attention to accessibility principles, like use of large target button elements, simplified and only necessary graphics, minimal amount of animation, colors used conservatively with high contrast, simple one-view display, and placing important information in the middle of the screen. (Díaz-Bossini & Moreno, 2014.) The games were designed to use obvious logics without additional need for introductions how to play (Sirkka *et al.*, 2014).

Client involvement and user-orientation are the most obvious cornerstones of the design approach. In DfS, significant work load is allocated to understanding the user's characteristics, desires and demands. It is also crucial to identify secondary user groups such as care professionals or

organizations. The developed game should serve all user groups, and in some cases there is a need for user group-based interfaces.

DfS can also be applied by taking user proxies into the development process, especially, if the application under development is rather complex and has multiple user groups with different needs. It is typical that the development process is started in collaboration with the secondary user group such as care professionals, who identifies potential needs and problems of their clients. However, it is important to involve the users as active parties throughout the entire process. Serious games require multidisciplinary knowledge (games development, technology, beneficiaries, user characteristics, etc.). While identifying user needs, technology knowledge transfer is extremely important. *Early prototypes* enhance the ideation phase. Interestingly enough, even a clumsy illustration or scketch on paper ignites further ideation towards redefining the product.

The games should be designed in a *modular* fashion from the beginning. Due to the user's highly specific needs, the design should be easily pesonalised. In game design, proper investigation on modifiable parts of the game should be committed. Some examples: customizable graphics (i.e. size or color of the objects, appearance/theme), intensity (i.e. speed of the game elements), control method (external sensors and special controllers), additional features (spoken instructions, repetition of instructions, visual and sound effects helping perception) were discussed. The usability, in the context of special user groups, includes *accessibility*. In the future, the researchers will make user profile-option in the games; the individual settings could be adjusted and stored according to the user. In addition to well-executed game design, the games can be made more accessible with the help of additional services. Service designing may be useful in implementation of serious games in care organizations. Service design and generic user-centered design frame is futher discussed in Sirkka *et al.* (2017).

The player-driven game logic may differ from that of the game designer. This should be factored into consideration by designing games which create *immediate responses* to actions by the player. The responses may be enough to engage the player continue and not immediately "kill" enthusiasm with rigid game logics. Although competitiveness and obtaining high scores are typically a source of motivation, with heterogenous user groups the competition could be focused on competing with oneself. Another option is the calibration of game difficulty and point collection according to the user abilities.

Experimental and iterative development is crucial with special user groups whose skills often surprise the care personnel. Developers should have somewhat complete prototypes to avoid frustrating the users, however, testing should occur early enough to allow changes and modification. As previously mentioned, user proxies are useful in the beginning, if the need is not clearly understood, to get an educated guess where to begin. The test groups can be individuals or small groups at the beginning, to facilitate deep-analysis of the needs and skills. The tests should also be organized for all user groups (i.e. clients and care professionals). Figure 5 describes the DfS process. After the small test group indicates positive experiences, quantitative mass tests (test phase 3, Figure 5) should follow (our future work).

Conclusions

This paper described DfS production approach and three serious games developed accordingly. DfS especially targets to user-centred and individualized product and service development. In most of the cases, the primary users' abilities to identify or describe their needs and wishes are limited due to their disabilities, which is why secondary users (professional carers or family members) have been actively involved, too. Challenging is to balance between secondary and primary users attitudes and real capabilities. User experiencesin discussed cases were encouraging though.

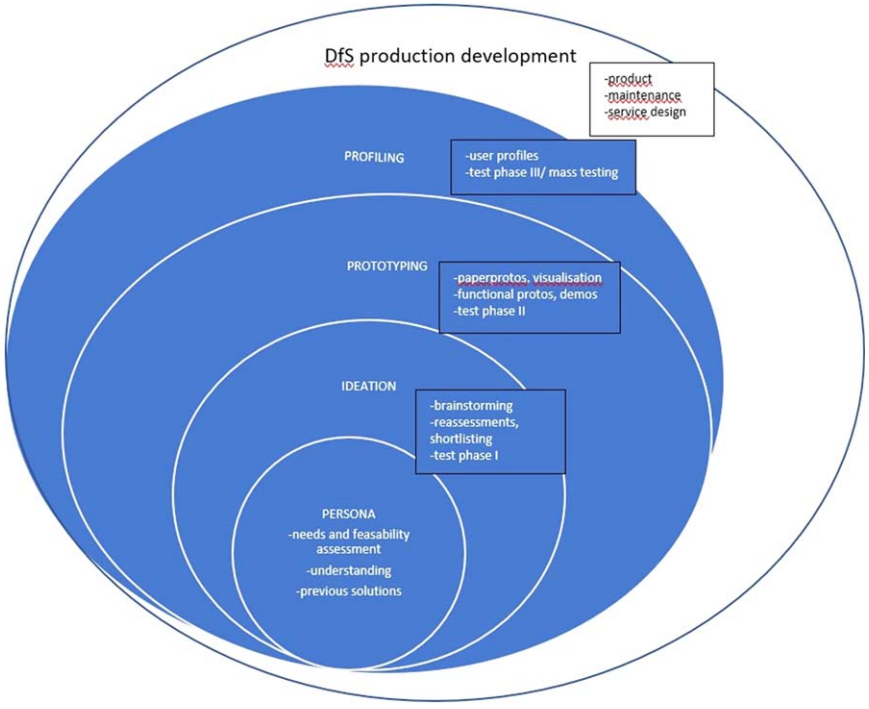

Figure 5: DfS development process. [Colour figure can be viewed at wileyonlinelibrary.com]

Compared to other production approaches, the overall modular thinking is one of the key benefits enabling unceasing product customization and update according to the user's condition. The implementation of user-centered serious games in care organizations typically requires changes to existing practices. Service designing is a potential tool in this.

Statements on open data, ethics and conflicts of interest

The data used in research are not publicly available, due to the small amount of participants, to which the participants identity could be revealed. However, the anonymized data can be received from the corresponding author for research purposes, if justified argument can be presented.

Sensitive user groups were participating in Case Studies 1 and 2. Case Study 3 did not include such users. The study's goal was to investigate the suitability of the DfS development approach rather than the performance of the participants. This is why ethical committee approval was not applied in this state. Ethical committee approval will be applied when proceeding to analysis of the effect of the developed solutions on end-users. All participants were volunteers. The researchers knew the identity of the participants during the research, due to the research method (thematic interview, small number of participants), but all data have been anonymized before publication of results. All participants signed an agreement in which the research and its purposes was described. Also individuals not able to read were able to sign the agreement which was read to the person with the care personnel present. The results are archived anonymously in the researcher's hard drive. Access requires identification of the researcher. This way the self-determination, anonymity and other questions considering research ethics have been taken into account.

The authors state there is no conflict of interest in the work reported in the article.

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