

Designing Serious Games for Adult Students with Cognitive Disabilities

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Abstract. Digital games have a great potential to improve education of people with cognitive disabilities. However, this target audience has attracted little attention from industry and academia, compared to other segments of the population. As a consequence, there is little knowledge available about how to design games that are usable and enjoyable by people with cognitive disabilities. In this paper we discuss how the eAdventure game platform can support their special needs. This tool has been used to develop two games to improve professional education of people with cognitive disabilities. Lessons learnt from these experiences are presented to serve as a first step to support further research in this field.

Keywords: accessibility, digital games, eAdventure, education, e-Learning, Game-Based Learning, social inclusion.

1 Introduction

The educational potential of digital games is rapidly being accepted within the academic community, as more experimental research that proves the effectiveness of this paradigm has become available recently. This body of research validate, at least partially, the hypothesis of academics who discussed unique characteristics of games that make them interesting for education [1].

Some of these features could be especially advantageous for students with cognitive disabilities. For example, digital games provide a virtual world that can be used as a safe test environment that students can freely explore, at their own pace, trying out hypothesis and receiving immediate feedback. Students get immersed in this virtual world, where they can rehearse and improve their abilities and knowledge but without taking any risk. In addition, digital games are able to capture students' attention more effectively than other contents, keeping them in the zone of optimal flow for knowledge creation. This characteristic may be especially beneficial for students with intellectual disabilities, as they usually suffer from attention deficit, which is a significant drawback for learning.

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Despite this potential, there are few games directed to people with cognitive disabilities [2, 3]. This deficiency is motivated by multiple causes, but one of the most important is that designing serious games for people with cognitive disabilities is an extraordinary challenge. Making games is always a complex activity requiring wide doses of creativity and highly specialized technical skills. Cognitive disabilities are complex and heterogeneous, difficult to categorize and model, requiring an individualized approach in many cases. Therefore, when the game design must also cope with these special needs the difficulty of the task increases, involving an additional development cost.

Specialized authoring tools can facilitate game development for this target population. High level tools like Unity or Game Maker facilitate the creation of games by providing code abstraction, automation of frequent tasks, built-in modules and game parts that are ready to use. However, it is necessary that these tools accommodate the special needs of people with disabilities to be really effective. But for this to be feasible, it is necessary to understand what are the requirements of this understudied population for interacting with games.

In this paper we discuss how the eAdventure game authoring tool can be used to create games for people with cognitive disabilities. We present two case studies of developing games to educate adults with cognitive disabilities: "My first day at work" and "The big party". The goal in both games is to improve their education as means to increase their opportunities for employment. Finally we discuss lessons learnt for designing games for this target population.

2 Digital Games for People With Cognitive Disabilities

Despite the ever-growing expansion of digital games, the collective of people with cognitive disabilities has not attracted too much attention yet. As recent literature reviews on accessibility in games reveal, there are few games available that cater for the needs of people with cognitive disabilities [2, 3]. Still, some interesting examples can be found, like Ilbo [4], where players navigate through a 3D maze by using their weight while sitting on a chair. Other games are oriented to facilitate collaboration among peers and improve social and communication skills [5], although in some cases the presence of game elements is limited to a 3D virtual world [6].

Most of the limited research reported on games for cognitive disabilities is concentrated on rehabilitation and therapy, usually combined with virtual reality techniques. For example, in [7] virtual reality games developed for the Nintendo™ Wii® are used to improve motor and cognitive skills of children with a diagnosis of Down Syndrome. Despite of research done, this field is also considered to be in its infancy, lacking of proper understanding of what causes the effectiveness of computer and virtual reality games for rehabilitation [8].

Some studies have addressed the potential of digital games to improve education of people with cognitive disabilities. For instance, in [9] computer games are used to teach safety knowledge to children with cognitive disabilities. This study also demonstrates that knowledge constructed in the virtual world can be transferred to persistent

skills in the real world. In [10], a puzzle game for training children with autism is described. A relevant study for the topic of this paper is the GOET project, whereby several games were developed to educate students with cognitive disabilities to improve their chances for employment [11].

Generally speaking, research on serious games for people with cognitive disabilities is still in its infancy, compared to other types of disabilities. It is necessary to conduct a deeper analysis of how game design can be tuned to cater for the special needs of this audience.

3 Point and click adventure games. eAdventure.

Choosing a right type of game is important to minimize the number of accessibility barriers that must be dealt with. *Point-and-click* adventure games is a genre where many of the most frequent accessibility issues are not present. Besides, this genre has been signaled by academics for having significant educational potential. It is a genre where reflection predominates over action. In fact, time pressure is rarely used to get players engaged. Other elements are used instead, as an appealing story or puzzles that players must solve by applying reasoning and problem solving skills. As a consequence, these games are usually low-paced, which is a desirable characteristic for people with cognitive disabilities [13]. Besides, *point-and-click* interaction is usually simple, requiring a minimum amount of input as controls are mouse clicks that could also be replaced by one-switch devices [3].

eAdventure is a game authoring tool especially devised for educational applications [12]. It is oriented to teachers as end users, providing a simple interface and educational features such as a tracking and assessment system. eAdventure supports the development of games accessible for people with cognitive disabilities in several ways. First, eAdventure is focused on *point-and-click* adventure games. Second, eAdventure includes an adaptation engine that adds personalization and flexibility to the game experience. This system can be used to adapt content and puzzles, reducing complexity and the number of objects as needed [14]. Besides, experimental development to improve the accessibility of the platform has been conducted.

4 My First Day at Work

The educational game "My first day at work" aims to facilitate the incorporation of a worker with a cognitive disability to a new company. The game assumes the player has already got his/her first job, and it covers competences and skills needed for daily work and achieve a successful integration into the team:

- Usage of standard equipment and materials used in the office: computer, printer, fax and a copy printer.
- Fundamentals of the e-mail system used in the company: how to access incoming messages, how to compose and send new messages, download files and use attachments.

Besides, the game covers transversal competencies that people with cognitive disabilities have problems to develop frequently:

- Basic social interaction skills, such as how to address colleagues with respect, ask for help when needed, etc.
- Structure of the company and the physical distribution of its headquarters.

The game has the form of an adventure quest where the player must complete different tasks that are assigned by the company's management board. To complete these tasks he/she must interact with different objects and characters.

Additionally, the game "My first day at work" includes accessibility features oriented to overcome potential barriers for students with a visual disability or limited mobility in hands. Therefore the game can be played using the mouse, the keyboard or speech commands, and the return of information is produced either visually or by audio. The game also includes a high contrast mode for people with limited vision. This visualization mode applies an alternative rendering mode to backgrounds and interactive elements, with the purpose of increasing the contrast of such a highly graphical application.

The game was developed in collaboration with Technosite, a company that belongs to the ONCE group (Spanish National Organization for the Blind). Experts in game accessibility, therapists and social workers were involved in the development of the game. A usability evaluation was performed with 15 users that were exposed to the game for one hour. Participants with the slightest disabilities were able to complete the game without further guidance or intervention from researchers. However, participants with severe disabilities had problems to remember short-term goals, which suggested the need for a "task list" feature that could be accessed at all times. Participants showed interest in the game and considered it a good asset to improve their education.



Fig. 1. Screenshots of the game "My first day at work".

5 The Big Party

The game "The Big Party" was designed to train a specific set of social and self autonomy skills and concepts in adults with a cognitive disability.

The topic of the game is to attend a social dinner organized by the company the player works for. The game covers a wide range of issues, from personal hygiene and choosing appropriate clothes for the occasion to addressing other colleagues.

When the game starts, the player chooses his/her gender on the game. This choice will be used by the game to adapt configuration of the resources, clothes, and hygiene habits displayed. The game covers the next specific competences:

- Personal hygiene: processes related to hygiene including showering, brushing teeth, applying cologne and deodorant, combing one's hair, etc. Tasks related to personal care must be executed in a specific right order (for example, cologne should not be applied before taking a shower).
- Preparation before leaving home: adequate dressing for the event.
- Take public transport to reach the event and dealing with unexpected issues (e.g. request help from underground's staff).
- Use of common resources and items in public places and transport vehicles (ticket vendor machines, control points, automatic elevator, etc.).
- Correct use of language in formal occasions.
- Basic rules of behaviour in public places, including interaction with peers, like give greetings, say good bye, bringing up conversation topics that may be of interest for other people or resolution of conflicts (e.g. stepping a colleague by accident). Aspects related to self control and moderate eating and drinking are also considered.

The game is linear, with a specific number of tasks to be completed in a specific order. Thus, completing the game implies succeeding in all game tasks. For that purpose, the player is provided with convenient feedback when he/she fails to complete a task. The player is allowed as many retries as needed.

The game has been developed in collaboration with the Prodis foundation, whose mission is to prepare adult students with cognitive disabilities for professional development. The game has been evaluated in two Living Labs with teachers of special education and also with students with Down Syndrome. The purpose of this evaluation was to identify potential improvements or modifications for enhancing its usability and guarantee usefulness for this particular educational context.



Fig. 2. Pictures of evaluation sessions during development of "The Big Party" (living lab with educators on the left, usability evaluation with students on the right).

6 Lessons Learnt from the Case Studies

Having a flexible and highly configurable game experience was very important in these cases. This is also a requisite identified by previous work in this field [11]. The one-size-fits-all principle does not usually fit games, where players have different motivations and even play styles. In special education this requisite is even more important, as each user is unique and requires personalized attention. In this sense digital games are more suitable than other kind of contents as digital games are flexible and easy to configure.

A good example is the high contrast mode developed for the game "My First Day at Work". Although this mode was developed in collaboration with people that normally use high contrast settings to interact with technology, not all people that participated in the evaluation felt comfortable with the interface. Through the feedback participants provided, researchers noticed that each user had a particular way to interact with the computer. In the case of "The Big Party", diverse aspects were added a posteriori to facilitate understanding and use by people with intellectual disabilities, like allowing multiple retries to complete a task, indication of possible solutions after a failure or mistake, etc. In this manner students could play the games and learn at their own pace.

Another problem found was that many people with intellectual disabilities have difficulties to identify themselves in the games [11]. Finding a solution to this problem is essential or many students would not be able to play as they would not understand what is going on in the game. In this sense, the ideal solution would be to use students' own image to set up a virtual avatar, but from a technical perspective this is quite complex to implement. In the case of "My First Day at Work", the workaround was to provide the player with a finite set of avatars with varied abilities and characteristics to choose from. Hence players could choose the avatar that was more close to their own characteristics and abilities. In "The big party" game students experienced the game in first person, limiting their choices to a simple selection of gender. The preliminary evaluation proved that any improvement in this aspect would be beneficial for the overall usability of the game.

Broadly speaking, design guidelines followed in the development of both games can be repurposed and applied to effectively develop other games for students with intellectual disability. For example, language style should be simple, clear and direct. It is also highly desirable to provide information using multiple modalities (e.g. complementing visual feedback with descriptive sounds, using subtitles but also speech recorded by actors. This feature will also make the games more accessible for students with other disabilities. It is important to gauge game's pace to ensure that players have enough time to read all dialogues, analyze all information provided by the game and take decisions according to options available. The eAdventure platform that was used to develop the games provided ready-to-use solutions that facilitated dealing with this issue (e.g. management of timing, progress in dialogs and interactions).

Reaching the highest level of realism possible is also a recommended practice. This facilitates the acquisition of new knowledge and abilities by students with abstract reasoning deficiencies. For this reason both "My First Day at Work" and "The

"Big Party" have been developed combining photos and videos from real environments with cartoon-like designs. This also helps to limit the number of graphic assets required, which reduces the production cost.

Both games were developed following a user-centered methodology, using living labs to identify potential barriers. This methodology allowed for a rapid detection of poor design strategies and supported an agile requirements capture process, which facilitated development and reduced the overall cost. This aspect was crucial for success as how this target population interacts with games is rather unknown and therefore it cannot be anticipated.

These case studies were useful to identify potential improvements in the eAdventure authoring tool. For example, people with Down Syndrome are slower at executing goal-directed tasks/activities compared to typically developing peers. Games usually set out a number of primary goals to entice the player that have to be completed in the long term (e.g. defeat the master boss of a level or unlock all possible levels) and are not prone to change frequently. These are complemented with secondary goals, whose completion is required to progress in the game and achieve the primary goals (e.g. unlock a certain weapon to beat the master boss). Secondary goals are set out frequently, and are used to keep the player challenged and engaged at all times. This structure of primary and secondary goals was also present in both case studies, and resulted to be too complex for some users with Down Syndrome as they were unable to remember short-term goals and had problems to distinguish between primary and secondary goals. This problem could be addressed by developing configurable tasks lists in eAdventure that could be accessed by the player at all times.

7 Conclusions and Future Work

The field of digital games has reached a considerable status of maturity and stability, both in its recreational and serious forms. However, there are areas that have not been thoroughly explored yet. This is the case of games for people with cognitive disabilities. The design of games for this audience is a challenge as classic solutions may not be applicable, given the diversity of this understudied target group that brings together multiple disability profiles with heterogeneous needs. Besides, the potential of games to improve the lives of people with cognitive disabilities remains almost unexplored. Research on digital games should address both issues systematically in the next years.

In this paper we have discussed how the eAdventure game authoring tool can support the needs of students with cognitive disabilities. We have presented the main lessons learnt from designing and developing two games for this purpose with eAdventure, in the aim that they may be useful for other serious games developers. However, this is just a first step. The guidelines discussed in this paper are still general and superficial, based on two examples. It is necessary to carry out a deep analysis of the successful strategies found in these games and others in the literature to produce more concrete guidelines that could be applied in the development of new games but also to improve eAdventure and other game authoring platforms.

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References

1. Gee, J.P.: What video games have to teach us about learning and literacy. Palgrave Macmillan, New York ; Basingstoke (2003).
2. Westin, T., Bierre, K., Gramenos, D., Hinn, M.: Advances in Game Accessibility from 2005 to 2010. Universal Access in HCI, Part II, HCII 2011. LNCS 6766, 400-409 (2011).
3. Yuan, B., Folmer, E., Harris, F.C.: Game accessibility: a survey. Universal Access in the Information Society. 10, 81-100 (2011).
4. Kwekkeboom, B., Ilse van Well: Ilbo, <http://www.game-accessibility.com/index.php?pagefile=ilbo>.
5. Ohring, P.: Web-based multi-player games to encourage flexibility and social interaction in high-functioning children with autism spectrum disorder. Proceedings of the 7th international conference on Interaction design and children. pp. 171-172. ACM, New York, NY, USA (2008).
6. Gaggioli, A., Gorini, A., Riva, G.: Prospects for the Use of Multiplayer Online Games in Psychological Rehabilitation. Virtual Rehabilitation, 2007. pp. 131-137 (2007).
7. Wuang, Y.-P., Chiang, C.-S., Su, C.-Y., Wang, C.-C.: Effectiveness of virtual reality using Wii gaming technology in children with Down syndrome. Research in developmental disabilities. 32, 312-21 (2011).
8. Levac, D., Rivard, L., Missiuna, C.: Defining the active ingredients of interactive computer play interventions for children with neuromotor impairments: a scoping review. Research in developmental disabilities. 33, 214-23 (2012).
9. Coles, C.D., Strickland, D.C., Padgett, L., Bellmoff, L.: Games that "work": using computer games to teach alcohol-affected children about fire and street safety. Research in developmental disabilities. 28, 518-30 (2007).
10. Sehaba, K., Estrailier, P., Lambert, D.: Interactive Educational Games for Autistic Children with Agent-Based System. LNCS. 3711, 422-432 (2005).
11. Lanyi, C.S., Brown, D.J.: Design of Serious Games for Students with Intellectual Disability. In: Joshi, A. and Dearden, A. (eds.) IHCI'10 Proceedings of the 2010 international conference on Interaction Design & International Development. pp. 44-54. British Computer Society Swinton, UK (2010).
12. Torrente, J., Del Blanco, Á., Marchiori, E.J., Moreno-Ger, P., Fernández-Manjón, B.: <e-Adventure>: Introducing Educational Games in the Learning Process. IEEE Education Engineering (EDUCON) 2010 Conference. pp. 1121-1126. IEEE, Madrid, Spain (2010).
13. IGDA: Accessibility in Games: Motivations and Approaches. (2004).
14. Torrente, J., Del Blanco, Á., Moreno-Ger, P., Martínez-Ortiz, I., Fernández-Manjón, B.: Implementing Accessibility in Educational Videogames with <e-Adventure>, (2009).