



Creation and Future Development Process of a Serious Game: Raising Awareness of (Visual) Impairments

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Abstract. Despite the UN Convention on the Rights of Persons with Disabilities and binding laws, digital accessibility is not yet a norm at universities. Therefore (digital) accessibility must be taken into account and be comprehensible to create a university accessible for everyone. Innovative learning methods such as using Serious Games seem suitable for this. A well-designed game narrative can engage and simultaneously lead to proactive thoughts for educators. Moreover, a Serious Game holds the potential to raise awareness among players of the problems students and staff with impairments face at university. The content of our Serious Game “Lola’s first semester” showcases initial possibilities for proactive action and raises an identity-creating reference with examples from their own university. For the conception and implementation, the design-based research approach was chosen. This paper presents the results of a first evaluation study of the Serious Game regarding the story, the integrated mini-games and the implementation. Furthermore, it shows how the game is suitable for the described purpose and how it was received. The importance of a well-paced narrative combined with modern visuals and freely available assets are also covered in this paper. Additionally, it is discussed how the next iteration of the development could reach a wider audience. Another goal will be an integration of other impairments, like hearing impairment and mental health issues.

Keywords: Inclusion · Serious game · Accessible educational technologies · Design-based research · Digital accessibility · Gamification · Impairment

1 A Serious Game for Raising Awareness of Impairments



Fig. 1. Lola's first day at Goethe University Frankfurt

Accessibility is a legal requirement¹ and a necessity, which can be taught in a playful manner. Serious Games can be a medium to simplify complex learning areas. Especially in university contexts, it can be an effective and sustainable self-learning method as well as a suitable, innovative

and informative tool of raising awareness. In 2020, we developed a Serious Game named “Lola's first semester”² with the aim of raising awareness for the problems of impaired students at universities. The target group are university members who produce digital content. By playing the game, an awareness of the problems should be created and possibilities to reduce digital barriers should be manifested. Digital accessibility needs to be implemented repeatedly to remain in memory and to maintain a learning anchorage. Ideally, the special requirements of impaired persons should be considered from the beginning when, e.g., designing courses, building plans or purchasing systems, so that no barriers do not occur at all. Using a game setting for that process can be the key to learning motivation. In the game, Lola is a first semester student to convey the feeling of being a freshman, including all its challenges, but also the support you expect as a student. This brings a narrative advantage. The game design follows the strategies of Dörner et. al (“Serious Games: Foundations, Concepts and Practice”) [1]. Within the frame story, there is a clear campus map and five integrated mini-games. Each mini-game looks at a different barrier faced by people with a visual impairment and has a different learning objective: During the “Lecture” game the players need to practice buy-sell decisions signaled by red and green arrows during a stock market simulation. “Online seminar” shows problems in video conferences that the player has to remove by fighting symbolic opponents. “Examinations Office” deals with inaccessible PDFs, which the player has to revise with different tools. “Validator” shows the problem that many machines (e.g., library systems, computer stations or printer) of universities are not barrier-free. The field of view during the game is limited by black borders and pixilation. This mini-game is deliberately difficult to simulate an everyday hurdle of a visually impaired person. “Cafeteria” illustrates the hurdle of time-bound content using the menus in the canteen, involving three different meals displayed, only one is without allergens. Based on the information on the slideshow the correct dishes have to be chosen. In the Serious Game “Lola's first semester”, knowledge is conveyed in a

¹ Commission Delegated Regulation (EU) 2016/2021 for websites: http://data.europa.eu/eli/reg_del/2016/2021/oj.

² Serious Game: <https://lolaserstessemester.sd.uni-frankfurt.de/> (In German).

playful way with tasks and further related information. The game concept is designed in a way that can be easily transferred to other types of impairments such as depression, hearing impairments or physical-chronic and psychological-physical impairments. The implementation was carried out with the aim of offering a low-threshold entry so that the players can quickly find their way in and use the game intuitively. The insights gained through the evaluation phase of the Design Thinking process will be incorporated in the revision of the story, the mini-games and the characters. In the first development cycle of the Serious Game, the focus was on the overall game, the acceptance and the experience of visual impairments. The next development cycle will focus even more on User Experience. To make profound and generally valid statements about user behaviour in the further research process, methods from the field of learning analytics can be used. This data can both support the research process and influence the players' gaming behaviour through feedback to users (Fig. 1).

2 Technical Implementation and the Design Thinking Process

The development of the Serious Game “Lola’s first semester” followed the process of Design Thinking [2]. The first two phases of empathizing and defining were conducted using data gathered through an online survey in 2019³. The survey’s aim was to collect data on the current situation of digital accessibility in higher education. Using said data, we were able to pinpoint specific barriers and define challenges. During the phase of ideation, we further generated ideas in weekly team meetups and a Hessian networking meeting. Following, a prototype was implemented and afterwards tested. Using the outcome of the evaluation, we are now in the phase of (re-)defining. We started by scouting for a software, which is easy and free to use. By looking into authoring systems at first, we soon discovered their restrictive nature of pre-implemented features, which would limit the scope of the game [3]. After reviewing the advantages and disadvantages for the technical implementation of various game engines, the decision fell on the open source Godot Engine V.3.2.2 because of its widely supported HTML5 exporting capabilities. The dialogues between Lola and her fellow students were implemented with a combination of the Dialogic⁴ add-on, Excel, JSON and Python. The development of the individual characters was done in-house, with the aim of representing a great diversity. Moreover, Audio, which also plays an important role for a better game experience, was taken into account. The whole game is designed to be played only with a mouse accompanied by a narrative conveyed via readable dialogues and distinctive set of characters.

3 Evaluation of the Game and the Integrated Mini-games

After completing the first development cycle, an online survey was conducted. On the one hand, the aim was to evaluate the overall game and the five mini-games in the context of game experience. On the other hand, the goal was to obtain feedback on the

³ http://innobar.studiumdigitale.uni-frankfurt.de/Umfrageergebnisse/Digitale_Barrierefreiheit_an_hessischen_Hochschulen.pdf (in German).

⁴ Dialogic: <https://github.com/coppolaemilio/dialogic>.

concept as well as the current implementation. The feedback results should also provide an answer to the research questions of whether the format of a Serious Game is suitable for creating awareness for the given topic. The Game Experience Questionnaire (GEQ) [4] of the FUGA project (The Fun of Gaming) [5] was used as an instrument and was integrated at the end of the game. The GEQ is characterized by reliability, validity and sensitivity, which are crucial for good measurement. A total of 36 people (13 male, 23 female, 0 diverse) participated in the study with following age groups: 17% under 25, 54% between 25–34, 26% between 35–44, none between 45–54 and 3% above 55. Of the total 36 participants, 25 described themselves as gamers and 11 as non-gamers. There were participants from various lines of work such as educators, tutors, students as well as people working in administration from a network of 11 different universities. Closed questions in the form of a 5-point Likert scale (strongly disagree to strongly agree) were asked in the GEQ. Those statements were assigned to the seven dimensions of Competence, Immersion, Flow, Tension, Challenge, Positive and Negative Effects [3]. The GEQ is followed by an open question at the end of the questionnaire with the possibility to express additional wishes, ideas and criticism. The evaluation followed the Mayring's procedure [6]. The most frequently mentioned statements ($n = 7$) were that the challenge is well communicated, that the game draws attention to existing challenges and that it is a good game ($n = 6$). Combined with the result of the best-rated surveyed statements (mean value of over 3 ($>=$)), the format of the Serious Game appears to be suitable for raising awareness for the topic of accessibility. Participants of various workshops and working groups also confirmed the sensitising effect when playing the game. Negative effects, such as "It put me in a bad mood" and "I felt angry", were hardly mentioned. Both items were rather disagreed with ($MW = 1.9$). Otherwise, the many pieces of content-related and technical feedback on the game can be incorporated in the next development cycle.

4 Improvements and Further Development

An online survey during the testing phase of the Design Thinking process gave an insight on how the players felt about each aspect of the game. This direct feedback is helpful in improving the game in a phase of (re)defining. Besides overhauling the technical side, another core focus will be to tackle the narrative side. One of the key elements during the development process was to make sure of the technical availability of the game regardless of the available hardware. Although the choice to put the game on the server takes away the steps of downloading a setup file and installation, it still caches (aka downloads) the game first when someone visits the website. Almost every reported technical issue can be traced back to users having slow internet connections and/or hardware with low specifications. The Pixel Streaming technology provided by Unreal Engine (UE4) resolves that problem by making it streamable via server. Playing the game will be like streaming a YouTube video from the user perspective but with the added benefit of controlling the interactive content shown. Moreover, making the game available via a cloud service with an added graphics card can lower the setup cost and time. The results from the GEQ show that the players were distracted and only moderately concentrated. They were not immersed enough to lose track of time or connection to

the outside world. Despite having a positive experience, they still felt moderately bored by the game. An introductory onboarding plan could prepare them for the challenging parts. To increase the pressure and challenge, the players need to get in the flow by challenges that are neither too easy nor too hard [7]. By creating metrics, we can easily specify the distracting issues and tackle them. Known distractions are inconsistencies like different designs for the same character. The controls have to be balanced through fine-tuning because of the large impact they have on the game feel [8]. An iterative loop consisting of observation, idea-generation, prototyping and testing can help us embrace the failures [9]. Furthermore, a built-in game analytics functionality could give us insights about player behaviour and help us eliminate more issues. A better User Experience can be achieved by a well-structured head-up display (HUD) and can help players to constantly know which buttons to press when a certain action needs to be done. By using Design Thinking, the capabilities of the audience can be considered and the levels and gameplay can be designed accordingly. Combined with the Gestalt principles in UX [10], the players are faced with an easily comprehensible environment, making the game more accessible. Although the concept was well received, the “Examinations Office” mini-game still faced some criticism regarding gameplay and the presentation of the tutorial. Demanding the players to read a so-perceived overload of instructions before playing the game required more attentional resources. Therefore, more distraction will have a disruptive effect leading to irritation [11]. A good narrative design will bind together the technical and gameplay improvements which will further enhance the User Experience. As the evaluation shows moderately happy players, we want to continue with the structure of our game. A more coherent storyline with an emotional attachment could evoke more empathy. This kind of involvement can create a platform for inducing implicit learning, which, according to some researchers, is more robust than explicit learning mainly because it seems to last longer [12]. Due to its uncomplicated licensing structure, using an industry standard tool like UE4 opens many possibilities. Implementing free to use and highly detailed 3D models and characters can add a modern look to the game in which the players would be embodying and emotionally connecting with the characters. All these processes combined should help to create a lived-in world designed for intrinsic as well extrinsic learning. We started with a focus on visual impairments, but regarding future versions of the game, other impairments are also taken into account. According to the best2 survey⁵, studying is made more difficult due to physical or health impairments for 11% of German students. This group includes students with mobility, hearing and speech impairments; mental illnesses; chronic illnesses; dyslexia and other partial performance disorders; autism and AD(H)S. Furthermore, according to the (US) National Center for education statistics, 12% postbaccalaureate students or 19% undergraduate students reported to have a disability.⁶ Whether individual impairments, illnesses or other challenges are suitable for a Serious Game like “Lola’s first semester” is part of our future research.

⁵ best2: 21st Social Survey of the German Student Union (DSW), 2016: <https://www.studentenwerke.de/de/content/studieren-mit-behinderung-%E2%80%93-geh%C3%B6re-ich-dazu>.

⁶ National Center for education statistics: <https://nces.ed.gov/fastfacts/display.asp?id=60> 16.05.2021.

5 Conclusion and Future Work

Using Serious Games has helped strengthen the process of inclusion and sensitization. Our lessons learned will be used to construct the next iteration of the game with an expanded target group including the older generation, improved User Experience and a better narrative design whilst upholding the current game structure. A cloud-based deployment could benefit eliminating technical issues and barriers, which will help us elevate our intended goals. A self-evident choice would be to lay the focus on hearing impairments, as the mini-game “Online Seminar” already deals with linked barriers. Another option is to shift the focus on depression, as it is the most common impairment. We have the vision that the concept and implementation of the game could easily be transferred to other contexts at university like orientation events or tutor training. A modular framework and a predefined workflow are required for this, so that elements can be exchanged. A standardized workflow with templates for creating the story and a selection of avatars will help teachers to create a similar Serious Game. The conceptual templates and pre-implemented set of visual elements (e.g., avatars) will be cost and time saving. Furthermore, the described structure will open the game concept of “Lola’s first semester” to a wide group of stakeholders. Though this is an ambitious goal, it holds the potential to shift teaching methods at universities into a more gamified learning environment. To underline the need of gamification in teaching and its advantages, future work will deal with the benefit of Serious Games in education.

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