IT Development Experience for VR Game Design. Would you have Thought of it?

Cecilia Sik-Lanyi[1] [0000-0003-3142-6824]

[1] University of Pannonia, Department of Electrical Engineering and Information Systems, Hungary

Abstract. In this book chapter, some interesting development experiences in the context of VR game design are presented. Things that we could have known with common sense, but can really only be learned through practice. Things that developers would not even think about until they encountered it. It is also presented because computer science engineers become really good game developers if they gain experience in practice when designing for users with different needs. The complexity is further increased if special attention must also be paid to the possible disability of the future user. Therefore, particularly interesting development experiences are presented in this chapter. Technical knowledge is not enough, it is also necessary to know the future user and user environment!

IT-Entwicklungserfahrung für die Entwicklung von VR-Spielen. Hätten Sie daran gedacht?

Zusammenfassung. In diesem Kapitel werden einige interessante Entwicklungserfahrungen im Zusammenhang mit dem Design von VR-Spielen vorgestellt. Dinge, die wir mit gesundem Menschenverstand hätten wissen können, die aber wirklich nur durch die Praxis gelernt werden können. Dinge, über die Entwickler*innen nicht einmal nachdenken würden, bis sie damit konfrontiert werden. Sie werden auch deshalb vorgestellt, weil Informatik-Ingenieur*innen zu wirklich guten Spieleentwickler*innen werden, wenn sie in der Praxis Erfahrungen mit der Gestaltung für Nutzer*innen mit unterschiedlichen Bedürfnissen sammeln. Die Komplexität wird weiter erhöht, wenn auch auf die mögliche Beeinträchtigungen der zukünftigen Nutzer*innen geachtet werden muss. Deshalb werden in diesem Kapitel besonders interessante Entwicklungserfahrungen vorgestellt. Technisches Wissen reicht nicht aus, man muss auch den zukünftigen Benutzer*innen und die Benutzerumgebung kennen!

1 Introduction

The improvement of computer science, information technology, and the available computing capacity opened the doors for more realistic visual images. As a consequence of this development, new disciplines were born, e.g., computer graphics and virtual reality. The question of color-fidelity display is an interesting part of this process. At the same time, these new research fields must also pay attention to users' demands. If the demographic changes are considered, the number of elderly people is increasing, and they have special needs. Moreover, if the principles of 'Desing for All' are also taken into consideration, then it reflects that demographic changes and 'Design for All' are clear proof that accessible design is necessary.
Referring to the rapid changes in technology, recently, several new hardware and software have been initiated, e.g. Virtual Reality (VR) and Virtual Environments (VE), which have become popular in almost every field in real life.
VE: a synthetic, spatial (usually 3D) world seen from a first-person perspective with real-time control of the user. In some literature, VR and Virtual World are more or less synonymous with VE (Bowman et al. 2004). More specifically, VEs are distinguished from other simulator systems by their capacity to portray three-dimensional (3D) spatial information in a variety of modalities. They are able to exploit the user's natural input behaviors for human-computer interaction and their potential to "immerse" the user in the virtual world (Sik-Lanyi 2014b). The effects of human differences in immersive VR environments are a cutting-edge research topic (Flogie et al. 2020; Sik-Lanyi et al. 2006).
More and more online three-dimensional (3D) games are to be found these days. According to Steinkuehler, the current global player populations of the most popular three games that she has studied over the past few years totals over 9.5 million – a population which rivals, e.g. most US metropolises (Steinkuehler 2006). However, there is an ever-expanding gap between game heroes and the characteristics of real-life people. This difference is also reflected in the choice of colors (Sik-Lanyi 2014a).
Most software engineering companies have not been developing products for users with special needs because they do not see a potential market in these users. However, figures have proven that at least 10 % of the world's population features some kind of impairment (Disabled World 2023). This number is estimated to reach 14 % in the USA, and 65 % of the population older than 65 years is to become handicapped. Disabilities correlate with age. In developed societies, more and more people turn older than 75 and are likely to have some kind of impairment. This group will comprise 14.4 % of the population by 2040, compared with 7.5 % in 2003 – an almost twofold increase (European Commission 2003).
Accessible Internet and software are an essential part of this process. It is not an easy task to make the Internet, software and VR applications accessible. The existence of the principles and standards of Universal Design/Design-for-All is not everything (Sik-Lanyi 2009; Universal Design n. d.; United Nations 2004). The regulations for accessible Internet also seem inadequate (W3C 2008). The question is even more complex if users' special needs are also being taken into account.
The global Augmented Reality (AR) and VR market is estimated to generate a revenue of USD 22.1 billion in 2020 and is expected to reach USD 161.1 billion by 2025, witnessing 48.8 % Compound Annual Growth Rate (CAGR) during the forecast period. The market is driven by factors such as increasing responsiveness to this technology,

rapid acceptance of AR and VR technology among various industry domains and the amalgamation of AR and VR to develop Mixed Reality that can be implemented for prospective applications (Vynz Research 2020). Economic analysts of VR and AR estimate a growth of USD 182 billion in the next ten years. It is made up of USD 110 billion from hardware and USD 72 billion from software (Vynz Research 2024). The leading software companies, e.g. Microsoft, are more reactive to developing accessible software. Thus, there is a growing need for accessible design in the game industry as well.
To sum it up, as far as demographic figures are concerned, the users' demands, and the e-commercial and e-health endeavors, we can see how inevitable accessible software and Internet are.
In the past three decades, I have designed and developed a number of multimedia and virtual reality-based games for rehabilitation with my student research group at Pannon University, Hungary. The majority of these serious games were made in the framework of international projects. To name just a few: GOET, StrokeBack, SG4Competence (GOET n. d.; StrokeBack n. d.; SG4Competence n. d.). In the following chapter, I draw attention to what to pay attention to when developing multimedia and VR-based software for rehabilitation purposes especially if we take cultural differences into account.

2 Some Examples as Case Studies

The examples presented in this chapter may seem trivial as developer experiences. However, this could only be realized when the products were presented to experts who knew the future user group during the development process.

2.1 Ecological Validity

Phobia is an anxiety disorder in which the person has an extreme, unrealistic fear of a particular situation, activity or object. The fear, over which one has no control, occurs whenever the object appears, or the situation arises, and the phobic man or woman experiences strong, unbearable anxiety and distressing symptoms such as heart palpitations, sweating or feeling of panic when presented with the feared object or situation (Laky and Sik-Lanyi 2003a, 2003b). For example, fear of public transport is part of agoraphobia. Its object can be travelling by train, bus, tram, aeroplane, car and the most frequent (at least in Hungary) is fear of travelling by underground.
The method of treating travel phobia with VR is practically the same as regular psychotherapy, called desensitisation. Before the exposition to the feared situation, patients learn relaxation and other methods for eliminating and controlling anxiety. They also have to create a hierarchy of the stimuli in order to show which causes the least and the strongest anxiety. After all this, the exposition starts. In the VR, the therapist can control, based on the hierarchy, the number and the quality of stimuli that the patient has to cope with (Sik-Lanyi et al. 2004).
Our team from the University of Pannonia and SOTE (Semmelweis Medical University in Budapest) aimed to develop a VE to be used in treating phobias. Obviously, treating every phobia is beyond our power, so we focused only on agoraphobia (fear of wide, open spaces), acrophobia (fear of height) and specific phobia (fear of travelling). For the phobia of travelling the treating environment imitates the underground railway in

Budapest (Simon, Lanyi, and Simon 2005). The development was based on original video recordings. This was necessary to measure how many minutes the escalator takes to reach the platform, how many minutes it will take for the next subway train to arrive on the track and to have an original audio recording. Moreover, the initial video recording provided the information for the later modelling phase using Maya (a 3D modelling software). After modelling the underground by Maya, we exported the virtual objects to Shockwave 3D file format (the extension of this file is W3D). This was done to get the VE interactive. For exporting, we use Shockwave Exporter. This program is able to export Maya made objects to the format (W3D), which can be easily used by Multimedia Director.
When we showed the psychiatrist the modelled subway car, as shown in Figures one and two (the "beautiful, modern" subway car), he gave a surprising opinion: "It's beautiful, modern, but in reality, it's a bit worn and has graffiti on it" (This was before the subway was renovated).

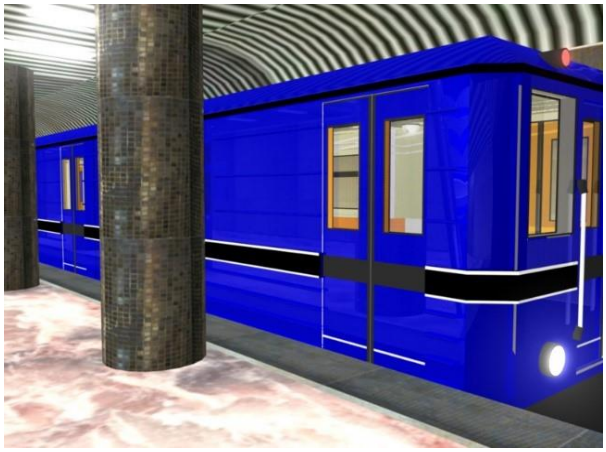

Figure 1 Underground car outside

Figure 2 Underground car inside

Sadly, in the later part, according to the psychiatrist's opinion, we had to redevelop the metro train to look more like reality (Fig5).

Figure 3 The real escalator

Figure 4 The virtual escalator

Figure 5 Second development of the metro car

Lesson learned: If you develop for rehabilitation purposes, e.g. to treat some phobia, the VE must be very realistic. In other words, it has to be ecological valid, this is much more important than good image quality.

2.2 Cultural Differences

People with Intellectual Disabilities often face a lack of control and opportunity in their everyday lives, with less than 10 % having jobs (Brown et al. 2011). People with Intellectual Disabilities experience low levels of employment and face barriers to employment. The UK Valuing People Report (Department of Health 2001) and a report to Ministers and the Learning Disability Task Force (Working Group 2006) have emphasized the need to promote and develop appropriate training and employment opportunities for this target group. The Game On Extra Time (GOET) project responds to these calls by developing engaging and accessible serious games to develop work-based skills in this target group. More than ten games were developed and tested in the partner countries under the umbrella of the GOET project. Here, only two of them are analyzed as an example for cultural differences.

The “My Appearance” game teaches the students everyday “morning” tasks, from getting up until leaving home, using a Flash game. The graphic interface of the game is clear, understandable and cartoon-like. It simulates the sequencing of morning tasks in preparation for leaving for work, and the structure of the game is very consistent. For example, after getting up, having a shower, getting dressed (Fig. 6) and eating breakfast (Fig. 7), the user’s avatar is ready to leave for work, and its appearance improves.

Abbildung 6 After getting dressed

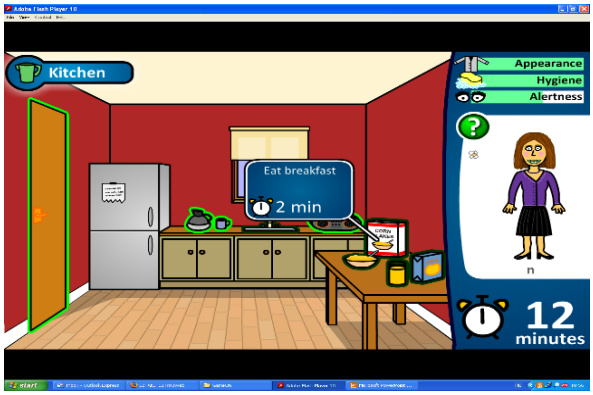

Abbildung 7 Eating breakfast

At the end of the game the user receives feedback on his/her performance using sound, subtitles or British Sign Language (BSL). If the student forgets to wash his/her hands or forgets to have a morning drink, the game does not interfere – it lets the student make mistakes and learn from doing so by reflecting on the game responses to their actions (Fig. 8). The "My Appearance" game was developed by the UK partners at the Nottingham Trent University, by English engineers.
What do we see in Figure 8? Forgotten: drink coffee, means: You forgot to drink your morning coffee. Here in Hungary, the coffee is very strong. Children and teenagers do not drink black coffee in Hungary because it is strong, real espresso coffee. That is why I asked that among the missed activities, there should be a warning that you forgot to drink your morning drink.

Figure 8 Showing the results graphically

Lesson learned: Pay attention to cultural differences. Ask testers from different partner countries to check all the functions of the developed software.

The "VR supermarket" game helps to teach students about money management skills within a store environment developed using Flash. The player enters the virtual supermarket (Fig. 9) and is given a virtual wallet, a shopping list (Fig. 10) and a shopping cart. The goods on a given shelf are displayed with their names, prices and images attached to them. To place an item in the shopping cart, the player only has to click on the given item.

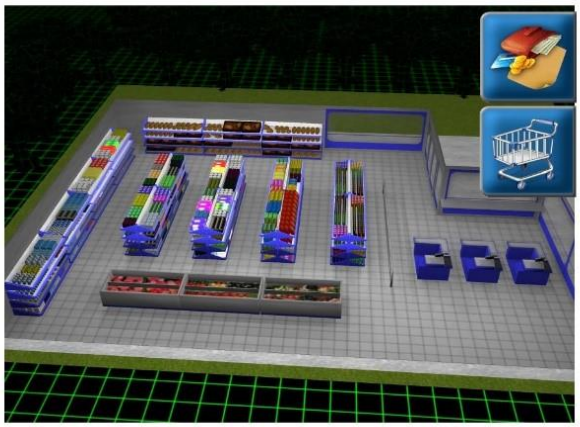

Figure 9 VR supermarket

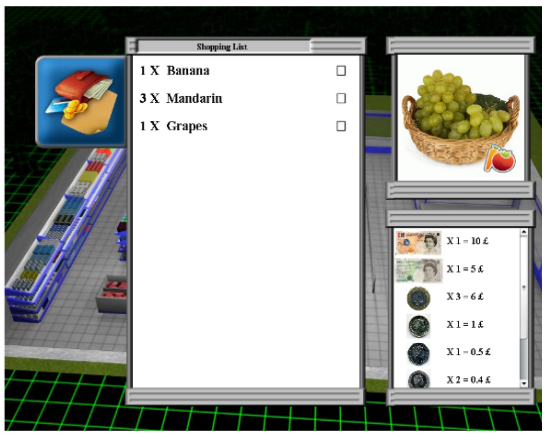

Figure 10 Shopping list

Before paying, the bar code scanner registers the price of each item in the shopping cart one by one. During this step, both the cashier and the cash register will give feedback to the student (Fig. 11). To pay for the items the student has to place a sufficient sum of money onto the drop panel by clicking the separate banknotes and coins in the wallet and then hitting the pay button.

Figure 11 At the cash register

Figure 12 Wrong invoice

We were very proud of our virtual store, but once again, it did not fit the reality. The error occurred on the bill (Fig. 12). In Hungary, the HUF sign is behind the price on the invoice, while in England, the Pound currency is listed before the price.

Lesson learned: Pay attention to cultural differences and ask a person who grew up there to test, or more precisely, was socialized there. Even though we have been to England several times, we did not notice this mistake.

2.3 Differences between patients' and therapists' ideas and needs

Within StrokeBack, a project funded by the EU, the goal was to improve the speed and quality of stroke recovery (Ortmann, Langendörfer, and Sik-Lanyi 2012) through the development of a telemedicine system which supports ambulant rehabilitation at home settings for stroke patients with minimal human intervention.
Changes in clinical practice cause most patients to be discharged from the hospital within a very short time, so the research and development mostly concentrate on home-based rehabilitation. This approach has various advantages; for example, new skills are automatically transferred into daily life, improving motivation and morale. In addition, home-based therapy is less expensive, more motivating and, – because of the familiar environment – more comfortable too.
The researcher and developer team at the University of Pannonia's role in the Stroke-Back project is to create games which can be used during the home rehabilitation process by the patients or replace clinical rehabilitation and speed up the process of recovery.
Seven games were developed (Dömők et al. 2012). Here only two of them are shown: Break the Bricks and Birdie. Break the Bricks is a classic brick-breaker game. It was a very famous arcade game in the 90s. The goal of the game is very simple: smash the wall of bricks by deflecting a bouncing ball with a paddle (it could be a car, a train, etc.). The aim of this game is to clear the screen by breaking the bricks on top of it.

To break a brick, hit it with the ball several times (Fig. 13). The control was performed using a Kinect sensor.

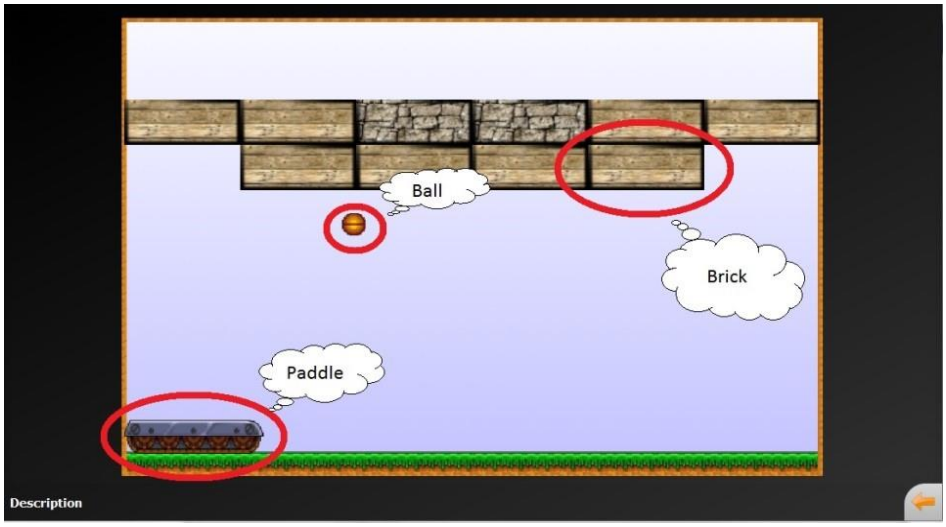

Figure 13 The Break the Bricks game

The therapists told us to make an instructional animation on the necessary movement to control the game. So, the instructional animation was developed. A screenshot is shown in Figure 14. When the therapists watched the animation, they said that this was not good, take out the small cloth under the hand because the patients may think that the table should be wiped with the movement.

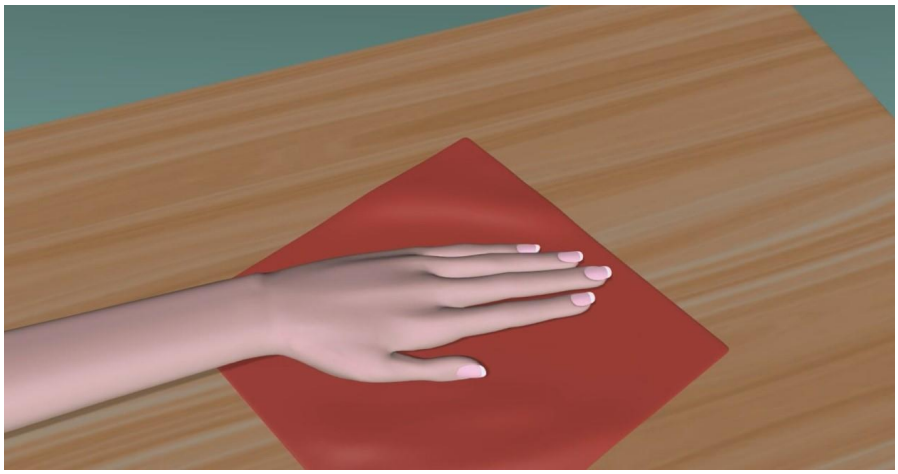

Figure 14 Screenshot from the Break the Bricks game control movement teaching animation

In the “Birdie” game the aim of the player is to help a bird to get back home. The bird is flying home, and the goal is to keep it in the air and prevent it from colliding with the obstacles, which can be other birds, rocks, trees, etc. If the bird bumps into something, the game will continue from the actual point, and the level will not restart. On the bottom of the screen a progress bar can be seen, which shows how much of the course is accomplished by the bird, and how much is left (Fig. 15).

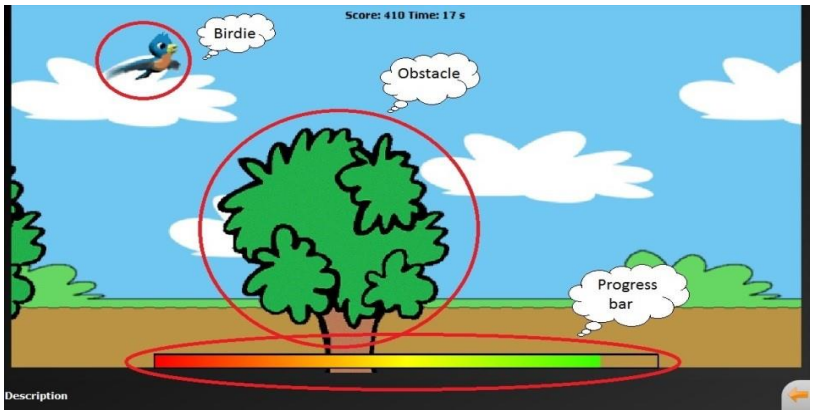

Figure 15 Screenshot from the Birdie game

An educational animation had to be made for this game as well.
However, when the therapists watched the animation (Fig. 16), they said this is not good, the pillow should be removed under the hand. The modified version is shown in Fig. 17.

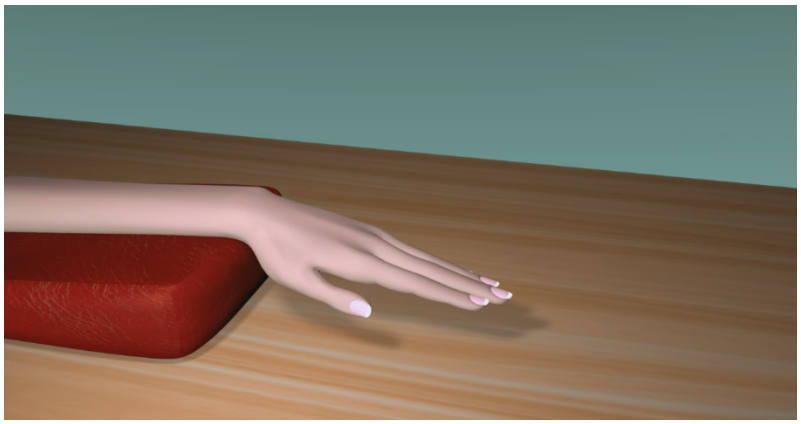

Figure 16 Screenshot from die Birdie game control movement teaching animation

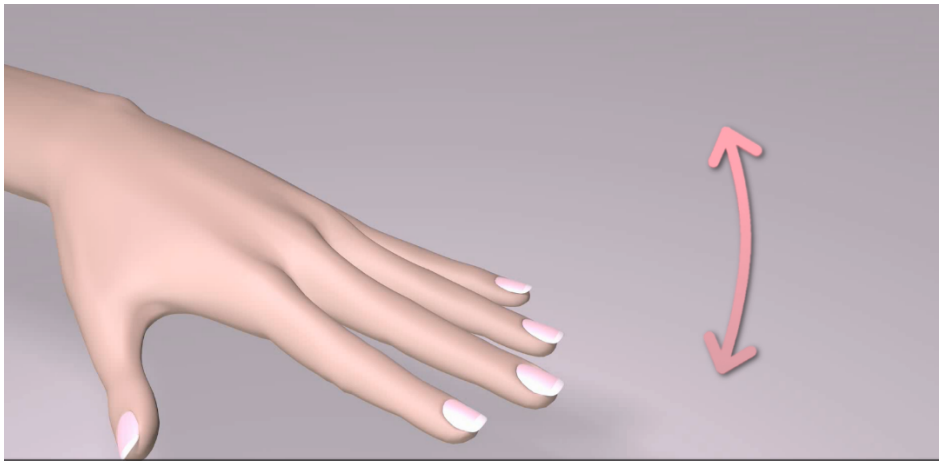

Figure 17 Screenshot from the Birdie game control movement teaching modified animation

We have developed different locations for each game. Sky for the Birdie game, mountainous regions, fields, jungles, urban environments, winter landscapes, etc.. When we asked patients at the Brandenburg Clinic to test the game, they did not know that I also speak German, so I understood what they said. One of the male patients commented that it was too "girly-style" game and why it did not have a bat, for example.

Although the bat is not a bird, at his request, we included a scene with a bat in the game (Fig. 18).

Figure 18 Screenshot from the Birdie game, "bat" scene

Lesson learned: There are differences between patients' and therapists' ideas and needs and the ideas of game developers. After practicing the individual movements, before the patient had to solve increasingly difficult repetitive movement tasks, the therapists asked for motivational animations during the rest period. Of course, we also prepared these according to different themes and scenes.

3 Conclusion: Take Away Message

In this book chapter, some interesting development experiences in the context of VR were presented. Things that a developer would not even think about until they encountered it. Game developers are good IT engineers not only because they can program well but also because they can take human skills into account when designing a software/game. Also, computer science engineers become really good game developers if they gain experience in designing for users with different needs. The complexity is further increased if special attention must also be paid to a possible disability of the future user.
To sum up what you can learn from this chapter, take care of:

- Ecological validity,
- Cultural differences,
- Motivating scenes,
- Differences between patients' and therapists' ideas and needs and the developer idea's,
- Focus on user needs!

Acknowledgements

I cannot emphasize how vital the role of my B.Sc., M.Sc. students was in creating the software that was developed within the framework of their dissertation and diploma thesis. Special thanks to the work of my Ph.D. students.
I am very grateful to the researchers and lecturers I met in the framework of the European Union projects supporting various research tasks.
In addition to the "King Salman Award for Disability Research" awarded to me by the King Salman Center for Disability Research. I would also like to thank the moral support of the "AAATE-Diamond-Award" awarded to me by the Association for the Advancement of Assistive Technology in Europe.

References

Bowman, Doug, Ernst Kruijff, Joseph LaViola, and Ivan Poupyrev. 2004. *3D User Interfaces: Theory and Practice*. Sydney: Addison Wesley.

Brown, David J., David McHugh, Penny Standen, Lindsay Evett, Nick Shopland, and Steven Battersby. 2011. "Designing Location-Based Learning Experiences for People with Intellectual Disabilities and Additional Sensory Impairments." *Computers & Education* 56 (1): 11–20. https://doi.org/10.1016/j.compedu.2010.04.014.

Department of Health. 2001. "Valuing People: A New Strategy for Learning Disability for the 21st Century: A Whtie Paper." https://assets.publishing.service.gov.uk/media/5a7b854740f0b62826a041b9/5086.pdf.

Disabled World. 2023. "Disability Statistics: Information, Charts, Graphs and Tables." https://www.disabled-world.com/disability/statistics/.

Dömők, Tamás, Veronika Szűcs, Erika László, and Cecília Sík Lányi. 2012. ""Break the Bricks" Serious Game for Stroke Patients." In *Computers Helping People with Special Needs*. Vol. 7382, edited by David Hutchison, Takeo Kanade, Josef Kittler, Jon M. Kleinberg, Friedemann Mattern, John C. Mitchell, Moni Naor et al., 673–80. Lecture Notes in Computer Science. Berlin, Heidelberg: Springer.

European Commission. 2003. "2010: A Europe Accessible for All, Brussels: Report from the Group of Experts Set up by the European Commission." https://www.accessibletourism.org/resources/final_report_ega_en.pdf.

Flogie, Andrej, Boris Aberšek, Metka Kordigel Aberšek, Cecilia Sik-Lanyi, and Igor Pesek. 2020. "Development and Evaluation of Intelligent Serious Games for Children with Learning Difficulties: Observational Study." *JMIR serious games* 8 (2): e13190. https://doi.org/10.2196/13190.

GOET. n. d. "GAME on EXTRA TIME - Serious Educational Games to Develop Prevocational Skills in People with Learning Difficulties: Projekt Azonosító: UK/08/LLP-LdV/TOI/163-181.".

Laky, Viktoria, and Cecilia Sik-Lanyi. 2003a. "To Develop Virtual Reality Worlds for Treating Agoraphobia and Acrophobia." In *VRIC Virtual Reality International Conference*. Laval.

Laky, Viktoria, and Cecilia Sik-Lanyi. 2003b. "Using Virtual Reality in Psychology (Virtual Worlds in Treating Agoraphobia and Acrophobia)." In *7th European Conference for the Advancement of Assertive Technology in Europe*, 628–32.

Ortmann, Steffen, Peter Langendörfer, and Cecilia Sik-Lanyi. 2012. "Telemedical Assistance for Ambulant Rehabilitation of Stroke Patients." In *9th World Congress on Brain Injury*, 644–45.

SG4Competence. n. d. "Intelligent Serious Games for Social and Cognitive Competence: Projekt Azonosító: 2015-1-TR01-KA201-022247.".

Sik-Lanyi, Cecilia. 2009. *Principles and Practice in Europe for E-Accessibility.* Veszprém: Pannonian University Press.

Sik-Lanyi, Cecilia. 2014a. "Styles or Cultural Background Does Influence the Colors of Virtual Reality Games?" *Acta Polytechnica Hungarica* 11 (1): 97–119. https://doi.org/10.12700/aph.11.01.2014.01.7.

Sik-Lanyi, Cecilia. 2014b. *The Thousand Faces of Virtual Reality:* InTech.

Sik-Lanyi, Cecilia, Viktoria Simon, Lajos Simon, and Viktoria Laky. 2004. "Using Virtual Public Transport for Treating Phobias." In *Proceedings / the 5th International Conference on Disability, Virtual Reality and Associated Technologies: 20 to 22 of September 2004, Oxford, UK*, edited by Paul Sharkey, Rachel McCrindle, and D. Brown, 57–62. Reading: Univ.

Sik-Lanyi, Cecilia, Jacqueline Ann Stark, Moremi Edit Kamson, and Zoltán Geiszt. 2006. "Do We Need High-Scale Flexibility in Virtual Therapies?" *International Journal on Disability and Human Development* 5 (3). https://doi.org/10.1515/IJDHD.2006.5.3.251.

Simon, Viktoria, Cecilia Sik Lanyi, and Lajos Simon. 2005. "Using Virtual Public Transport for Treating Phobias." *International Journal on Disability and Human Development* 4 (3): 211–16. https://doi.org/10.1515/IJDHD.2005.4.3.211.

Steinkuehler, Constance. 2006. "Massively Multiplayer Online Games-Based Learning." In *M3 - Interdisciplinary Aspects on Digital Media & Education: Proceedings of the 2nd Symposium of the WG HCI&UE of the Austrian Computer Society*, edited by Margit Pohl, 15–16. Wien: Österr. Computer-Ges.

StrokeBack. n. d. "Telemedicine System Empowering Stroke Patients to Fight Back: Grant Agreement Number: 288692.".

United Nations. 2004. "Accessibility for the Disabled a Design Manual for a Barrier Free Environment." https://www.un.org/esa/socdev/enable/designm/.

Universal Design. n. d. "Universal Design." http://www.universaldesign.com/.

Vynz Research. 2020. "Global Augmented Reality and Virtual Reality Market Is Expected to Reach USD 161.1 Billion by 2025, Witnessing 48.8% CAGR During the Forecast Period (2020–2025)." https://www.globenewswire.com/news-release/2020/05/29/2041108/0/en/Global-Augmented-Reality-and-Virtual-Reality-Market-is-expected-to-reach-USD-161-1-billion-by-2025-witnessing-48-8-CAGR-during-the-forecast-period-2020-2025-VynZ-Research.html.

Vynz Research. 2024. “Augmented Reality and Virtual Reality Market.” https://www.vynzresearch.com/ict-media/augmented-reality-and-virtual-reality-market/request-sample.

W3C. 2008. “Web Content Accessibility Guidelines (WCAG) 2.0: W3C Recommendation 11 December 2008.” https://www.w3.org/TR/WCAG20/.

Working Group. 2006. “Mproving Work Opportunities for People with a Learning Disability Report of a Working Group on Learning Disabilities and Employment a Report to Ministers and the Learning Disability Task Force.” https://www.base-uk.org/sites/default/files/knowledgebase/learning_disabilites_employment_report_july_06ver1.pdf.

How to Cite this Article:

Sik-Lanyi, Cecilia (2024). IT Development Experience for VR Game Design. Would you have Thought of it? In: Vanessa Heitplatz & Leevke Wilkens (eds.). Rehabilitation Technology in Transformation: A Human-Technology-Environment Perspective, 525-537. Dortmund: Eldorado.

Diesen Artikel zitieren:

Sik-Lanyi, Cecilia (2024). IT Development Experience for VR Game Design. Would you have Thought of it? In: Vanessa Heitplatz & Leevke Wilkens (Hrsg.). Die Rehabilitationstechnologie im Wandel: Eine Mensch-Technik-Umwelt Betrachtung, 525-537. Dortmund: Eldorado.