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Exploring the Immersive Potential of Accessibility Options for Deaf and Hard-of-Hearing Players*

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This study examines the implementation and effectiveness of accessibility options in digital games, focusing on their role in shaping immersive experiences for deaf and hard-of-hearing players. Using a mixed-methods approach, this research combines game design analysis and qualitative interviews with deaf and hard-of-hearing users, focusing particularly on Polish video games. The findings reveal that text transcription, visual indicators, and haptic feedback significantly influence player engagement, yet their inconsistent implementation often disrupts immersion. By addressing the challenges faced by hard-of-hearing players, this study contributes to the broader discourse on inclusive game design and the artistic potential of accessibility solutions.

Keywords: inclusive game design, accessibility options, deaf and hard-of-hearing players, video games accessibility, player immersion, Polish video games

Introduction

Accessibility in video games is an increasingly important aspect of digital entertainment design, facilitating broader participation among individuals with diverse disabilities. Amid the rapid growth of the gaming industry and growing social awareness of the needs of users with disabilities, inclusive design stands out as one of the primary challenges for contemporary creators of interactive experiences. While accessibility in digital games has been the focus of numerous academic and popular works, it is often addressed only peripherally in discourse and remains an area in need of deeper, more comprehensive exploration.[1]

Research on accessibility in this medium often takes a broad approach, addressing the historical evolution of accessibility in games,[2] analysing the barriers faced by players with different types of impairments,[3] and exploring the potential benefits of accommodating the

[1] Mark Brown, Sky L. Anderson, *Designing for Disability: Evaluating the State of Accessibility Design in Video Games*, "Games and Culture" 2021, no. 16(6), p. 703.

[2] Emilia Kiecko, *Accessibility of Video Games in the Context of Disability. A Historical Overview*, "Quart" 2024, no. 1(71), pp. 76–99.

[3] An illustrative example of this approach is the systematic review *Accessibility in Video Games* ("Universal Access in the Information Society" 2020, no. 19(1), pp. 169–193) by Juan Aguado-Delgado, José-María Gutiérrez-Martinez, José R. Hilera et al., which explores the impact of different types of disabilities on

needs of diverse user groups.[4] These discussions frequently highlight the role of accessibility options in enhancing the artistic potential of games.[5] Accessibility is also examined through social and communicative lenses, as illustrated by the collective monograph *Gaming Disability: Disability Perspectives on Contemporary Video Games*, which delves into three interrelated domains: representation, inclusion, and community.[6]

While such studies provide a broad perspective on accessibility and help identify key challenges in the field, they often take a more synthetic approach, emphasizing overarching trends, challenges, and future directions. Though valuable for understanding the broader context, this perspective offers limited insight into the practical aspects of implementing accessibility solutions. As a result, there is growing interest in research that explores game prototypes designed specifically for players with certain disabilities, such as blind gamers.[7] Although these studies yield important insights into the specific needs of different user groups and the technological potential of the medium, they primarily focus on prototypes. Consequently, a key challenge remains in translating these experimental solutions into widely accessible commercial productions.

The need for detailed research on video game accessibility is becoming increasingly evident, particularly studies that systematically examine specific implementations, evaluate their effectiveness, and assess their impact on the experiences of players with various disabilities. A notable example of such an approach is the article *Designing for Disability: Evaluating the State of Accessibility Design in Video Games* by Mark Brown and Sky LaRell Anderson.[8] The authors conducted

gamingexperiences, the barriers encountered by players, and the significance of inclusive design. The study also addresses assistive technologies, such as specialized controllers and headsets. While it provides a valuable overview of the general challenges associated with accessibility, its primary focus is on global trends and supportive tools rather than an in-depth analysis of accessibility features in specific game titles.

[4] In her review of scholarly literature on the accessibility of games and game-based applications, Lobna Hassan cites numerous articles that have examined the general accessibility of digital games, both broadly and specifically in relation to individuals with cognitive, intellectual, motor, and visual disabilities. Lobna Hassan, *Accessibility of Games and Game-based Applications: A Systematic Literature Review and Mapping of Future Directions*, "New Media & Society" 2023, no. 26(4).

[5] There is a frequently held, and justified, belief that inclusive design can expand the boundaries of narrative expression within the medium and enhance its capabilities. Yiqi Deng, in the article *Inclusive Games: Accessible Game Design for the Visually Impaired*, argues that "an inclusive approach promotes innovation and encourages developers to explore new paths in game design" and "enrich game gameplay." Yiqi Deng, *Inclusive Games: Accessible Game Design for the Visually Impaired*, "Applied and Computational Engineering" 2024, no. 37(1), p. 61.

[6] *Gaming Disability: Disability Perspectives on Contemporary Video Games*, eds. Katie Ellis, Tama Leaver, Mike Kent, Routledge, Abingdon and New York 2023.

[7] See, for example: Silviu Ivascu, Florica Moldoveanu, Alin Moldoveanu et al., *Flying a Quadcopter – An Audio Entertainment and Training Game for the Visually Impaired*, "Applied Sciences" 2023, no. 13(11); Emmanouel Rovithis, Nikolaos Moustakas, Andreas Floros et al., *Audio Legends: Investigating Sonic Interaction in an Augmented Reality Audio Game*, "Multimodal Technologies and Interaction" 2019, no. 3(4), 2019.

[8] Mark Brown, Sky L. Anderson, op. cit., pp. 702–708.

a comprehensive analysis of major video game releases from 2019, critically evaluating their accessibility for players with diverse disabilities. In addition to motor, visual, and cognitive impairments, they also considered challenges associated with hearing disabilities – an aspect that served as a crucial foundation for my research on identifying and assessing accessibility features in video games.

Another significant contribution to the discourse on game design and accessibility is Junjie Zheng's study, *Human Factors in Game Design: The Importance of Accessibility.*[9] This work provides an in-depth examination of accessibility features implemented in popular games and offers practical recommendations for game developers. By bridging theoretical considerations with empirical analysis, Zheng's research further advances the understanding of inclusive design practices in the gaming industry.

This article contributes to the aforementioned research landscape by examining accessibility features in digital games, with a particular focus on their functionality and potential to enhance player immersion. The study centres on the needs of a specific user group: deaf and hard-of-hearing individuals. Methodologically, it combines game design analysis with qualitative interviews conducted with deaf and hard-of-hearing players. By assessing both the implementation and practical usability of accessibility features, this research aims to determine their effectiveness in fostering immersive experiences for deaf and hard-of-hearing players.

Conducting this research is particularly significant, as inclusive game design remains an underexplored area within academic discourse, especially in the context of the Polish gaming market. Despite the rapid expansion of the domestic game development industry, studies on accessibility features in Polish video games remain limited. Poland has emerged as one of the leading countries in the European Union in terms of employment in the video game sector, alongside France, with both countries employing the highest number of professionals in the industry across Europe,[10] and many Polish-produced titles have achieved substantial international recognition and commercial success. This reinforces the importance of analysing accessibility practices within this national context, as Polish games increasingly shape global gaming experiences. There is a distinct lack of detailed qualitative and comparative research examining the implementation of accessibility solutions within a national framework. Furthermore, existing scholarship predominantly focuses on the needs of blind players, while accessibility for deaf and hard-of-hearing individuals remains largely overlooked. This study seeks to address this gap by providing a comprehensive analysis of accessibility in Polish video games, specifically from the perspective of

[9] Junjie Zheng, *Human Factors in Game Design: The Importance of Accessibility*, "Applied and Computational Engineering" 2024, no. 42, pp. 102–110.

[10] Statista, *Workforce in the Video Game Industry in Europe in 2022, by Country*, https://www.statista.com/statistics/1400250/europe-video-game-industry-workforce-by-country/ (accessed: 27.01.2025).

players with hearing disabilities. The analysis focuses on six well-known titles developed in Poland: *The Witcher 3: Wild Hunt* (CD Projekt RED, 2015), *Cyberpunk 2077* (CD Projekt RED, 2020), *Dying Light 2: Stay Human* (Techland, 2022), *The Medium* (Bloober Team, 2021), *Frostpunk* (11 bit studios, 2018), and *Green Hell* (Creepy Jar, 2019).

This article consists of five sections. The first outlines the study's methodological and conceptual framework, along with its key objectives. The second examines selected accessibility options[11] in games designed for deaf and hard-of-hearing players. The third section describes the qualitative research conducted, while the fourth presents key findings on effective inclusive design for deaf and hard-of-hearing individuals. The conclusion reflects on best practices in game accessibility.

Assumptions and Objectives of the Study: Accessibility Options for Users with Hearing Disabilities in Polish Video Games

This study focused on analysing inclusive solutions in Polish video games and assessing their actual usability from the perspective of deaf and hard-of-hearing players. To achieve this, interviews were conducted with thirteen deaf and hard-of-hearing individuals who identify as gamers. All participants were familiar with the six analysed titles, as prior knowledge of these games was a key criterion for inclusion in the study. The interviews were preceded by a detailed research survey.

The study had several key objectives:

1. to identify accessibility solutions in digital games, with a particular focus on Polish video games;

2. to evaluate the actual functionality of inclusive options by collecting data from adult players with hearing disabilities who are familiar with Polish games;

3. to determine which accessibility features are most crucial in shaping an immersive gaming experience for deaf and hard-of-hearing players;

4. to lay the groundwork for developing recommendations for game developers on inclusive design that takes into account the needs of deaf and hard-of-hearing individuals.

A key aspect of this study was the precise conceptualization and operationalization of accessibility, which formed the foundation of the analysis. In the context of video games, accessibility is not merely about enabling individuals with disabilities to participate in gameplay; rather, it ensures that their gaming experience is qualitatively equivalent to that of non-disabled players.[12] Equally important is providing access

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[11] In this text, the terms 'options' and 'features' are used interchangeably to describe accessibility elements in video games. 'Options' generally refers to adjustable settings that players can modify to enhance accessibility, while 'features' denote built-in functionalities designed to improve the gaming experience for users with disabilities. The interchangeable use reflects the overlapping nature of these concepts in game design.

[12] As stated on the Accens portal, 'An "accessible" [product] is one that is able to be reached or easily obtained, able to be used or entered by everyone, easy to understand or enjoy, and possible to approach, enter, or use.' Thus, accessible software is not only functional for individuals with disabilities but also characterized by intuitiveness and attractiveness, providing them with experiences comparable to those of non-disabled users (Dariusz Drezno, *Digital*

to the same forms of gameplay, fostering an inclusive environment where all players can engage on equal terms. As noted by Paul Cairns, Christopher Power, Mark Barlet et al., based on their survey research, video gaming for players with disabilities is primarily about participating in the same activities as non-disabled players. It provides them with a sense of agency and supports the fulfilment of social needs.[13]

The analysis reveals that while many accessibility features are designed with inclusivity in mind, their implementation can inadvertently distort the gaming experience for players with disabilities. A notable example is the use of screen readers – assistive technologies designed to enhance spatial awareness for blind players – which simultaneously introduce an additional layer of mediation in the form of a non-diegetic narrator. This design choice can diminish immersion by distancing the player from direct interaction with the game environment.[14] A more immersive alternative lies in sonification systems, which convert data into dynamic auditory signals, facilitating a more direct and engaging gameplay experience. From the perspective of player engagement, sonification proves to be significantly more effective, as it minimizes mediational barriers and fosters deeper interaction with the virtual world.[15]

In this study, my primary focus was to assess the extent to which existing accessibility options are truly functional and effectively meet user needs. To examine the immersive potential of implemented inclusive solutions, I employed a modified version of the self-report measure of dispositional flow experience in the video game context, originally developed by Xiaowei Cai, Javier Cebollada, and Mónica Cortiñas.[16] Rooted in positive psychology, the concept of flow refers to a state in which an individual, fully engaged in an activity, attains an optimal experience characterized by deep satisfaction and overall well-being. By utilizing the modified scale, I aimed to determine the extent to which accessibility options support optimal user experience for deaf and hard-of-hearing individuals and, in this context, to evaluate their overall functionality.

Accessibility – Definition, Accens, 20.07.2022, https://accens.pl/blog/en/digital-accessibility-definition/ [accessed: 27.01.2025]).

[13] Paul Cairns, Christopher Power, Mark Barlet et al., *Enabled Players: The Value of Accessible Digital Games*, "Games and Culture" 2021, no. 16(2), pp. 139–159.

[14] Oana Balan, Alin Moldoveanu, FloricaMoldoveanu, *Navigational Audio Games: An Effective Approach toward Improving Spatial Contextual Learning for Blind People*, "International Journal on Disability and Human Development" 2015, no. 14(2).

[15] The immersive potential of sonification systems is inherently dependent on their structural and design characteristics. An increasing body of research focuses on optimizing sonification techniques to enable individuals with visual impairments to intuitively and efficiently process and utilize auditory cues. A notable example of such efforts is the study by Giorgio Presti, Dragan Ahmetovic, Mattia Ducci et al., which outlines an iterative design process for sonification techniques aimed at enhancing obstacle avoidance for individuals with visual impairments (*Iterative Design of Sonification Techniques to Support People with Visual Impairments in Obstacle Avoidance*, "ACM Transactions on Accessible Computing (TACCESS)" 2021, no. 14(4), pp. 19:1–19:26).

[16] Xiaowei Cai, Javier Cebollada, Mónica Cortiñas, *Self-report Measure of Dispositional Flow Experience in the Video Game Context: Conceptualisation and Scale Development*, "International Journal of Human-Computer Studies" 2022, vol. 159, 102746.

The research project employed two complementary methods, enabling a comprehensive analysis of inclusive solutions, including those implemented in Polish video games. The first method involved a detailed examination of accessibility options available for deaf and hard-of-hearing individuals in contemporary digital games. This process facilitated the development of a preliminary typology of inclusivity-supporting tools, which served as a foundation for subsequent research stages. A key aspect of this analysis was the consideration of both the technical and functional characteristics of accessibility features, particularly in relation to their potential impact on the gameplay experience of deaf and hard-of-hearing users.

The primary research method employed in this study was qualitative research, consisting of a survey and in-depth interviews with individuals who regularly use these accessibility solutions. The study involved thirteen adult deaf and hard-of-hearing players, all of whom identified as active members of the gaming community. The key criterion for participant selection was their experience in utilizing accessibility features and their ability to critically assess these solutions in relation to their own needs.

First, I will discuss the identified accessibility options, with a particular focus on their typology and potential applications. I will then outline the research framework, detailing the survey design methodology and the approach to individual interviews. Finally, I will summarize the key findings, highlighting their implications for the development of more inclusive solutions within the video game industry.

Typology of Accessibility Options for Deaf and Hard-of-Hearing Players

To develop a comprehensive list of key accessibility features for deaf and hard-of-hearing players, I conducted an in-depth analysis of contemporary action-adventure video games – a genre that has increasingly become a significant area for the implementation of inclusive solutions. Particular attention was given to titles recognized for their advancements in accessibility, such as *The Last of Us: Part II* (Naughty Dog, 2020) and *Marvel's Spider-Man 2* (Insomniac Games, 2023).

The analysis extended beyond the functionality of in-game accessibility features to include insights from user discussions, particularly on platforms such as *Can I Play That* – a website run by disabled journalists specializing in evaluating game inclusivity.[17] Additionally, data from online forums, including discussions on Reddit, provided valuable perspectives on the diverse needs and expectations of deaf and hard-of-hearing players.

As previously mentioned, despite the rapid development of research on video game accessibility, much of the existing academic literature remains focused either on broad overviews of the field or detailed analyses of specific solutions designed for particular game

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[17] Can I Play That? An Abilitypoints Initiative,
https://caniplaythat.com/ (accessed: 27.01.2025).

prototypes. In the context of developing a typology of key accessibility features, the Games Accessibility – a set of recommendations established in 2012 by a team of designers, academic consultants, and disability advocacy organizations – proved to be particularly useful.[18] These guidelines, categorized into three levels of complexity (basic, intermediate, and advanced), serve as a fundamental tool in inclusive game design. However, it is important to note that their generalized nature, as well as discrepancies between the proposed solutions and actual user experiences, necessitate further critical analysis.

Based on an examination of video games, player feedback, and existing literature, six primary categories of accessibility features relevant to deaf and hard-of-hearing players were identified:

1. Sound Transcription – including dialogue transcription, environmental sound transcription, gameplay sound transcription, and text-based information about the audio track in use.[19]

2. Communication Tools in Online Games – such as text chat, simplified text chat with pre-set phrases, and speech-to-text options.[20]

3. Visual Aids – including sound indicators, the use of colour and visual effects to represent sound, and sign language translation options.[21]

4. Haptic Feedback – including controller vibrations and advanced haptic features provided by external peripheral devices.[22]

5. Text Display Customization – for example, the ability to modify font size, type, and colour.[23]

[18] Game Accessibility Guidelines, https://gameaccessibilityguidelines.com/ (accessed: 27.01.2025).

[19] Notable examples of well-implemented sound transcription features can be found in *The Last of Us: Part II* and *Spider-Man 2*. Among the Polish titles analysed in this study, *Cyberpunk 2077* also provides strong implementations of this accessibility solution.

[20] *Apex Legends* (Respawn Entertainment, 2019) serves as an excellent case of a game that integrates a variety of accessible communication features. It is widely regarded as one of the most inclusive online multiplayer titles for players with disabilities, including those who are deaf or hard of hearing.

[21] An example of a game featuring sign language translation is *Forza Horizon 5* (Playground Games, 2021). Additionally, as highlighted on the Game Accessibility Guidelines website, visual aids are crucial for accessibility. It is important that no essential information is conveyed solely through sound. If an auditory element can be replaced by a visual one, the game becomes more accessible (*Ensure No Essential Information Is Conveyed by Sound Alone*, Game Accessibility Guidelines, n.d., https://gameaccessibilityguidelines.com/ensure-no-essential-information-is-conveyed-by-sounds-alone/ [accessed: 27.01.2025]).

This approach is exemplified in *The Last of Us: Part II*, where visual cues replace sound in various contexts, making the game more inclusive for players with hearing impairments.

[22] Exclusive PlayStation 5 games, developed specifically for Sony's hardware, have made significant advancements in the use of haptic feedback. A prominent example is *Ratchet & Clank: Rift Apart* (Insomniac Games, 2021), which effectively utilises the advanced haptic capabilities of the DualSense controller. The *Spider-Man* series, also developed by Insomniac Games, further exemplifies the immersive potential of haptic feedback. As highlighted in the article *Exploring Players' Perceptions of the Haptic Feedback in Haptic Digital Games* ("Journal of Digital Media & Interaction" 2022, no. 5(13)) by Sotiris Kingiras, haptic feedback plays a crucial role in enhancing player immersion in digital games, as it offers tactile sensations that deepen engagement and emotional connection with the game world.

[23] Text display customization is one of the most commonly implemented accessibility features in games, as it is relatively easy to integrate. All six games analysed in this study – *The Witcher 3: Wild Hunt*, *Cyberpunk 2077*, *Dying Light 2: Stay Human*,

6. Audio Modifications – including volume control for individual audio elements, sound separators, and mono sound options, which are particularly crucial for hard-of-hearing players, allowing them to tailor their audio experience to their specific needs.[24]

From the perspective of players with hearing impairments, sound transcription is the most fundamental accessibility tool. Dialogue subtitles have become a standard feature in many games, allowing deaf and hard-of-hearing players to follow the narrative. However, transcription options extend beyond dialogue to include environmental sounds, such as wind rustling, footsteps, or doors opening. These auditory cues not only enhance immersion but also provide essential situational and spatial context, especially when paired with appropriate visual icons.

Equally important for gameplay comprehension is the transcription of in-game sounds – those directly linked to the player's actions, such as jumping, attacking, or using items. These auditory elements function as an informational sound interface, conveying real-time feedback about interactions within the game world. Meanwhile, text-based transcriptions of the soundtrack (e.g., indications of ambient music mood or intensity) serve primarily a prompting function: they can signal an impending threat or a pivotal narrative event, encouraging players to adopt an appropriate strategic approach.

While transcription features are critical for understanding narrative structures, internalizing gameplay mechanics, and navigating the game world effectively, well-implemented communication tools are essential for ensuring inclusivity in online multiplayer modes. The most universally accessible communication method in this context is text chat, valued for its flexibility and capacity for detailed information exchange. However, study participants reported difficulties using text chat in fast-paced gameplay scenarios where reaction time is limited.

In such cases, a simplified text chat with pre-set phrases (e.g., *"Help me"* or *"I'm going left"*) proves more efficient, enabling rapid communication of essential information. However, its narrative and strategic limitations make it less useful in complex in-game situations that require nuanced interactions. Another inclusive communication solution is speech-to-text technology, which converts spoken language into text, facilitating interaction between hearing and deaf players and enhancing accessibility in online multiplayer environments.

The Medium, *Frostpunk*, and *Green Hell* – offer some form of text customization, allowing players to adjust font size, type, or colour to suit their needs.
[24] Among the analysed games, *Cyberpunk 2077* and *Dying Light 2: Stay Human* offer the most comprehensive audio modification options, allowing players to adjust individual audio elements to better suit their needs. In a broader context, *The Last of Us: Part II* stands out for its exceptional audio accessibility features, including a custom-developed, advanced sonification system created by the game's developers to enhance the auditory experience for players with hearing impairments. Additionally, *God of War: Ragnarok* (Santa Monica Studio, 2022) also provides excellent audio accessibility options, offering players a variety of sound adjustments to improve their gaming experience.

The third category of accessibility features identified in this study – visual enhancements – plays a crucial role in shaping immersive experiences. Various forms of graphical representation serve as effective substitutes for auditory information, enabling players to engage with the game environment more intuitively. A key example is the use of sound icons, such as dialogue indicators signalling nearby conversations or symbols representing specific sounds (e.g., explosions, footsteps). These visual cues enhance situational awareness, allowing players to better comprehend the game world. Another effective form of visual communication involves colour changes or intensity variations in objects that emit sound. Such dynamic indicators can be rapidly processed by players, making them particularly useful in fast-paced interactions.

An additional visual accessibility feature is sign language translation. While seemingly an optimal solution for deaf players who use sign language as their primary mode of communication, user responses suggest a more complex reality. As discussed in the conclusion section, many players perceive this feature as distracting rather than beneficial.

Similarly, haptic feedback has received mixed reactions. Technologies such as controller vibrations and advanced haptic peripherals significantly enrich sensory engagement, yet their practical implementation remains limited. The primary obstacle is the high cost of haptic devices, which creates a substantial barrier to accessibility. As a result, inclusive technologies paradoxically risk becoming exclusive due to economic constraints.[25]

When designing games for deaf and hard-of-hearing individuals, it is essential to consider audio modification features that allow users to tailor sound characteristics to their specific needs. One of the most significant implementations in this regard is the ability to independently adjust the volume of different audio elements, such as dialogue, sound effects, and music. This feature is particularly crucial for players with hearing loss, as it enables them to prioritize auditory cues according to their preferences. Additionally, the mono audio option serves as a valuable accessibility tool for individuals with asymmetric hearing loss, allowing all sound to be directed to a single channel for improved clarity.

The accessibility features discussed above highlight the complexity of designing inclusive gaming experiences for deaf and hard-of-hearing players. Each category, ranging from sound transcription to haptic feedback and audio modifications, plays a vital role in enhancing player engagement and ensuring more equitable access to gameplay. At the same time, diverse user preferences and technological constraints underscore the need for further refinement of these solutions based on

[25] The high cost of haptic devices has been a subject of academic discussion for years, particularly in the context of disability assistive applications. This issue has been highlighted by Fakhreddine Karray, Milad Alemzadeh, Jamil A. Saleh et al. in their article *Human-Computer Interaction: Overview on State of the Art*, published in the "International Journal on Smart Sensing and Intelligent Systems" 2008, no. 1(1), p. 138.

the actual needs of players. This necessity was strongly emphasized in qualitative interviews conducted as part of this study, which provided in-depth insights into the experiences and expectations of individuals with hearing impairments.

Stages and Methodology of Qualitative Research

The qualitative research conducted as part of this study was divided into two stages. In the first stage, participants completed a structured survey designed to gather data on the immersive potential of accessibility features and the level of flow experienced during gameplay, with a particular focus on Polish video games. The second stage involved in-depth individual interviews, where participants provided insights and reflections on the functionality of the analysed accessibility options. For respondents communicating in Polish Sign Language, interviews were conducted with the assistance of a certified interpreter to ensure data accuracy and reliability.

The survey questionnaire consisted of four main sections:

1. Participant Demographics – This section collected detailed information regarding the type and degree of hearing impairment, the use of hearing aids or cochlear implants, and preferred communication methods.

2. Gaming Experience – Participants were asked about their gaming history, frequency of play, preferred platforms, favourite game genres, and key gameplay elements they valued.

3. Accessibility Features – This section focused on the accessibility options used by participants, including sound transcription, text chat, visual indicators of sound, controller vibrations, sign language interpretation, font size and shape, mono and stereo sound modes, and volume adjustment. Participants rated the functionality of each feature on a five-point Likert scale.

4. Perception of Polish Video Games – Participants evaluated selected titles developed by Polish studios: *The Witcher 3: Wild Hunt*, *Cyberpunk 2077*, *Dying Light 2: Stay Human*, *The Medium*, *Frostpunk*, and *Green Hell*. The survey aimed to assess not only how specific accessibility solutions were perceived but also their impact on the overall experience of these games.

To assess player satisfaction and engagement, a modified version of the self-report measure of dispositional flow experience in the video game context was employed. The scale comprises nine indicators of flow experience, arranged hierarchically.[26] The first three indicators assess the perceived balance between game objectives and feedback, serving as prerequisites for the flow state. While these factors do not directly constitute the flow experience, they are essential second-order conditions for its emergence. The remaining six indicators directly contribute to the experience of flow. The specific indicators are defined

[26] Xiaowei Cai, Javier Cebollada, Mónica Cortiñas, op. cit., p. 7.

as follows: (1) clear goals (the player receives well-defined objectives and has a clear understanding of the tasks required at each stage of gameplay); (2) unambiguous feedback (the player receives immediate feedback on their progress in the game; (3) challenge-skill balance (the player perceives an equilibrium between the difficulty of in-game challenges and their own skill level, enabling them to effectively navigate the game's demands, thereby fostering an optimal and balanced gameplay experience); (4) concentration (upon reaching the flow state, the player becomes deeply engaged in the game and focuses entirely on its objectives); (5) action-awareness merging (in the flow state, the player becomes fully immersed in the game world, feeling as if they are an integral part of it and making conscious decisions within it); (6) sense of control (players experiencing flow maintain an inherent sense of control over the game environment); (7) loss of self-consciousness (as flow emerges, the player's self-awareness diminishes, and external stimuli from the real world have limited impact on their conscious experience; (8) transformation of time (in the flow state, the player's perception of time becomes distorted, leading to a diminished awareness of its actual passage); (9) autotelic experience (experiencing flow generates an intrinsic sense of fulfilment, making gameplay inherently rewarding in and of itself.

To assess participants' individual predisposition to flow, the original questionnaire included 28 items corresponding to the aforementioned indicators. The authors of the scale emphasize its primary advantage – its adaptability – which allows for substantial reduction in the number of items, enabling researchers to focus on specific indicators or tailor the scale to the needs of a particular study population.[27] In the present study, the scale was modified by reducing the number of items to 10. This decision was driven by the specific focus of the research, which examined the impact of accessibility features on gameplay experiences among deaf and hard-of-hearing players. The modification allowed for a targeted analysis of key indicators that most significantly contribute to an equitable and inclusive flow experience.

The selection of indicators was not arbitrary; rather, it was driven by their critical role in designing accessible games. Clear goals and immediate feedback enable players to quickly grasp game mechanics and assess their progress, which is particularly crucial for individuals with limited access to auditory cues. Ensuring a balance between task difficulty and player skill helps tailor challenges to individual abilities, mitigating potential barriers arising from mismatched difficulty levels. Furthermore, the merging of awareness and action, along with a strong sense of control, are essential for deep engagement in the game world – an aspect that may be especially challenging for players who encounter limitations due to inadequate interface or gameplay design.

[27] Ibidem, p. 16.

These selected indicators were directly reflected in the questionnaire items. When evaluating their experiences with specific Polish video games, participants responded to the following statements: *While playing [game title]: I knew how to proceed in the game*; *I understood its goals*; *I received immediate feedback on my progress*; *I felt that my skills were sufficient to meet the challenges*; *I was fully concentrated on the game*; *I felt like the protagonist of the game*; *I experienced a sense of belonging to the game world*; *I was in control of the game system*; *I lost awareness of reality*; *I lost track of time*; and *I felt rewarded*.

Responses were recorded using a seven-point Likert scale with the following labels: 1 – Never, 2 – Almost never, 3 – Rarely, 4 – Sometimes, 5 – Often, 6 – Almost always, 7 – Always. This approach not only enhanced the validity of the measurement tool within the studied population but also provided deeper insights into how specific game design elements either support or hinder the flow experience. Thus, the modification of the scale was not merely a technical adjustment but a crucial methodological decision that allowed for the acquisition of precise and practically applicable findings.

Building upon the responses gathered from the survey, a structured interview framework was developed as a key component of the second phase of the qualitative study. The interviews were conducted individually, with an average duration of 70 minutes. The questions were carefully tailored to reflect the questionnaire findings, allowing for a deeper exploration of participants' experiences and perspectives.

The interview protocol comprised four thematic sections:

1. Player History – Questions addressed participants' gaming origins, the influence of games on their social relationships, evolving preferences over time, and notable gaming-related experiences.

2. Genre Preferences – Discussions centred on favoured game genres, inspirational titles, and gameplay elements that foster immersion.

3. Gaming Practices – Participants self-identified within Richard Bartle's[28] player typology, reflected on their preferred difficulty levels, responses to failure, and favoured game mechanics.

4. Game Accessibility – A detailed examination of early encounters with accessibility challenges, perceived changes in accessibility over time, assessments of specific accessibility features, and an evaluation of Polish games in terms of their adaptability to player needs.

The primary objective of the interviews was to deepen the survey findings and obtain granular insights into players' experiences, particularly concerning game accessibility. The analysis provided valuable perspectives on the gaming practices of deaf and hard-of-hearing players, their specific needs, and the potential of video games as immersive

[28] In Richard Bartle's seminal 1996 paper on player typology, he categorizes players into four primary types: Killers, Achievers, Socializers, and Explorers.

Richard Bartle, *Hearts, Clubs, Diamonds, Spades: Players Who Suit MUDs*, https://mud.co.uk/richard/hcds.htm (accessed: 27.01.2025).

and expressive artistic media. Additionally, the responses highlighted specific design solutions present in Polish digital games that influence the immersive experience of deaf and hard-of-hearing players.

Insights on Implementing Text Transcription Options in Games

Key Findings of the Study

Participants consistently emphasized that certain accessibility features, particularly those related to text transcription, are essential for ensuring playability. A major concern was the ability to modify text properties such as size, colour, display speed, and highlighting. Unfortunately, despite growing industry awareness, contemporary games still exhibit numerous instances of poor implementation of these critical features.

According to the Game Accessibility Guidelines, basic accessibility options include the ability to adjust font size and colour.[29] While text transcription has become a standard feature in the industry, many games still fail to meet these minimum requirements. A notable example is *The Outer Worlds* (Obsidian Entertainment, 2019), which initially did not allow font size adjustments – the default size was merely 12 points, significantly hindering readability (for comparison, the standard subtitle size on Netflix is 50 points).[30]

Another recurring issue reported by participants is the use of white subtitles on bright backgrounds, which makes text nearly illegible. The lack of options to customize font, background contrast, or text display speed greatly diminishes gameplay comfort and immersion. In such cases, players are forced to exert unnecessary cognitive effort to decipher text, detracting from their ability to follow the game's events and fully engage with the visual narrative.

One of the most pressing accessibility issues in video games is the lack of transcription for environmental sounds. This limitation is particularly pronounced in horror games, where complex soundscapes are integral to the experience.[31] The absence of subtitles or visual cues signalling impending danger effectively excludes deaf and hard-of-hearing players from fully engaging with the game, significantly diminishing both immersion and the ability to make informed decisions.

[29] *If Any Subtitles / Captions Are Used, Present Them in a Clear, Easy to Read Way*, Game Accessibility Guidelines, n.d., https://gameaccessibilityguidelines.com/if-any-subtitles-captions-are-used-present-them-in-a-clear-easy-to-read-way/ (accessed: 27.01.2025).

[30] Mark Brown and Sky L. Anderson discuss this issue in their previously cited article, *Designing for Disability: Evaluating the State of Accessibility Design in Video Games*, noting that the situation later improved. A few months after the game's release, Obsidian Entertainment issued an update that addressed this issue (p. 708).

[31] On the impact of sound on user immersion in digital games, see, among others: Guillaume Roux-Girard, *Listening to Fear: A Study of Sound in Horror Computer Games*, [in:] *Game Sound Technology and Player Interaction: Concepts and Developments*, ed. Mark Grimshaw, Information Science Reference, Hershey 2011, pp. 192–212; Nicola Gallacher, *Game Audio – An Investigation into the Effect of Audio on Player Immersion*, "The Computer Games Journal" 2013, no. 2(2), pp. 52–79.

A similar issue was noted by participants in the study regarding *Green Hell*, where jungle sounds serve to signal impending danger. Playing without these auditory cues made it more difficult for players to orient themselves and anticipate upcoming events, further hindering their gameplay experience.

Nevertheless, some games have implemented solutions that inadvertently enhance accessibility, as these features were not necessarily designed with accessibility in mind but emerged as unintended by products of other design choices. For instance, participants in the study praised *The Witcher 3: Wild Hunt* for its innovative approach to dialogue presentation. In this game, text spoken by non-player characters appeared above their heads when they were within the player's field of view. One respondent highlighted this feature as a groundbreaking improvement that significantly enhanced her gameplay experience, citing it as an exemplary model of accessibility.

It is also worth noting that while dialogue transcription is now considered a standard feature, its widespread adoption only took place in the early 21st century. For example, the original release of *Assassin's Creed* (Ubisoft Montreal, 2007) did not include Polish-language subtitles, forcing deaf players to rely on hearing individuals for assistance. While this form of collective play emerged as a by-product of inaccessibility, it also fostered social bonds and underscored video games' potential as tools for social interaction.[32]

In conclusion, the implementation of comprehensive transcription features in video games remains a significant challenge, necessitating careful consideration of both technical and social dimensions of accessibility. While optimizing these features should be a fundamental aspect of game design, they are often poorly executed or entirely neglected. This oversight reflects a broader failure to adequately address user needs during the design process. A case in point is *Green Hell*, which still lacks the ability to adjust subtitle size or customize their display according to individual player preferences. Such deficiencies restrict the accessibility of the medium and highlight the urgent need for a more conscientious approach to designing features that are essential for an inclusive user experience.

Multimodal Accessibility in Digital Games: The Role of Visual and Haptic Options

The analysis of research findings clearly indicates that contemporary digital games still suffer from a significant lack of solutions supporting visual accessibility. Notably, both diegetic and non-diegetic

[32] In this context, both local and online collective game modes, although originally not designed with accessibility in mind, can support individuals with disabilities. As Kathryn E. Ringland, the author of *Minecraft as an Online Playground: Reframing Play and Games in a Minecraft Community for Autistic Youth* (in: *Gaming Disability: Disability Perspectives on Contemporary Video Games*, eds. Katie Ellis, Tama Leaver, Mike Kent, Routledge, London 2022), points out, the shared experience of a virtual environment can have a positive impact on social and emotional development, particularly for individuals with disabilities.

spatial interfaces[33] that enrich the on-screen environment received strong approval from study participants. Examples of such solutions include visual markers for key environmental elements, such as the distinctive climbable rock ledges in *God of War* (SIE Entertainment, 2018), which signal interactive surfaces for the player's avatar, or the use of highlighted lighting along paths to indicate the correct direction of movement.

These design choices serve a dual purpose: they enhance the intuitiveness of navigation while simultaneously enriching the game's narrative and artistic depth. Visual cues encoded through multimodal channels deepen player engagement, reinforcing both the aesthetic identity and storytelling framework of the game. Such practices foster immersion and highlight the artistic potential of video games, expanding the scope of their narrative expression.[34]

From the perspective of deaf and hard-of-hearing players, visual cues related to in-game events, interactive objects, and navigational hints are of paramount importance. Intuitive visual solutions not only compensate for the absence of auditory stimuli but also enhance immersion and the immediacy of the gaming experience. At the same time, they serve as an effective alternative to excessive textual information, which often overwhelms the on-screen space in contemporary games. Study participants pointed out that in games such as *Cyberpunk 2077*, the excessive presence of text – including dialogue, diegetic sound representations, and interface notifications – combined with its rapid display speed significantly hindered content comprehension. This underscores the necessity of designing a balanced visual environment based on multimodality and redundancy across communication channels.[35] Such an approach not only facilitates efficient information delivery but also deepens player engagement with the narrative and the game world.

Haptic feedback in game controllers, such as vibration effects, also plays a crucial role in enhancing accessibility and immersion, a point confirmed by the majority of study participants. Thoughtfully designed haptic effects can serve not only an informational function

[33] When discussing spatial interfaces (both diegetic and non-diegetic), I refer to the key principles outlined in the work of Erik Fagerholt and Magnus Lorentzon, whose findings are widely cited in game studies research. Erik Fagerholt, Magnus Lorentzon, *Beyond the HUD: User Interfaces for Increased Player Immersion in FPS Games*, Master of Science Thesis, Chalmers University of Technology, Göteborg 2009, https://odr.chalmers.se/server/api/core/bitstreams/fd267f70-c295-4eae-ae01-af5db676e61d/content (accessed: 27.01.2025).

[34] Steven E. Jones, *Meaning of Video Games: Gaming and Textual Strategies*, Routledge, New York 2008, p. 9.

[35] Accessibility options that require a multimodal design approach not only improve inclusivity but also enhance narrative depth and artistic expression in games. However, even seemingly minor design choices can be exclusionary. For instance, the visualization of equipment wear in *Death Stranding* (Kojima Productions, 2019) by using red and yellow colours unintentionally disadvantages players with colour blindness. As Mark Brown and Sky L. Anderson note, every design decision shapes player experience, underscoring the need for a thoughtful and inclusive approach to game development (op. cit., p. 710).

but also a narrative one, conveying in-game events that would typically be communicated through sound. For instance, subtle vibrations can signal an approaching threat, such as an enemy's footsteps, while more intense feedback can warn of an imminent attack or explosion. Additionally, haptic responses can reinforce immersion by simulating environmental textures, the sensation of impacts, or variations in a character's heartbeat during high-stress moments. Participants in the study particularly noted that in *Cyberpunk 2077*, the varied intensity of vibrations corresponding to different in-game events and their intensity was especially helpful in orienting them to the situation, compensating for the absence of certain auditory cues and improving their ability to react effectively in dynamic scenarios.

However, for these features to be truly effective, they must be designed with diverse user needs in mind, including those of players with disabilities. Vibration settings should be adjustable in terms of intensity and type, allowing users to tailor them to their sensory preferences and limitations. Furthermore, integrating haptic feedback with visual cues – such as synchronizing vibrations with animations or colour changes on screen – can enhance clarity and reinforce the conveyed information. This multimodal approach holds significant potential for creating a more inclusive and engaging gaming experience, ensuring that accessibility features are not merely add-ons but integral components of game design.

The study results also reveal a clear preference among participants for conveying auditory information through visual effects rather than textual transcription. In this context, one participant highlighted the positive impact of games that adopt a comic book aesthetic, praising their use of conventionalized, easily recognizable visual cues that provide instant feedback on in-game events. For example, in *Comix Zone* (Peter Morawiec, Sega, 1995), sounds are visualized through expressive onomatopoeic effects, while information about combat interactions is communicated via distinctively coloured icons.

The absence of such visual cues can render certain game genres entirely inaccessible. A notable example is the *Resident Evil 2 Remake* (Capcom, 2019), where a core gameplay element involves evading the antagonist, Mr. X. Players rely solely on the sound of his footsteps to detect his presence, making this crucial gameplay cue inaccessible to deaf or hard-of-hearing players. Implementing visual representations – such as footprint icons that change colour or intensity based on proximity – could effectively address this issue. A similar solution has been successfully applied in the widely praised online multiplayer game *Apex Legends* (Respawn Entertainment, Panic Button Games, 2019), where the colour and intensity of footprint icons indicate both the distance and movement direction of nearby enemies. It is important to note that not all conventionalized visual solutions are fully effective. One study participant highlighted an example from *Dying Light 2: Stay Human*, where the screen turned an intense shade of red to signal that the char-

acter was under attack. However, this mechanism proved insufficient, as it failed to provide information about the direction of incoming attacks and also restricted the player's field of view. This widely used method of visualizing threats in games can therefore be problematic and unclear, particularly for players who rely more heavily on visual cues.

The lack of such accessibility features points to insufficient play-testing at various stages of game development, often resulting from a failure to account for the needs of diverse user groups. These challenges could be mitigated by incorporating sensory-limited testing conditions – such as gameplay sessions with disabled audio – to identify potential barriers. An even more effective approach would involve actively integrating players with disabilities into the game testing process, ensuring that accessibility considerations are embedded into the design from the outset.

Broader Implications and Emerging Considerations in Game Accessibility

The study participants provided critical insights regarding the implementation and perception of accessibility features in Polish video games. Among the most frequently cited positive examples was *Cyberpunk 2077*, which now offers a comprehensive suite of accessibility options, such as field-of-view (FoV) adjustments and customizable subtitle backgrounds. However, it was noted that many of these features were introduced only in post-launch updates, highlighting a significant oversight in considering accessibility during the game's initial design phase. In its original release, *Cyberpunk 2077* lacked even basic warnings about the risk of photosensitive epilepsy, despite extensive use of flashing lights, strobe effects, and high-intensity flickering. This omission represented a severe lapse in player safety, potentially exposing individuals to serious health risks.

Although subsequent updates made the game more accessible to players with diverse needs, the delayed implementation of key accessibility features underscores a broader issue within the gaming industry – the tendency to treat accessibility as an optional enhancement rather than an integral component of game quality and safety. This approach not only limits the potential audience but also perpetuates the misconception that accessibility is a secondary concern, contradicting the principles of inclusive design.

Another critical finding from the study highlights that features not originally designed as accessibility tools can unexpectedly play a significant role in assisting players with disabilities, effectively filling gaps left by conventional assistive mechanisms. A prime example is *The Witcher 3: Wild Hunt*, in which Geralt of Rivia regularly verbalizes key in-game information, such as the presence of monster nests, shifting weather conditions, and other contextually significant details. For players who are deaf or hard of hearing, these narrative monologues provide crucial environmental cues that would otherwise be conveyed

through audio signals, such as approaching enemy footsteps or ambient sounds like the wind intensifying before a storm.

This feature allows players to anticipate challenges and mitigate surprise elements that might otherwise impede or disrupt gameplay. More importantly, it demonstrates how character-driven narration can function as a form of "audio description" for players who rely primarily on visual input. Additionally, such mechanics contribute to immersion by fostering a deeper connection with the protagonist; players not only receive information but also gain insight into how the character perceives and processes the game world. This approach enhances the overall sense of presence and engagement, which is vital for maintaining flow in gameplay. Similar mechanisms could be adapted across various genres – in survival horror games, for instance, having the protagonist verbalize their fear or unease in response to unseen threats could simultaneously enhance accessibility and add an additional layer of narrative depth.

One of the most advanced yet underutilized accessibility features in video games is the implementation of sign language interpretation. Notable examples include *Forza Horizon 5* (Playground Games, 2021) and *Spider-Man 2*, where sign language interpreters appear on-screen during key narrative sequences. While this innovation significantly improves accessibility for deaf players, it also raises certain challenges. Study participants noted that the additional visual layer could sometimes be distracting, particularly in fast-paced or visually complex game environments where the interpreter's presence may compete with other critical on-screen elements.

Another major challenge concerns linguistic diversity. Sign languages vary across regions and countries, necessitating the involvement of interpreters fluent in specific national or regional variations. Unlike subtitles, which can be relatively easily translated into multiple languages, implementing sign language interpretation is time-consuming and resource-intensive. Moreover, not all deaf players prefer this solution – many opt for subtitles, which are often more practical and less intrusive in the context of high-intensity gameplay.

To ensure the effective integration of sign language interpretation, further research is needed to optimize its placement and scale within the visual hierarchy of the game environment, minimizing potential interference with gameplay. However, it is crucial to recognize that even simpler and less resource-intensive solutions – such as well-designed subtitles, high-contrast UI elements, and clear visual indicators – can significantly enhance accessibility.

The prioritization of such features as fundamental design principles, rather than optional add-ons, represents a cornerstone of inclusive game development. By embedding accessibility considerations from the earliest stages of game design, developers can create experiences that are not only more equitable but also richer and more immersive for all players.

This study provided detailed insights into players' individual experiences, preferences, and expectations, enabling a deeper understanding of which specific game elements and mechanics pose the greatest challenges and require improvement. Participants articulated clear expectations regarding immersive and playable game design and identified technical issues and shortcomings in the implementation of accessibility features. These findings offer valuable guidance for game developers aiming to create more inclusive gaming experiences.

Ensuring that video games accommodate the needs of deaf and hard-of-hearing players necessitates a multifaceted and holistic approach. This includes the personalization of accessibility options, the implementation of visual alternatives, and rigorous testing from an inclusive design perspective. Based on the findings of this research, a set of best practices has been developed to enhance the accessibility of interactive digital media.

One of the study's key conclusions is the critical need for full subtitle customization. Accessibility options should allow players to adjust the size, colour, font style, and background of subtitles, as well as control their display speed. Particular emphasis should be placed on features such as text highlighting or outlining, which significantly improve readability across diverse backgrounds. Moreover, incorporating subtitles for ambient sounds – such as sound effects – represents a crucial aspect of accessibility. Clear and intuitive descriptions (e.g., *"loud explosion"* or *"soft rustling"*) can effectively convey auditory context. At the same time, maintaining a balance between the quantity of subtitles and their clarity is essential to prevent cognitive overload. Subtitles should be presented in a way that remains intuitive and non-intrusive, ensuring a seamless understanding of in-game events.

The implementation of visual substitutes for sound is crucial to the gameplay experience of deaf and hard-of-hearing players. Introducing visual indicators, such as icons, light effects, and animations, allows these players to perceive key in-game events. Additionally, both diegetic and non-diegetic interface solutions, such as visual navigation cues, should be considered, as they enhance immersion and gameplay fluidity. It is essential that these visual cues remain clear and even conventionalized – designers might explore enriching the game's aesthetics with elements inspired by other media (e.g., comic book aesthetics) or employing genre-specific informational strategies, such as visual indicators and RPG-style maps or dynamic visual effects commonly associated with action games.

Furthermore, the study highlights the necessity of involving individuals with disabilities, including deaf and hard-of-hearing players, in playtesting at every stage of game development. This approach enables a deeper understanding of their specific needs and facilitates the early detection of potential barriers in game mechanics, interface design, and system functionality.

Conclusion

Equally important is integrating accessibility considerations into the early stages of game design. Accessibility should be treated as an inherent aspect of game development rather than an add-on implemented in the final production phases, a practice that, unfortunately, remains prevalent in the industry. Addressing the needs of players with disabilities from the outset allows for the design of cohesive and well-thought-out features, such as visual sound substitutes, intuitive customization options, and carefully structured interfaces. Moreover, this approach promotes a seamless integration of accessibility within the game's narrative, mechanics, and aesthetics, not only enhancing inclusivity but also enriching the overall player experience.

In conclusion, adapting games to the needs of deaf and hard-of-hearing players requires a broad range of solutions, encompassing both transcription technologies and innovative approaches to sound design and visualization. A key factor is the inclusion of individuals with disabilities in the design and testing process to ensure that games genuinely address their needs.

Moreover, research on gaming practices among deaf and hard-of-hearing players remains in its early stages, and its further development presents a promising direction for future studies in this field. Given the limited scholarly attention to specific accessibility features in the existing literature, this area warrants deeper exploration. As a society, we should strive to create media that are accessible to the widest possible audience, regardless of individual limitations.

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