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Marcelo M. Soares, Francisco Rebelo, Tareq Z. Ahram

### **Accessibility Features in Digital Games that Provide a Better User-Experience for Deaf Players**

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# 8 Accessibility Features in Digital Games that Provide a Better User-Experience for Deaf Players *A Proposal for Analysis Methodology*

*Sheisa Bittencourt, Alan Bittencourt  
and Regina de Oliveira Heidrich*

## CONTENTS

8.1	Introduction .....	136
8.2	Development .....	137
8.2.1	Universal Design.....	137
8.2.2	Usability.....	139
8.2.3	Exclusion of Deaf People in Digital Games .....	141
8.2.4	User-Experience.....	142
8.3	Methodology.....	143
8.3.1	Choice of the Analyzed Games .....	144
8.4	Analyzing the Games .....	146
8.4.1	<i>Marvel's Spider-Man</i> (2018).....	147
8.4.2	<i>God of War</i> (2018) .....	148
8.4.3	<i>The Last of Us Part 2</i> (2020) .....	148
8.4.4	Crossing of the Accessibility Features .....	149
8.5	Results Evaluation .....	153
8.6	Conclusion .....	154
	References.....	155

## 8.1 INTRODUCTION

Digital games represent an important part of the entertainment industry, both in numbers of avid consumers and in terms of the high amount invested and generated by them. The interest of the industry and the academy also grows at great speed and it is possible to verify the increase of works on this theme, as explained by Westin et al. (2019). Data taken from a study by the North American company NPD Group (2020)\* points out that between the years 1999 and 2009, the digital games industry grew over 400% in revenue, a growth that represents more than ten times than the one in the film industry, which has always been seen as a giant in the entertainment industry, which, however, in the same period grew only by 32%.

The interest that has formed around digital games shows that they are also increasingly solidifying as an important form of sociability, an example of this is the use of words related to digital games on the Instagram platform. The word *gamer* has been marked 36.9 million times, while the games *The Last of Us*<sup>†</sup> (2015) and *The Last of Us Part 2*<sup>‡</sup> (2020) appear together with more than 284 thousand mentions. Through the use of hashtags of these words, users can find content and other people who share their interests and thus can practice network sociability. These data were extracted from the Instagram platform itself and are an indication that it is not only the act of playing that is important to the user, but also the sharing of their experiences and perceptions about the games. Because they are frequently cited and referenced, AAA games were chosen as the object of analysis in this work. Aquino et al. (2019) state that this category, AAA, encompasses games that receive high financial and advertising investment, and consequently end up in managing the rules and future aesthetic trends of the games industry. Based on the wide research of AAA games, it is possible to assume that a deaf person who marks these games on their social networks would receive much more interactions with their publication than if they were to post about an independent game made especially for a deaf person, for example. It is important to emphasize that it is not minimizing the importance that educational games have for cognitive development, but this work is limited to games produced by large companies, due to their great reach and, consequently, to the high degree of sociability that these games can generate.

If games have been an important factor in sociability, it is also necessary to think of those who are left out of this expanding universe due to limitations that arise from disability. According to the World Report on Disability (2011), carried out by the UN, there are more than one billion people with disabilities in the world, representing at least one-eighth of the world population, and consequently, a large number of possible consumers of digital games could have been overlooked several times by the game industry. As pointed by Westin et al. (2019), several non-governmental initiatives have pressured various segments of the entertainment industry to also

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\* NPD Group is a North American company specialized in offering data related to market research. NPD Group: Market Research and Consumer Trends (2020) is available at <<https://www.npd.com/>>. Accessed August 13, 2020.

<sup>†</sup> *The Last of Us*. Sony Interactive Entertainment, 2015. 1 Electronic game.

<sup>‡</sup> *The Last of Us Part 2*. Sony Interactive Entertainment, 2020. 1 Electronic game.

design their product for people with disabilities. This directly moves forward the game industry, which in recent years has sought to correct this mistake. It is increasingly possible to notice that large game producers include accessibility features as a highlight of their releases. It is possible to mention the case of the game *The Last of Us Part 2*, launched in June 2020, which has great prominence in the world press, being even pointed out by the BBC\* as the most accessible digital game ever made, with more than 60 options available for accessibility.

Accessibility to digital games is established to remove barriers that cause exclusion of the target audience from the game, maintaining an equivalently challenging user-experience, regardless of whether a player has a disability or not. Therefore, the objective of this article is to analyze how accessibility features, linked to hearing, are related to the principles of Universal Design and Jakob Nielsen's usability heuristics. As a hypothesis, it is expected that this analysis will make it possible to identify strengths that the industry has developed in terms of accessibility features, related to hearing, and to identify opportunities that can be explored in this field in order to reduce the exclusion of people with disabilities in digital games. As the methodology, a comparison will be made between the accessibility features of the three games and the principles of Universal Design and Jakob Nielsen's Heuristics. It is important to note that this article does not intend to assess the efficiency of the accessibility features and, therefore, does not do tests with end users. The intention of this study is to categorize the accessibility features found in the three games analyzed using accessibility and usability principles.

## 8.2 DEVELOPMENT

This work intends to do an analysis of the accessibility features in digital games, linked to hearing, but for that, it is necessary to specify some concepts that are important for this research. Therefore, this section is divided into four parts: Universal Design, usability, exclusion of deaf people in digital games and user-experience (UX).

### 8.2.1 UNIVERSAL DESIGN

The Universal Design aims the development of projects that can be used by anyone: children, tall and shorts adults, the elderly, pregnant women, obese, people with disabilities or with reduced mobility. It applies to products or environments, physical or digital. The main concept of Universal Design is that it is not necessary to develop products for a specific group of individuals but to develop them in a way that can be used universally by anyone. According to Bassani et al. (2010), the expression Universal Design was created in 1987 by the American Ron Mace, a wheelchair architect, who needed an artificial respirator. Carletto and Cambiaghi (2008, p. 12) state that "Mace believed that this was the beginning, not of a new science or style,

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\* This BBC article about the accessibility of the game *The Last of Us Part 2* (2020) is available at <https://www.bbc.com/news/technology-53093613>

but the perception of the need to bring together the things we design and produce, making them usable by all people.”\*

The concept of Universal Design is not the most suitable for digital games, as a large part of these is not intended to be universally played by anyone. Just like movies and television series, digital games are divided into genres and rating systems of indicative age that end up not only restricting the access of younger players to violent content but making each product developed according to the wishes of their desired target audience. The *Dark Souls*<sup>†</sup> game franchise, for example, is known for its high degree of difficulty and for not having a choice of levels such as easy, normal and hard. Its players seek the extreme challenge, as pointed out by Nuenen (2016). So it is not of great interest for the company, creator of the franchise, to make the game easier, with the purpose of expanding the target audience of its product, not even offering different difficulty options that allow a casual player to be able to enter the franchise, because *Dark Souls* is a difficult game, for people who like difficult games.

The important thing at the moment is to point out that Universal Design was chosen for this research, not because of its conceptual alignment with the way that the games industry develops its products, but because the principles of Universal Design are important for the analysis of the accessibility features made in this research. In the 1990s, a group of architects, product designers, engineers and design researchers was formed to establish the principles of Universal Design. According to Mace et al. (1998, p. 32), “the principles could be applied to evaluate existing designs, guide the design process, and educate designers and consumers about the characteristics of more usable products and environments.”

The Universal Design proposes seven principles that seek to supply the needs to organize accessibility into categories regarding possible uses, analysis and even considerations when designing a product (physical or digital) or an environment (public or private). According to Mace et al. (1998), these seven principles are:

1. **Equitable Use:** The design is useful and marketable to people with diverse abilities.
2. **Flexibility in Use:** The design accommodates a wide range of individual preferences and abilities.
3. **Simple and Intuitive Use:** Use of the design is easy to understand, regardless of the user’s experience, knowledge, language skills, or current concentration level.
4. **Perceptible Information:** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user’s sensory abilities.
5. **Tolerance for Error:** The design minimizes hazards and the adverse consequences of accidental or unintended actions.

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\* Original text in Portuguese Brazil. Translated by the authors.

<sup>†</sup> *Dark Souls*. Namco Bandai Games, 2009. Electronic game.

6. **Low Physical Effort:** The design can be used efficiently and comfortably as well as with fatigue to be a minimum one.
7. **Size and Space for Approach and Use:** Appropriate size and space are provided for approach, reach, manipulation and use regardless of the user's body size, posture or mobility.

It is important to point out that according to the seven principles of Universal Design, creating a product that meets these principles does not necessarily mean developing something that will be used in the same way by everyone. Universal Design recognizes that people create a wide variety of modes of use for the same product and that is exactly what the first two principles, Equitable Use and Flexibility in Use, refer to.

When it is said that a product must be of Equitable Use for people with different capacities, it is proposing that the product should enable the same way of use for all users, be identical when possible, equivalent when not. According to Mace et al. (1998), an example is the door handles that go from the top to the bottom of the door, making it possible for people of different heights or postures to be able to open it. The Flexibility in Use refers to the ability of a product to offer a wide range of preferences regarding its use and a specific example in digital games would be the possibility to reconfigure a game controller functions according to the preferences of each player, making it possible, for example, that all important functions are on a single side of the controller, enabling use by people who have reduced mobility in either hand or even who do not have one of them. These specific cases show that the concept of universality of Universal Design is not about making each product a kind of Swiss Army Knife, with spare features and functions that will not make sense to those who do not need it, but through its flexible use and equivalence, it has the potential to become more specific to each niche of individuals.

Although there are many approaches to Universal Design, and when the gaming industry directs its efforts to offer a large range of accessibility features, it does not intend in any way to exceed the limits of its target audience, because there is a regulatory system of laws which guarantees the control of these limits, in the case of age classification.

### 8.2.2 USABILITY

With the advancement of technology, there have been discussions about ways to make digital environments friendlier and easier to use. Bassani et al. (2010) point out that to avoid problems with the use of digital tools, issues related to usability and accessibility must be foreseen from the beginning of the project. The ISO/IEC 25030:20083\* defines usability as “the ability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions.” Bassani et al. (2010) explain that there are different proposals to evaluate the

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\* This rule provides the requirements and recommendations for specifying software product quality requirements.

usability of a digital product, but that among the different methods, the evaluation by Nielsen's Heuristics stands out.

Jakob Nielsen is the creator of the heuristics, which bear his name, and according to the information displayed on his own website,\* it is possible to notice that Nielsen created several usability assessment methods, including the heuristic evaluation. According to Dias (2007), the heuristics were developed in 1990 with the collaboration of Rolf Molich, and in 1994, Nielsen refined the heuristics based on a factor analysis of 249 usability problems, resulting in a revised set of ten heuristics. According to Nielsen (1994), the following are the ten heuristics:

1. **Visibility of system status:** The system should always keep users informed about what is going on, through appropriate feedback within a reasonable time.
2. **Match between system and the real world:** The system should speak the user's language, with words, phrases, and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
3. **User control and freedom:** Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
4. **Consistency and standards:** Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
5. **Error prevention:** Even better than good error messages is a careful design that prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
6. **Recognition rather than recall:** Minimize the user's memory load by making objects, actions and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
7. **Flexibility and efficiency of use:** Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
8. **Aesthetic and minimalist design:** Dialogues should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
9. **Help users recognize, diagnose and recover from errors:** Error messages should be expressed in plain language (no codes), precisely indicate the problem and constructively suggest a solution.

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\* Jakob Nielsen's website: <https://www.nngroup.com/people/jakob-nielsen/>



10. **Help and documentation:** Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, be focused on the user's task, list concrete steps to be carried out and not be too large.

Nielsen's ten heuristics, along with the seven principles of the Universal Design, will be the foundation for the analysis of accessibility features related to hearing in digital games.

### 8.2.3 EXCLUSION OF DEAF PEOPLE IN DIGITAL GAMES

The author Collins (2008) says that in the early days of digital games, sound insertion functioned more as a mechanical feedback response to a given action; she offers as an example *Pong*\* (1972), the first commercially successful digital game that consisted of a kind of digital ping pong where each player should hit a ball with a rectangular platform, throwing it to the other side of the screen. Every time that the player managed to prevent the ball from falling, a sound is played. The sound, in these types of games, had the function of being a complement to the functions that were already evident on screen; they served to reassure the player that the task had been performed as expected. The sound in this scenario was not a restriction for a deaf player, who could be fully capable of playing *Pong*, both against the machine and with other players, without impairing his performance.

Collins (2008) points out that this started to change in the early nineties, when most home computers started to be launched with a CD-ROM player and Sony, in 1995, launched the PlayStation console, which also featured a CD-ROM player for their games. This made it possible for video games to invest much more in the sound of their narratives. The exponential expansion of technology and the popularization of home computers and video game consoles meant that the old technical limitations that prevented the insertion of more complex audio in digital games were overcome, making it possible to develop sophisticated soundtracks and character's speeches, arriving at a point where there are games nowadays in which entire orchestras are able to create the immersion atmosphere as designed by the game's creators. That is the case, for example, in the game *God of War 2*<sup>†</sup> (2007); the musical team consisted of four composers, three orchestrators, three ensembles (metals, strings and choir), a variety of soloists, a development team and an implementation team (Collins 2008). This, at the time, became common among the major producers of digital games, especially among AAA games.

This technical diversity paved the way for new possibilities, both at artistic and at gameplay level. Many games have started to use sound as elements in their gameplay to achieve the success of a mission, for example. This is the case of the game *God of*

\* *Pong* – video game released in 1972, named as the first profitable video game in history. *Pong* is an electronic game from Atari.

<sup>†</sup> *God of War 2*. Sony Interactive Entertainment, 2007. Electronic game.



*War*\* (2005), where during a challenge in the desert, the player must find and battle with three enemies and although the fights with them are quite challenging, the most difficult part is finding the enemies. This search must be done through different frequencies of sound that are revealed between heavy sandstorms, and even if the enemy is eventually shown briefly, the player's sense of orientation is almost entirely through hearing only. Although there are many positive criticisms regarding the great differential of adding audio as an essential part of the gameplay, an important fact can go unnoticed in this regard: by adding audio as an obstacle to be overcome, it causes the exclusion of an audience that previously was not excluded. If the use of elaborate orchestras can serve for a more refined setting in the story, creating a challenge where the player needs to use his hearing skills to move on, can make a deaf player unable to finish the game and it is exactly in this scenario that accessibility features, linked to hearing, are needed in digital games.

Digital games companies have developed accessibility features that offer ways for deaf players to complete tasks within games using other resources besides hearing. These range from game controller vibrations, to subtitles and visual elements to identify approaching enemies, for example.

#### 8.2.4 USER-EXPERIENCE

This research intends to analyze the accessibility features, linked to hearing, in digital games, so that it is possible to verify whether the experience of this deaf player is really equivalent to what other players, without hearing loss, experience. To do so, at this moment it is necessary to bring the concept of user-experience and the concept of experience itself. Bondía (2002) states that "Experience is what goes through us, what happens to us, what touches us. Not what is going on, not what is happening, or what it touches." In this way, the author establishes that the experience is only relevant if it involves the subject, in fact, that is, if it is important for what the user deems relevant. Borges et al. (2019) state that the main goal of game development is to create a product that is fun to play, presents surprises, provides a challenge to players and promotes social connections. Thus, it is up to the game company to make a game that goes through us, that happens to us and that touches us, being characterized as well as what Bondía (2002) calls experience.

Stull (2018), on the other hand, offers the definition of user-experience, which in a way, is more in line with what is investigated in this research, since the concept of experience itself can have much broader developments. Stull (2018) says that the user-experience includes aspects of cultural anthropology, human-computer interaction, engineering, journalism, psychology and graphic design, and is related to enabling the user to experience a service or product in a satisfactory way, meeting their needs and expectations generated in relation to the product. The user-experience appears as an intersection between the user's expectations, how much he expects from a finished product or service and the company's objectives for that product or service.

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\* *God of War*. Sony Interactive Entertainment, 2005. Electronic game.

Borges et al. (2019) say that user-experience, when referenced in the area of digital games, is commonly used as a synonym for player experience. When we, then, apply the concept of user-experience of Stull (2018) to the digital games, especially with regard to players with disabilities who make use of accessibility features, the user-experience refers to offering a game experience that meets the expectations of this player. But this must be done without simplifying the game or reducing the game's challenge, as this is often part of the experience designed for the user.

### 8.3 METHODOLOGY

As this research does not plan to apply its results to a specific product, its nature is established as basic, that is, it aims to generate new knowledge useful for the advancement of science without expected practical application. Prodanov and Freitas (2009) say that this type of research involves universal truths and interests.

The way of approaching the problem of this study is qualitative, since it is a selection made from the principle of data collection, fragmenting and extracting what is necessary and always analyzing the value of each information, but without necessarily requiring the use of statistical methods and techniques. Further on, it will be possible to view a table with the accessibility features, in which it is possible to count and list these items, but for that purpose, no specific statistical technique is necessary, which would characterize the work as quantitative.

This work has the purpose of exploratory research, providing, this way, greater familiarity with the problem and allowing the construction of hypotheses. This research adopts bibliographic and documentary procedures, and Prodanov and Freitas (2009) say that the bibliographic procedure is characterized when a work is carried out from material already published, with the objective of putting the researcher in direct contact with material already written on the researched subject. In the case of this research specifically, the search for academic articles was carried out by crossing the words accessibility, digital games and deafness, between the years 2013 and 2020. Seven academic works were found in four different journals through this research. After doing a preliminary reading in their abstracts, it was decided to choose two of them for in-depth research where it was observed how the repetition of concepts was covered and how the theoretical framework was divided. The documentary procedure concerns the use of digital games as objects of analysis. This type of research is based on materials that have not yet received an analytical treatment or that can be reworked according to the research objectives. Prodanov and Freitas (2009) quote as examples the documental procedures of the analysis of "official documents, newspaper reports, letters, contracts, diaries, films, photographs, recordings, etc." (Prodanov and Freitas 2009, p. 56). The authors do not mention digital games in their examples as they are characterized as an audiovisual product, and because of its aesthetic and technical proximity to films and recordings, it was decided that it would be characterized in terms of documentary procedure.

To analyze the accessibility features themselves, different methodological approaches were needed. After choosing the three games to analyze, it would still be necessary to define a procedure for the analysis of these games. Some alternatives

**TABLE 8.1.**  
**Stages of the Method of Analysis of Digital Games**

- (1) Purchase and install all three games.
- (2) Play for 60 minutes each game, without activating accessibility features and with audio on.
- (3) Access the accessibility features menus and capture screenshots.
- (4) List the accessibility features for each game.
- (5) Play each game for 60 minutes, with active accessibility features and audio turned off.
- (6) Detail the resources found in Step 4, inserting the insights obtained from Step 5.
- (7) Cross-check the listed resources with the principles of Universal Design and Jakob Nielsen's Heuristics.

were outlined, but in the end, it was chosen to work as follows: first, it would be necessary to purchase the chosen games. After that, it would be necessary to play at least one hour of each of these, without any accessibility feature activated. After playing them, open the accessibility features menus, one game at a time, capture the image of these screens and then make a list of all the features that are found. After identifying the available accessibility features, they were activated and three games were played for another 60 minutes. With the information on how each of these features operates, it was possible to detail the functioning and objective of each of the features. This procedure uses some approaches to what Kilpp (2010) framing method proposes, which suggests the dissection and division of moving images into groups of information by approximation or similarity, removing fragments from the video and analyzing them in a different way separately, and then, returning to the flow and observing how these elements behave in a fluid environment, but with prior knowledge of how it operates separately.

With the three lists of detailed accessibility features, a table was created where the features linked to hearing could be analyzed through a cross between the principles of Universal Design and Jakob Nielsen's Heuristics. This crossing is an adaptation of a method created by Bassani et al. (2010) to analyze accessibility and usability in distance learning teaching interfaces.

So, after the table is completed and analyzed, it is expected to find strengths that have been practiced by the game industry with regard to accessibility features, linked to hearing impairment, and to also identify possible opportunities to be explored in order to reduce the exclusion rate of deaf people in digital games. A table of this process can be checked below, with the steps of the analysis method that was developed (Table 8.1).

### 8.3.1 CHOICE OF THE ANALYZED GAMES

Since it was defined that a research would be carried out to analyze the accessibility features in digital games, it was summarily defined that this research would be restricted to games launched by major digital game producers, due to the great reach that they have in the current scenario. There have been initiatives to create accessible

games made by independent companies and even by research groups at universities for a long time, and many of the features used by the game industry today are due to the pioneering nature of these initiatives that provide a wide range of materials aimed at disabled people. These high numbers can be verified in online stores, such as Google Play Games\* or Steam,† which have hundreds of games in this line, and many of these games are free.

It is not the intention of this research to say that the big producers of digital games are not all concerned with accessibility, as there has been a general growth in recent years in games that offer accessibility options, including from big producers. Information about this can be found at the Game accessibility guidelines website,‡ where studies carried out collaboratively between game studios, specialists and academics are exposed, which they intend to produce for the developers a direct reference in ways to avoid the exclusion of players with disabilities and ensure that more digital games can be experienced by as many people as possible. In this website, several games are mentioned and their accessibility features are commented.

In this way, this research initially chose to use the three best-selling games of the year 2020 as the object of analysis. As a source of this data, the NPD Group (2020) was used, which is a company widely cited when referring to digital games, being a research source for newspapers such as *New York Times* and *Metro UK*.

But during the selection, the choice criteria for the games would have to be a little more funneled, compared to what was initially foreseen. Instead of analyzing the three best-selling games of 2020, it was decided that only the exclusive PlayStation 4 games would be analyzed. This choice was made because it was necessary that all the analyses were using the same peripherals that other deaf users would use to play. If it was analyzed as a game that was offered for a different type of console, or a computer, for example, it would have a large number of variables to consider, such as which control the user would be using to perform the tasks, or even if he would be using a keyboard and mouse.

Once it was decided that there was a need to choose a specific console, the choice was for Sony's PlayStation 4, due to the popularity of the console that was pointed out by the NPD Group (2020), as the best-selling console of the decade. Another point that needed to change was the time period of the choice, this had to be changed from "the best-selling games of 2020" to "best-selling games of all time," because the first information was not found in our searches on the internet. So, Table 8.2 was created by the authors and built according to the list released by the NPD Group in July 2020 and published by *Metro UK*,§ showing the best-selling PlayStation 4 exclusive games of all time, until the time of the survey (Table 8.2).

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\* Google Play Games: the store calls itself as a game manager, where you can purchase paid and free games. Available at <https://play.google.com/>. Accessed July 15, 2020.

† Steam is a digital game management software and website.

‡ Game accessibility guidelines website: <http://gameaccessibilityguidelines.com/>

§ The research about the best-selling games can be seen in the site: <https://metro.co.uk/2020/07/22/marvels-spider-man-best-selling-ps4-game-ever-us-13023245/?ito=cbsshare> Accessed September 27, 2020.

**TABLE 8.2.**  
**The Five Best-Selling Playstation 4 Exclusive Games  
 in the U.S. until July 2020**

1. <i>Marvel's Spider-Man</i> (2018)	Release date: September 7, 2018
2. <i>God of War</i> (2018)	Release date: April 20, 2018
3. <i>Horizon Zero Dawn</i> (2017)	Release date: February 28, 2017
4. <i>The Last of Us Part 2</i> (2020)	Release date: June 19, 2020
5. <i>Final Fantasy 7 Remake</i> (2020)	Release date: March 2, 2020

Despite that, the list in Table 8.2 presents that the three best-selling exclusive games are *Marvel's Spider-Man*\* (2018), *God of War*† (2018) and *Horizon Zero Dawn*‡ (2017), and this list has become impractical, because in the second half of 2020 the third game, *Horizon Zero Dawn* (2017), was launched on computers with Microsoft Windows. Thus, this game becomes ineligible for this analysis, because of the reasons previously mentioned. In this way, the third item on the list is eliminated, the three games analyzed according to the announcement made by the *NPD Group* (2020) are *Marvel's Spider-Man* (2018), *God of War* (2018) and *The Last of Us Part 2* (2020).

## 8.4 ANALYZING THE GAMES

As described in the methodology chapter, to analyze the *Marvel's Spider-Man* (2018), *God of War* (2018) and *The Last of Us Part 2* (2020) games, the games were purchased at first, then downloaded and finally installed. It was stipulated that each game would be played for one hour, without using any accessibility feature and with the audio on. The time of 60 minutes was chosen because it is noticed that this would be the minimum time for checking the accessibility features, since the first minutes are used mainly for tutorials on game mechanics and it would not be possible to accurately analyze the features during these initial moments.

After that time, image captures were made from the accessibility features menus and with these images it was possible to create lists of all the features offered. With this list in hand, the three games were played again, this time with the accessibility features, related to hearing impairment, enabled and the audio turned off. After another 60 minutes of play, it was possible, with these new insights, to create a more detailed list that effectively describes what it serves and how each accessibility feature works effectively. Table 8.3 presents the list of features found in the three games.

Next, all the features found were detailed and how the cross-check was made with the principles of Universal Design and Jakob Nielsen's Heuristics was explained

\* *Marvel's Spider-Man*. Sony Interactive Entertainment, 2018. Electronic game.

† *God of War*. Sony Interactive Entertainment, 2018. Electronic game.

‡ *Horizon Zero Dawn*. Sony Interactive Entertainment, 2018. Electronic game.

**TABLE 8.3.**  
**List of Features Found in the Three Games Analyzed**

<i>Marvel's Spider-Man (2018)</i>	<i>God of War (2018)</i>	<i>The Last of Us Part 2 (2020)</i>
1. Subtitle	1. Subtitle	1. Subtitle
2. Subtitle background	2. Subtitle name	2. Subtitle name
3. Subtitle size	3. Subtitle background	3. Subtitle direction
4. Combat camera	4. Subtitle size	4. Subtitle background
5. Attack alert	5. Combat camera	5. Subtitle size
6. Vibration	6. Enemy indicator	6. Name color
	7. Vibration	7. Subtitle color
		8. Danger indicator
		9. Damage indicator
		10. Notification of collected item
		11. Frequent dodge alert
		12. Impact marker
		13. Combat vibration alert
		14. Guitar vibration alert

#### 8.4.1 *MARVEL'S SPIDER-MAN (2018)*

When checking the options menu of the *Marvel's Spider-Man (2018)* game, three accessibility features were found, which are subtitles for dialogues and the possibility of placing a background on it or increasing its size.

Three other features were found in the game, which help to eliminate barriers for deaf people, but these are always active by default and they are as follows: camera positioning assistant, visual alert of enemy attack and a diverse range of game controller vibrations as a return for specific actions in the game.

The features found are explained as follows:

1. **Subtitle:** enables subtitles for character dialogs in most of the game. When enabled, it also shows the name of the character who is speaking next to his caption and defines different colors for different characters, to facilitate differentiation.
2. **Subtitle background:** a background is added behind the subtitles to increase the contrast between the elements and facilitate, in that way, the reading.
3. **Subtitle size:** increases the size of the subtitles that will be displayed on the screen.
4. **Combat camera:** constantly adjusts the camera's position in the game to show nearby enemies. Thus, the player does not need to rely solely on his hearing to identify nearby enemies. This feature is active by default for all players.
5. **Attack alert:** named in the game as "Spider-Sense," this feature visually alerts the player when an attack is about to be launched in the direction of the player's character. This feature is active by default for all players.

6. **Vibration:** several actions in the game, in and out of combat, are confirmed by the vibration of the game controller. These often occur together with sounds and visual cues.

#### 8.4.2 GOD OF WAR (2018)

When browsing through the options menus of the game *God of War* (2018), four accessibility features were found with the purpose of eliminating barriers for deaf people, which are subtitles and the possibility of adding names to it, background or increasing their size.

Three other features were found in the game, which help to eliminate barriers for deaf people, but these are always active by default, in the same way as in the *Marvel's Spider-Man* (2018) game.

The features found are explained below:

1. **Subtitle:** enables subtitles for character dialogs in most of the game.
2. **Subtitle background:** a background is added behind the captions.
3. **Subtitle size:** makes it possible to increase the subtitle size.
4. **Subtitle name:** shows the name of the character who is speaking next to the subtitles.
5. **Combat camera:** automatically adjusts the position of the camera in the game to show enemies that are attacking. This feature is active by default for all players.
6. **Enemy indicator:** this feature visually shows, through arrows, in which direction the enemies are. But only the enemies that are not being seen on the screen. Also exhibits different colors of arrows to differentiate enemies between who are carrying out physical attacks and who attack with projectiles. This feature is active by default for all players.
7. **Vibration:** several attacks, actions and interactions with objects are accompanied by vibrations of the control, facilitating their identification. These often occur together with sounds and visual cues.

#### 8.4.3 THE LAST OF US PART 2 (2020)

When checking all the options on the menus of the game *The Last of Us Part 2* (2020), 13 accessibility features were found.

Another feature was found in the game, which helps to eliminate barriers for deaf people, but it is always active by default, which are indicators of damage.

The features found are explained below:

1. **Subtitle:** enables subtitles for character dialogs in and out of combat.
2. **Subtitle name:** shows the name of the character who is speaking next to the subtitles.
3. **Subtitle direction:** an arrow is visible next to the subtitles to show the direction of the speaking character.



4. **Subtitle background:** a background is added behind the subtitles.
5. **Subtitle size:** makes it possible to increase or decrease the subtitle size.
6. **Name color:** brings several color options for the character's names displayed next to the subtitles.
7. **Subtitle color:** allows the user to change the colors of the subtitles text.
8. **Danger indicator:** visual indicators appear on the screen warning that an enemy is about to see the player's position and in which direction the enemy is. When this option is off, the danger and direction indicators are transmitted to the player via audio only.
9. **Damage indicator:** visual indicators appear on the screen showing in which direction the enemy attacked and caused damage to the player's character.
10. **Notification of collected item:** visual notifications appear on the screen when collecting an item. When this option is off, only one sound is heard when collecting an item.
11. **Frequent dodge alert:** the dodge button appears on the screen whenever an enemy initiates a body attack. Players without hearing impairment can identify the enemy's attack by the increase in sound it makes when approaching the player's character.
12. **Impact marker:** the visual marker that is in the middle of the screen, and is used as a crosshair to fire firearms, changes the color to red, for a short period, to show that an enemy was defeated with one shot.
13. **Vibration alert in combat:** enables game controller vibration alerts (1) when an enemy initiates a body attack, (2) when the character is aiming at an enemy and (3) when a shot hits an enemy. When this option is turned off, part of this information is only transmitted to the player by sound. An example of this is when the player hits a shot at the enemy, and when the enemy screams, the sound of screams makes the player to understand that enemy is hit.
14. **Guitar vibration alert:** game controller vibrations occur when hitting a guitar note.

#### 8.4.4 CROSSING OF THE ACCESSIBILITY FEATURES

Step 7 of the game analysis procedure consists of crossing the accessibility features found in the three games analyzed, the principles of Universal Design and Jakob Nielsen's Heuristics. As can be seen in Table 8.4, the principles of Universal Design are represented in each of the columns in the table, and the Jakob Nielsen's Heuristics in each of the lines. The 27 accessibility features identified were placed at the cross between these concepts, so that it is possible to identify patterns and opportunities between the features related to accessibility for deaf people. In order to see the results at once in the same table, acronyms of the games are placed in parentheses next to each of the accessibility features: **SM** for *Marvel's Spider-Man* (2018), **GW** for *God of War* (2018) and **LU** for *The Last of Us Part 2* (2020) (Table 8.4).

**TABLE 8.4.**  
**Crossing of the Accessibility Features in the Games**

	Equitable Use (18)	Flexibility in Use (8)	Simple and Intuitive Use (4)	Perceptible Information (22)	Tolerance for Error (0)	Low Physical Effort (9)	Size and Space for Approach and Use (0)
Universal Design							
- Columns							
Nielsen's Heuristics							
- Lines							
Visibility of the current state of the system (14)	(SM, GW e LU) Subtitle (GW e LU) Subtitle Name (LU) Subtitle direction (SM e GW) Combat camera	(LU) Name color (LU) Subtitle color	(SM e GW) Combat camera (SM) Attack alert	(GW e LU) Subtitle Name (LU) Subtitle direction (LU) Name color (LU) Subtitle color (SM) Attack alert (GW) Enemy indicator (LU) Danger indicator (LU) Damage indicator	-	(LU) Subtitle direction (GW) Enemy indicator (LU) Danger indicator (LU) Damage indicator	-
Correlation between the system and the real world (4)	(GW) Enemy indicator (LU) Danger indicator (LU) Damage indicator (SM e GW) Vibration (LU) Combat vibration alert (LU) Guitar vibration alert	-	-	(SM e GW) Vibration (LU) Combat vibration alert (LU) Guitar vibration alert	-	(SM e GW) Vibration (LU) Combat vibration alert	-
User control and freedom (0)	-	-	-	-	-	-	-
Consistency and standards (0)	-	-	-	-	-	-	-

(Continued)

**TABLE 8.4. (CONTINUED)**  
**Crossing of the Accessibility Features in the Games**

	Equitable Use (18)	Flexibility in Use (8)	Simple and Intuitive Use (4)	Perceptible Information (22)	Tolerance for Error (0)	Low Physical Effort (9)	Size and Space for Approach and Use (0)
<b>Universal Design</b>							
- Columns							
<b>Nielsen's Heuristics</b>							
- Lines							
<b>Error prevention (17)</b>	(SM e GW) Combat camera (GW) Enemy indicator (LU) Danger indicator (SM e GW) Vibration (LU) Notification of collected item (LU) Frequent dodge alert (LU) Combat vibration alert (LU) Impact marker	(SM, GW e LU) Subtitle background (SM, GW e LU) Subtitle size	(SM e GW) Combat camera (SM) Attack alert (LU) Frequent dodge alert	(SM, GW e LU) Subtitle background (SM, GW e LU) Subtitle size (SM) Attack alert (GW) Enemy indicator (LU) Danger indicator (SM e GW) Vibration Notification of collected item (LU) Frequent dodge alert (LU) Combat vibration alert (LU) Impact marker	-	(GW) Enemy indicator (LU) Danger indicator (SM e GW) Vibration (LU) Notification of collected item (LU) Combat vibration alert (LU) Impact marker	-
<b>Recognition instead of memorization (1)</b>	(LU) Frequent dodge alert	-	(LU) Frequent dodge alert	(LU) Frequent dodge alert	-	-	-
<b>Flexibility and efficiency of use (0)</b>	-	-	-	-	-	-	-

(Continued)

**TABLE 8.4. (CONTINUED)**  
**Crossing of the Accessibility Features in the Games**

	Equitable Use (18)	Flexibility in Use (8)	Simple and Intuitive Use (4)	Perceptible Information (22)	Tolerance for Error (0)	Low Physical Effort (9)	Size and Space for Approach and Use (0)
Universal Design							
- Columns							
Nielsen's Heuristics							
- Lines							
Aesthetic and minimalist design (0)	-	-	-	-	-	-	-
Support for users in collecting, diagnosing and recovering errors (0)	-	-	-	-	-	-	-
Help and documentation information (0)	-	-	-	-	-	-	-

## 8.5 RESULTS EVALUATION

When analyzing the completed Table 8.4, it is noticeable that some rows and columns have more accessibility features than others, and some do not have at least one item in their extension. It is possible to realize that when it comes to Universal Design, the principle of *Equitable Use* is the one that has received the most attention from AAA games. Of the 27 identified features, 18 of them are intended to match the dynamics and mechanics based on sound in the analyzed games. These resources serve to bring more than one sensory dimension (sight, hearing and touch) to information that would often only be transmitted by one of these dimensions.

Still talking about Universal Design, it is possible to realize that the principle of *Perceptible Information* is also widely used with regard to accessibility features, being identified in 22 of the 27 features found. This happens when there is important information to be transmitted during the game. In these moments, this information is transmitted in multiple ways, such as being passed through image, sound and vibration, from the accessibility feature. This fits perfectly with one of the guidelines of this principle of Universal Design, guideline number 4a, which according to Mace et al. (1998, p. 34), says “Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.”

Another principle of Universal Design that was repeated in several features was *Low physical effort*, with an impact on 9 of the 27 accessibility features. These features mean that the player does not need to move the character excessively or rotate the camera constantly, just to check information, which would be passed to the player only by audio, if these features were not activated. This, in a way, minimizes the fatigue that the player could experience, if the images on his screen were constantly moving and rotating.

The principle of *Flexibility in Use* was related to 8 of the 27 resources, and all of them are related to making subtitles more flexible. In a general way, 14 of the 27 resources, more than 50% of the features are linked to subtitles. This shows that the use of subtitles receives a lot of attention from game developers. Emilia Schatz and Matthew Gallant, the developers of *The Last of Us Part 2* (2020), confirm this by showing that among the 12 most used accessibility features in the game, 7 of them are related to subtitles (#Gaconf 2020).

As for Jakob Nielsen’s Heuristics, one of the most recurring was *Visibility of the current state of the system*, being found 14 times in the 27 accessibility features analyzed. In general, these features were used with the function of visually showing what is happening with the player’s character and around him. Part of this information would be transmitted only by audio to the player, but with the feature activated, they are transmitted in a visual and sonorous way.

Still on Jakob Nielsen’s Heuristics, it is possible to note that *Prevention of errors* is also found with great recurrence, in 17 of the 27 cases found. It is noted that the features related to this item are mainly related to danger alerts and confirmations of essential actions in the game that are transmitted mainly by audio to the player when these features are not activated.

## 8.6 CONCLUSION

The hypothesis of this work was that a detailed analysis of the accessibility features and the position in which they appear in the crossing table would serve to identify strengths that the industry has developed so far in terms of accessibility features. It was also expected to identify the opportunities to be explored in this field, in order to find alternatives to provide a better user-experience for deaf players. And so, in that way, also identify ways in order to decrease the exclusion rate in digital games. Thus, in general, it can be said that the initial hypothesis was confirmed, and by filling in the table it was possible to see empty areas that show opportunities for the game industry in terms of accessibility and usability for deaf players.

It is possible to, for example, mention that a strong point developed by the game industry is the features that refer to *Perceptible Information*, according to the principle of Universal Design. When information is important for the game to progress, it appears in different ways, with sound, messages on the screen and through the tactile vibration feature of the game controller. There is great concern in the industry to make the gaming experience comparable at the most diverse levels, and this is already related to another principle of Universal Design, which is the *Equitable Use*. Important information is passed on in different ways to the user, and redundantly, to ensure its transmission to the player and to contemplate different cognitive abilities.

On the other hand, there is a gap in the table, which can be interpreted as an opportunity to be explored, would be the lack of resources that refer to *Flexible Use*, appearing only in 8, of the 27 features. At the #GAconf (2020),\* international conference on the accessibility of digital games, during one of the panels, disabled players unanimously said that they prefer to have access to a list with the greatest number of accessibility features possible, as this makes it possible to activate features that meet their accessibility needs. This claim places the *Flexible Use*, a major priority for players with disabilities and yet resources with this characteristic do not receive as much attention from the industry when compared to other principles of Universal Design. The situation becomes even more problematic when it is realized that all eight *Flexible Use* features mentioned are related to subtitles, that is, of all the resources that the deaf player can access, only the subtitles can be changed more flexibly according to their own needs. A scenario where the deaf player has the possibility of greater flexibility in accessibility features, in terms of size, frequency, contrast, colors, intensity, among others, seems to be an alternative that could solve many problems of accessibility and usability.

As future research proposals, this project intends to study in greater depth the empty spaces in this intersection table through agile design methodologies, such as design thinking and design sprint. Further, with the partnership of deaf players, it is planned to find new ways to offer the players a better user-experience through solutions that can fill the existing gaps related to accessibility features in order to reduce the exclusion of deaf players.

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\* #GACONF: Game Accessibility Conference, 6, 2020, Online. Available at <<https://www.gaconf.com/gaconf-online-2020/>>. Accessed September 19, 2020.

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