SEVEN
publicações acadêmicas

ANALYSIS OF THE CURRENT OVERVIEW OF USE AND INTERACTION: BLIND USERS AND E-LEARNING PLATFORMS

ANÁLISE DO PANORAMA ATUAL DA UTILIZAÇÃO E INTERAÇÃO: USUÁRIO CEGO E PLATAFORMAS E-LEARNING

ANÁLISIS DEL PANORAMA ACTUAL DE USO E INTERACCIÓN: USUARIOS CIEGOS Y PLATAFORMAS DE E-LEARNING

https://doi.org/10.56238/sevened2025.029-070

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ABSTRACT

E-Learning platforms have the potential to improve the quality of learning and increase access to education, as long as they are attentive to the needs of diverse users. One of the motivations for this research was the potential to contribute by investigating the experience of blind users interacting with online educational content. This study aimed to investigate the accessibility profile of content on Brazilian distance learning institutions' e-learning websites from the perspective of blind students interacting with online educational content. Is the user experience of blind students interacting with educational content on e-Learning platforms positive? Are there limitations to achieving their goals and meeting their needs? We used online qualitative and quantitative questionnaires to collect data. We identified difficulties experienced by blind students in their interactions and the need for greater awareness among those involved in distance learning about these difficulties.

Keywords: Accessibility. E-Learning. Human-Computer Interaction. Blind Student.

RESUMO

As plataformas de e-Learning têm o potencial para melhorar a qualidade do aprendizado e aumentar o acesso à educação desde que estejam atentas às necessidades dos diversos tipos de usuários. Perceber a possibilidade de contribuir investigando a experiência do usuário cego na sua interação com conteúdos educacionais online foi um dos motivos que motivou esta pesquisa. Este estudo pretendeu pesquisar o perfil de acessibilidade dos conteúdos dos sites educacionais à distância – e-Learning - das instituições de ensino a distância brasileiras na perspectiva da experiência do aluno cego ao interagir com os conteúdos educacionais online. A experiência do usuário aluno cego ao interagir com os conteúdos educacionais nas plataformas de e-Learning é positiva? Há limitações que se apresentam para que ele atinja seus objetivos e tenha suas necessidades preenchidas? Usamos para a obtenção dos dados questionários qualitativos e quantitativos online. Identificamos dificuldades vivenciadas pelo aluno cego na sua interação e, a necessidade

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de uma maior conscientização daqueles envolvidos na educação a distância sobre tais dificuldades.

Palavras-chave: Acessibilidade. E-Learning. Interação Pessoa-Computador. Aluno Cego.

RESUMEN
Las plataformas de aprendizaje electrónico tienen el potencial de mejorar la calidad del aprendizaje y aumentar el acceso a la educación, siempre que presten atención a las necesidades de los diversos usuarios. Una de las motivaciones para esta investigación fue el potencial de contribuir investigando la experiencia de los usuarios ciegos que interactúan con contenido educativo en línea. Este estudio tuvo como objetivo investigar el perfil de accesibilidad del contenido en los sitios web de aprendizaje electrónico de las instituciones brasileñas de educación a distancia desde la perspectiva de los estudiantes ciegos que interactúan con contenido educativo en línea. ¿Es positiva la experiencia de usuario de los estudiantes ciegos que interactúan con contenido educativo en plataformas de aprendizaje electrónico? ¿Existen limitaciones para lograr sus objetivos y satisfacer sus necesidades? Utilizamos cuestionarios cualitativos y cuantitativos en línea para recopilar datos. Identificamos dificultades experimentadas por los estudiantes ciegos en sus interacciones y la necesidad de una mayor concienciación entre los involucrados en la educación a distancia sobre estas dificultades.

Palabras clave: Accesibilidad. Aprendizaje Electrónico. Interacción Persona-Computadora. Estudiante Ciego.

1 INTRODUCTION

To collaborate in this research, participants would have to be e-learning students, in an undergraduate or technical/specialization course, with complete 2nd grade or higher education, with visual impairment or blindness.

The visually impaired or blind students had completed online courses in Brazil. The group consists of a sample of 21 people, between 25 and 61 years old, 12 males and 9 females.

For a detailed characterization of the target audience, we will use the ICF classification – International Classification of Functioning, Disability and Health 2004 – which proposes standardized operational definitions of health domains and health-related domains in contrast to current definitions of health.

"Visual functions" are defined in "terms of the ability to perceive the shape and contour of objects, at various distances, using one or both eyes, so that the severity of vision difficulties can be coded at the mild, moderate, severe, or complete levels in relation to these parameters" (ICF, 2008).

From an educational perspective, a blind person is one who does not use his sight for learning and who needs Braille systems or systems that verbalize texts on computers.

The target audience for our study is characterized by total blindness, as we understand that this audience is the one that needs it most and will also benefit the most from guidelines to reduce obstacles and maximize their experience in their interaction with online educational content.

2 ANALYSIS OF THE CURRENT PANORAMA OF USE AND INTERACTION: BLIND USER AND E-LEARNING PLATFORMS

This preliminary study was of great importance because it allowed us to know the current panorama of the blind user experience in their interaction with online educational content, in this specific case, as revealed by the results of the study with the Moodle platform.

The study also reveals that there is room for implementing changes and increasing the awareness of the parties involved in distance education regarding the need to respect the laws and guidelines for inclusive digital education.

2.1 CREATION OF THE QUESTIONNAIRE

For the analysis of the current panorama of the use and interaction of blind users and e-learning platforms, a questionnaire was prepared in Google Forms. This is composed of four tabs, the first three with multiple-choice questions and some with open answers for possible complementation of the answer by the participant, if he did not find the item he wanted among the alternatives presented or, if he wanted to add a comment.

The fourth tab is composed of questions that require an answer on a scale of 1 to 7 evaluation, with one being the most negative answer and 7 the most positive. Also in this tab, open-ended questions were included to allow the participant to add comments.

Once the first version of the questionnaire was prepared, it was sent via e-mail to a blind user in order to test its accessibility.

To improve the effectiveness of the questionnaire, we used the Participatory Design approach, through the experience and comments of the participants, "their direct interaction with the designer throughout the development cycle, and the user's control over design decisions" (Bonacin, 2004).

In this phase, a blind, unidentified user participated (it is not possible to provide sociodemographic information about the co-creator, at his request). When interacting with the questionnaire, the user sent feedback regarding the degree of accessibility. Their iterative collaboration, the entire process of creating and fine-tuning the questionnaire, through the sending of suggestions and essential changes to make this data collection instrument accessible to participants.

The change, suggested and accepted, in the first three tabs was the reduction in the number of questions to make the questionnaire less tiring.

In the last tab, the Likert Scale was modified in the way of answering questions, where the scale of answer options is typically a five, seven, or nine-point agreement scale, used to measure respondents' agreement with various statements. The user's justification was that screen readers cannot read this type of scale, which would make it impossible for the participant to answer the question.

Based on this feedback, the questionnaire was adapted for accessibility issues of the target audience, although it did not suffer changes in its original content. The changes were only by design, as the questionnaire in its original form is not readable by screen readers and, therefore, inaccessible to the target audience.

2.2 APPLICATION OF THE QUESTIONNAIRE

After the iterations made to refine the questionnaire in terms of interaction and design, the final version was applied to obtain information about the user's experience when interacting with the online educational content.

2.3 FRAMEWORK OF THE QUESTIONNAIRE

This form was filled out by 21 blind people and based on these answers, the data were analyzed according to the variables listed in the annex (Annex 1), in which each variable corresponded to a question on the form. Some questions had no answers and only one was used as the answer in the previous item, as it contained the answer as an option (marked in red). These questions were intended to give the subject the option of a free answer, in case he did not find, among the options provided, the desired item.

The objective of the questionnaire was to identify, from the perspective of the blind user's experience, the difficulties faced by them in their interaction with online educational content.

Each question deals with a specific moment of this interaction, namely, platform accessibility, accessibility features, technological resources, problems faced and user experience.

2.3.1 Biographical data of the participants

All 21 participants are attending or have attended an online distance course, which can be a technical, undergraduate or graduate course. Of the 21 respondents, 12 were male and 9 were female, of which the youngest person was 25 years old and male and the oldest person was 61 years old and female.

2.3.2 Questionnaire results

According to Table 1, it is observed that females were older than males. In addition, we can observe the presence of discrepant age values in both sexes. To test whether the mean ages are equal or not in relation to gender, the non-parametric Wilcox test was used, since the hypothesis of normality of the data was rejected by the Shapiro-Wilk test, making it impossible to use the Student's t-test. It is concluded that, although the behavior of the ages is different between the sexes, the test did not reject the hypothesis of equality (W = 78, p-value = 0.09469) at the level of 5% of significance.

Table 1

Descriptive measures of age (in years) by gender

Gender	Min	1st	Median	3rd	Max		Detour pattern	Coef.de Change (%)	Coef.de asymmetry
Female	27,0	40,0	44,0	47,0	61,0	42,6	10,2	23,9	0,03
Male	25,0	27,5	31,5	36,5	60,0	35,1	11,4	32,5	1,15
General	25,0	29,0	35,0	45,0	61,0	38,3	11,3	29,5	0,59

Among the platform(s) of the online course she attends, the most cited was Moodle, followed by Zoom (FIGURE 2). It is worth mentioning that each respondent could mention more than one platform.

Figure 1

Boxplot of the age (in years) of the respondents, according to gender

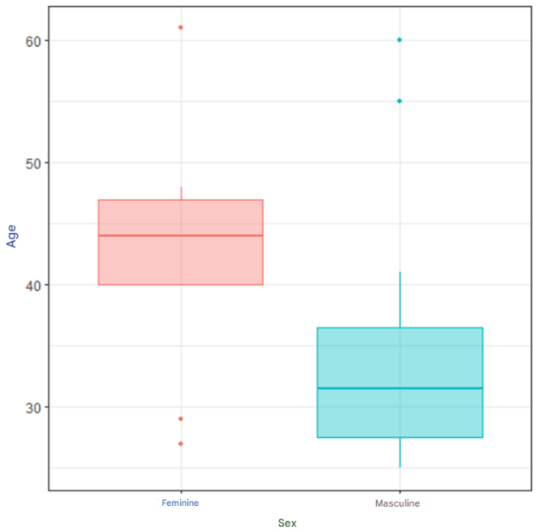
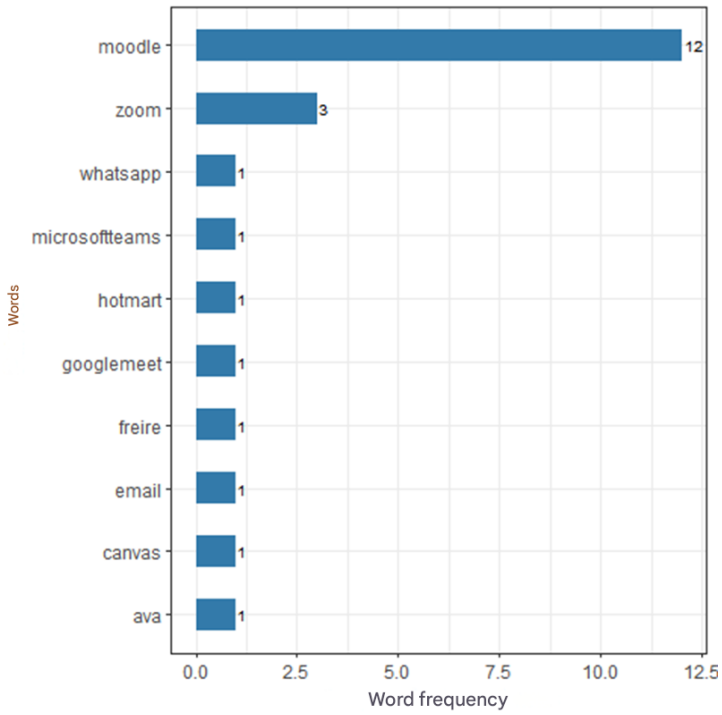


Figure 2

Frequency distribution of the words cited as the platform of the online course attended



Of the 21 respondents, 16 said that the accessibility of their course platform was "More or less" and 3 respondents said the platform was not accessible (FIGURE 3). Table 2 presents the frequency distribution of the platform used according to the opinion about its accessibility, it is observed that the majority who use the Moodle platform consider the platform with accessibility "More or less". When performing an independence test using Fisher's exact test, it is concluded that these two variables are independent (p-value = 0.0805).

This result seems to indicate that the Moodle platform is the most used for online distance learning courses and that it has medium accessibility.

Figure 3

Frequency distribution on the accessibility of your course platform

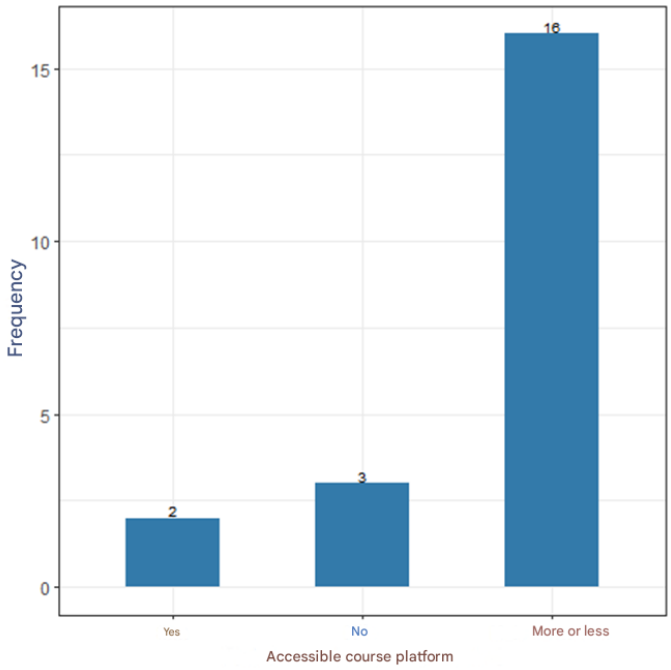


Table 2

Frequency distribution of the platform used according to the opinion on its accessibility

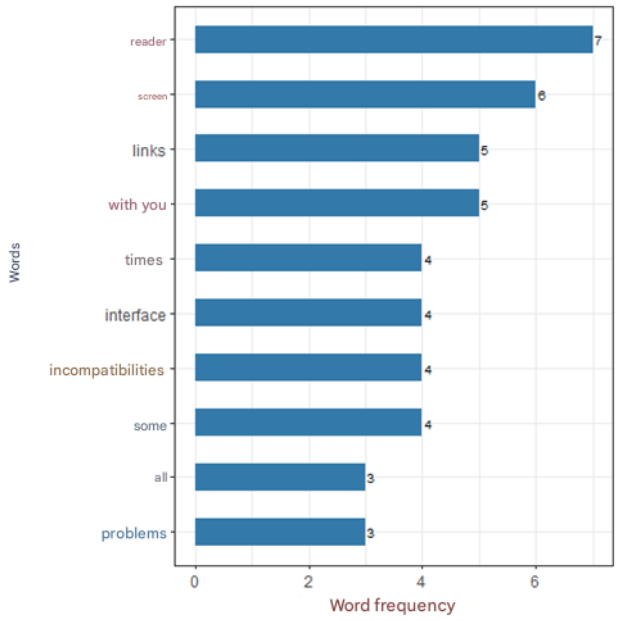
Platform	Do you consider your course platform accessible?				Grand Total
	Yes	No	lo	More or less	
AVA	0	0	0	1	1
Email	0	1	1	0	1
Freire	0	0	0	1	1
Google Meet	0	1	1	0	1
Hotmart	0	0	0	1	1
Microsoft Teams	1	0	0	0	1
Moodle	1	0	0	11	12
ıtsApp, Zoom, Canvas	0	0	0	1	1
Zoom	0	1	1	1	2
Grand Total	2	3	3	16	21

Among these 19 respondents who were not satisfied (considering the answers "No" and "More or less") with accessibility, justified it and the word frequencies of the reasons are shown in Figure 4. The words that are in the graph are those that appeared more than twice, it is observed that the most cited were: reader, screen, links, with you, some, incompatibilities,

interface, times, all and problems. The first two are related to "screen reader", whose main complaint is about the incompatibility with the interface. About the links, the main complaint is about the difficulty of accessing them. Other words that appeared, but less frequently, can be seen in Figure 4.

Figure 4

Frequency distribution of the words cited in the justification about the accessibility of the platform used in your course



It can be concluded, therefore, that the incompatibility of the screen reader with the interface and the difficulty in accessing links are the main reasons for the dissatisfaction of blind users regarding the accessibility of the Moodle platform.

Figure 5

Cloud of words cited in the justification about the accessibility of the platform used in your course

Among the indication(s) of the accessibility resources used in the course, the most cited was NVDA, followed by JAWS (Figure 6) and among the indication(s) of the technological resources used in the course, the most cited was Notebook, followed by Cell Phone (Figure 7). It is worth mentioning that each respondent could mention more than one accessibility or technological resource.

Regarding the formats of the educational content that are present in the respondents' course, Figure 8 shows the frequency with which the different formats were cited, the most cited were: videos, forums, links, files, figures, among others. Figure 9 shows the word cloud with these items, including the least cited items.

Figure 6

Frequency distribution of accessibility features used in the course

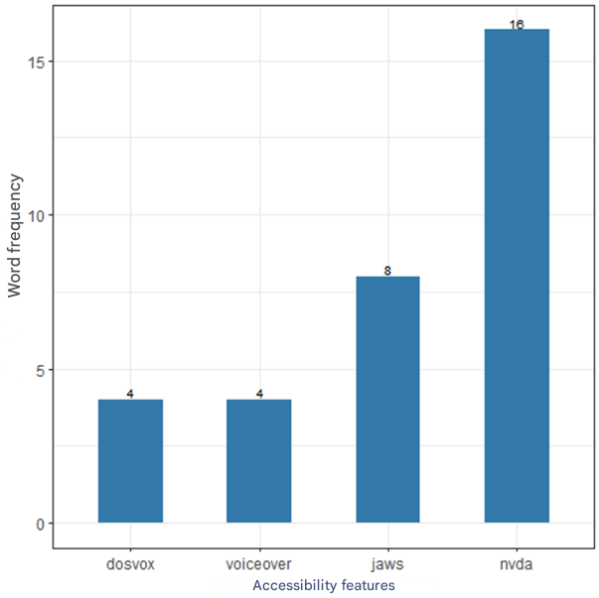


Figure 7

Frequency distribution of the technological resources used in the course

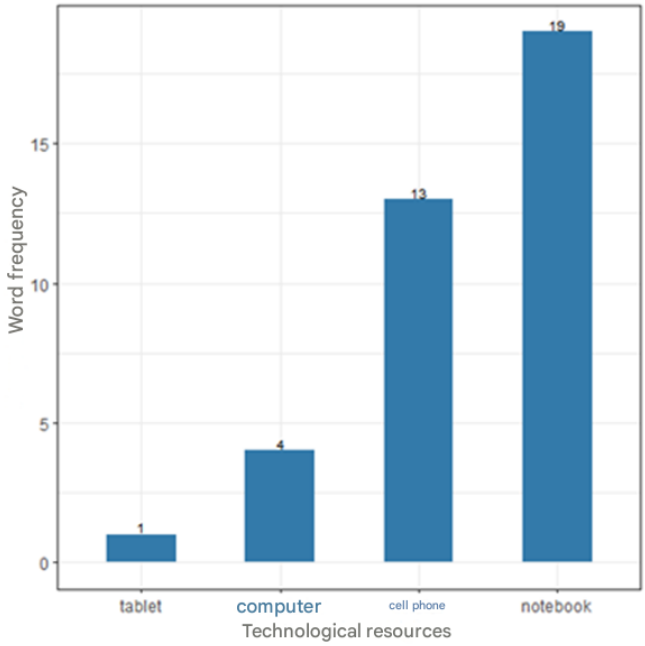


Figure 8

Frequency distribution of the words cited and how educational content is present in your course

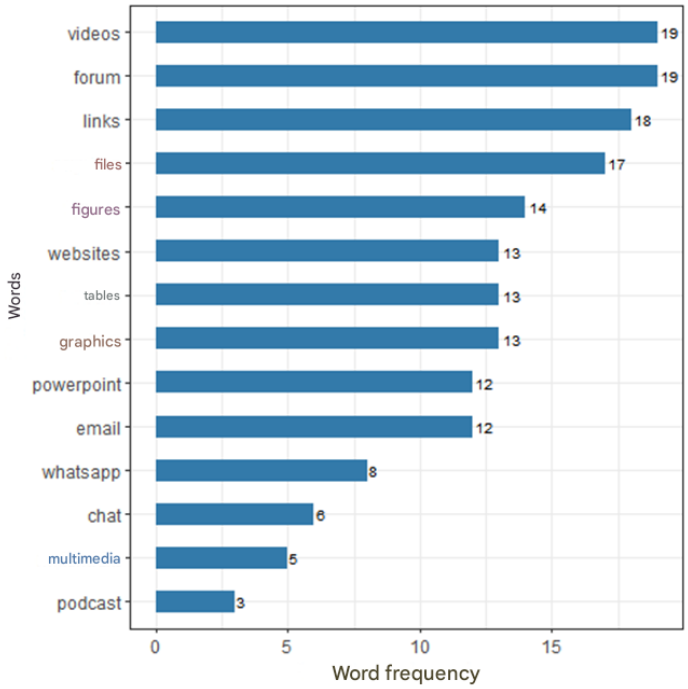


Figure 9

Cloud of words cited as how educational content is present in your course

Of the 21 respondents, 17 said they faced some type of problem when accessing educational content. However, all indicated at least some problem(s) faced, as problems in the interface between the screen reader and the platform was the most reported type, the second most pointed type was about links without appropriate description and the third type was related to the difficulty in accessing educational content.

Table 3

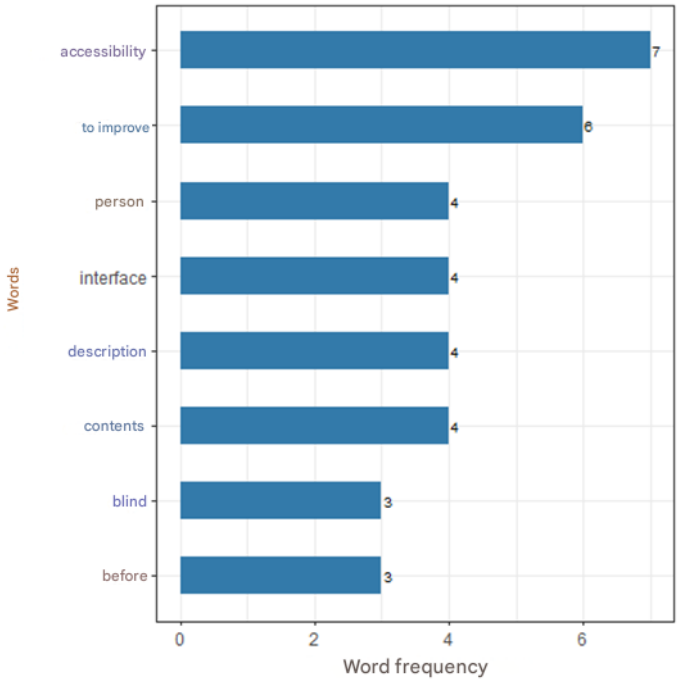
Frequency distribution of problems faced when accessing educational content

Problems faced	**N**
Problems with the interface between the screen reader and the platform	17
Links without proper description	14
Difficulty in accessing educational content	12
Difficulty using the forum	11
Content presented in a disorganized manner	8
Difficulty in completing course assignments	6
File Submission Issues	2

Figure 16 shows the frequencies of the words that appear three times or more in the suggestions to solve the problem(s) described earlier. The term that appears most often is accessibility, followed by improve, person, interface, description, content, among others. Overall, respondents suggested. The other words that appeared are in the word cloud shown in Figure 16.

Figure 10

Frequency distribution of the words cited as a solution to the problems of accessibility of educational content



It can be concluded, therefore, that the solutions pointed out by the blind user for the problem of accessibility of online educational content are: improvements in the interface and description of the links, in addition to suggesting that content and accessibility be tested/validated by blind people.

Figure 11

Word cloud cited as a solution to the problems of accessibility of educational content

Regarding the type of technological assistance due to their visual impairment offered by the institution of their online course, 11 respondents answered that they do not receive technological assistance and 10 answered that they do. Of those who receive it, the screen reader was the most pointed feature by them, only 3 mentioned the platform (Figure 12). Other words mentioned can be seen in Figure 13. It is worth noting that 17 respondents said they would like to receive assistance from the institution of their online course.

Figure 12

Frequency distribution of the words mentioned as some type of technological assistance due to their visual impairment offered by the institution of their online course

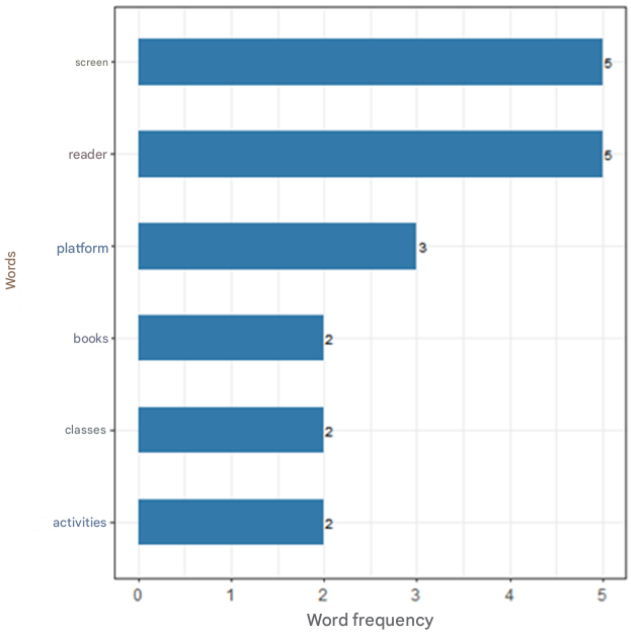


Figure 13

Cloud of words cited as some type of technological assistance due to their visual impairment offered by the institution of their online course

However, 17 respondents stated that they would like their online course to provide educational content adapted to their needs. As a tool suggestion, Figure 14 presents the most cited words, it is observed that 9 respondents cited description, 6 cited audio and graphics

and 5 cited images, it can be observed that the words quality, improve and better appear, which shows that the respondents suggest, in general, improvements in the quality of the descriptions of audios/graphics/figures/videos. Other words mentioned can be seen in Figure 15.

This result seems to indicate a dissatisfaction of blind students regarding the availability by distance learning institutions of adapted content, notably audio description of graphs and images.

Figure 14

Frequency distribution of the words mentioned how you would like your online course to provide educational content adapted to your needs

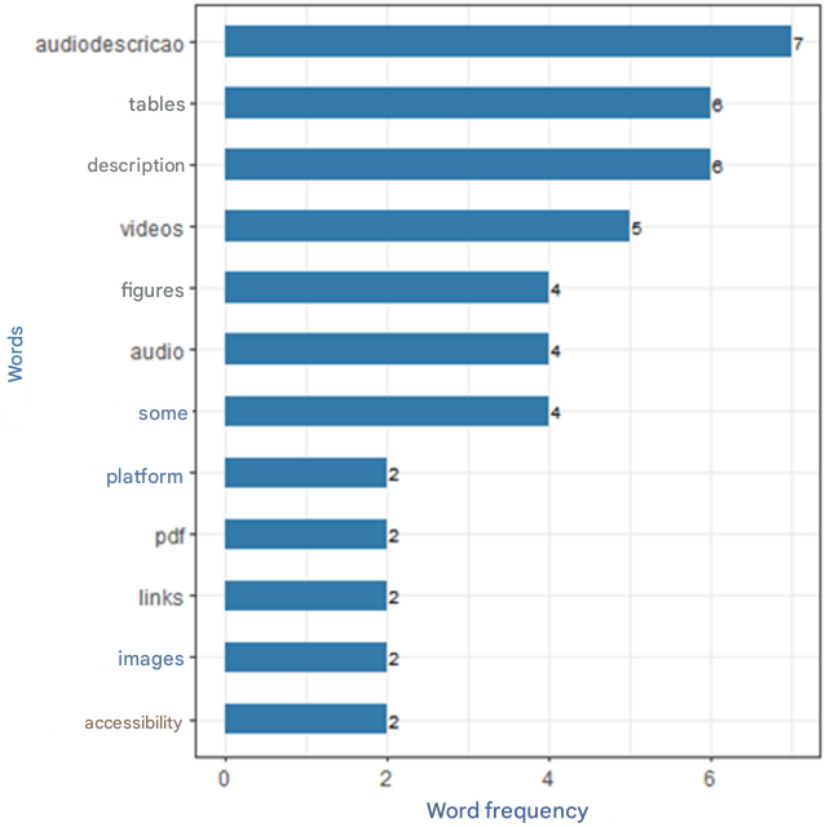


Figure 15

Cloud of words cited as you would like your online course to provide educational content adapted to your needs

Questions with answers measured by a scale of 1 to 7 were classified from the letter The Word for word Or, which correspond to the 15 questions in the following order: A – "On a scale of 1 to 7, being 1 Nasty and 7 Nice, how is your experience with the course platform?"; B – "On a scale of 1 to 7, being 1 Incomprehensible and 7 Understandable, your experience interacting with your course platform can be classified as"; C – "On a scale of 1 to 7, being 1 boring and 7 Exciting, your experience with the platform can be classified as"; D – "On a scale of 1 to 7, being 1 complicated to interact with and 7 Easy to interact, your experience interacting with your course platform can be classified as"; E – "On a scale of 1 to 7, being 1 does not meet my expectations and 7 Meets My Expectations, your experience of interacting with your course platform"; F – "On a scale of 1 to 7, where 1 Inefficient and 7 Efficient, your experience interacting with your course platform can be classified as"; G – "On a scale of 1 to 7, being 1 Disorganized and 7 Organized, your experience interacting with your course platform can be classified as"; H – "On a scale of 1 to 7, where 1 Tricky to use and 7 Easy to use, your experience interacting with your course platform can be classified as"; I – "On a scale of 1 to 7, being 1 dissatisfied and 7 satisfied in relation to their degree of satisfaction, it is considered"; J – "On a scale of 1 to 7, being 1 Unreachable and 7 Affordable, the degree of accessibility of your course platform can be classified as"; K – "On a scale of 1 to 7, being 1 Tricky and 7 Clear in relation to the way educational content is presented, the platform of

your course does it in a way"; L – "On a scale of 1 to 7, where 1 Unpredictable and 7 Predictable, your experience interacting with your course platform can be classified as"; M – "On a scale of 1 to 7, being 1 Demotivating and 7 Motivating, your experience interacting with your course platform can be classified as"; N – "On a scale of 1 to 7, where 1 presents obstacles and 7 Easy guidance, your experience interacting with your course platform can be classified as"; O – "On a scale of 1 to 7, where 1 confused and 7 Evident, your experience interacting with your course platform can be classified as".

For the scale questions, the reliability of the items was studied through the analysis of internal consistency using Cronbach's alpha reliability coefficient (Cronbach, 1951). Generally, the optimal range of alpha values is considered to be above 0.7.

For these items measured on a scale of 1 to 7, the mean response of the items was 4.5 and a Cronbach's alpha of 0.92 (92%) was found (Table 4) and even with the removal of each item, the value is not less than 90% in all situations. Thus, it is possible to affirm that the items are homogeneous and that the scale consistently measures the characteristic for which it was created (Table 5).

Table 4

Internal consistency of the items evaluated in the questionnaire according to Cronbach's alpha value

Alpha Value	Internal consistency
Greater than 0.80	Almost perfect
From 0.80 to 0.61	Substantial
From 0.60 to 0.41	Moderate
From 0.40 to 0.21	Reasonable
Less than 0.21	Small

Source: LANDIS; KOCH (1977).

Table 5

Statistical measures referring to the 15 items evaluated by scale measure from 1 to 7

Issues	ge of the scaleif the tem is deleted	Variance of the scale if the is deleted	rrected item/total correlation	ach's alpha f the item is eliminated
A	4,8	0,56	0,78	0,9165
B	5,0	0,25	0,93	0,9162
C	4,2	0,86	0,63	0,9203
D	4,3	0,61	0,75	0,9169
E	4,2	1,17	0,88	0,9104
F	4,6	0,66	0,81	0,9153
G	4,6	0,94	0,72	0,9172
H	4,5	0,76	0,49	0,9242
I	4,6	0,96	0,77	0,9160
J	4,5	0,90	0,83	0,9136
K	4,5	1,25	0,64	0,9208
L	4,8	0,66	0,50	0,9242
M	4,5	0,76	0,63	0,9203
N	4,3	1,12	0,60	0,9218
O	4,4	0,96	0,60	0,9213

It can be concluded, therefore, that the experience of the blind user in his interaction with online educational content is average, that is, neither totally unsatisfactory nor totally satisfactory. This fact demonstrates that there is room for improvement and implementation of guidelines that seek to maximize this experience.

Finally, it was asked if there is any aspect that can improve your user experience that has not been mentioned in the questionnaire presented. The results can be seen in Figure 17, with the most cited words, and in Figure 18, in a broader way. It is observed that the most

cited words are: content, before, person, test, among others. The suggestions are basically requested for the content to be tested beforehand by blind people.

Figure 16

Frequency distribution of the answers referring to the questions with a scale from 1 to 7

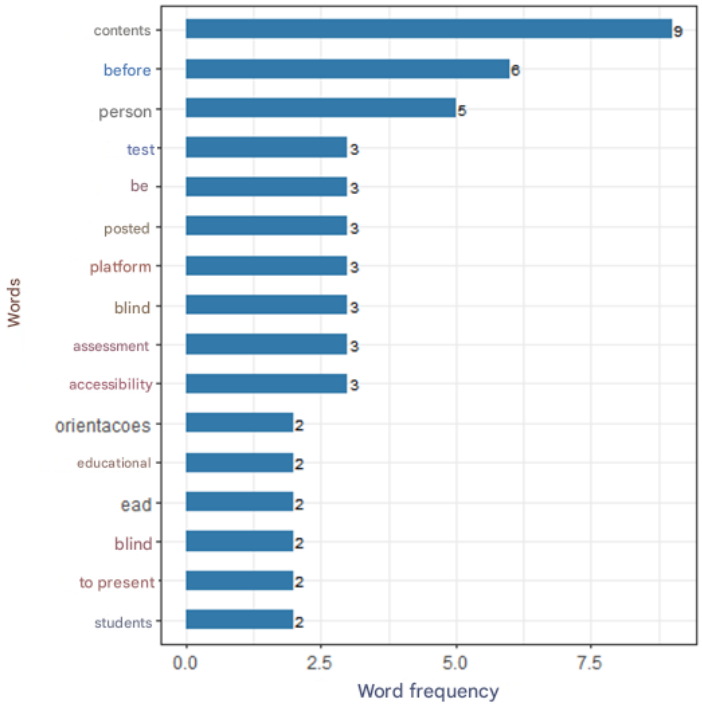


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Figure 17

Frequency distribution of the words mentioned as suggestions for improvement, in some aspect, of their user experience that has not been mentioned in this questionnaire

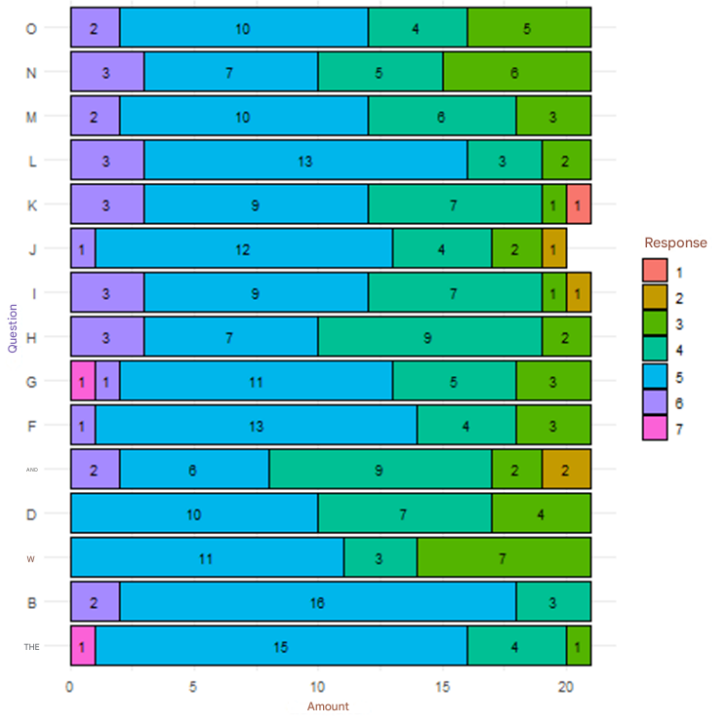

Figure 18

Cloud of words cited as suggestions for improvement, in some aspect, of your user experience that has not been mentioned in this questionnaire

Based on the results obtained, guidelines are proposed to maximize the experience of the blind user in their interaction with online educational content on the Moodle platform, namely:

1. Prioritize the compatibility of the screen reader with the interface;
2. Improve the description of access to links;
3. Test/validate educational content by a blind person;
4. Provide technological assistance aimed at visual impairment;
5. Provide educational content adapted to the visual impairment;
6. Provide detailed audio description of graphs, tables and figures.

The results obtained show many similarities with the results previously known in other studies and, mainly, corroborate with the laws and guidelines for the inclusion of people with disabilities. It can be said that they confirm and highlight what is exhaustively described in the World Content Accessibility Guide (WCAG) and in the W3C.

It is worth noting, however, that our study was carried out with co.design within a very specific context, that of the Brazilian case.

The guiding document of the on-site evaluation committees for higher education institutions with a focus on accessibility, prepared by the Ministry of Education and Culture of Brazil, highlights item 3 of the guidelines by stating that regarding institutional self-evaluation, it is suggested that the evaluator consider that institutional self-evaluation requires the full involvement of the academic community, which implies considering the participation of students and/or employees with some type of disability or specific educational need. It is recommended that the way in which accessibility is promoted be verified, ensuring that this public has effective participation in the process. In addition, measures related to accessibility must be discussed, elaborated and implemented from the perspective of the subjects of rights, users of resources and services of special education in higher education. The other items of the guidelines are present in several excerpts of the document, such as, for example, in chapter 2.4 accessibility strategies for the target audience of special education in higher education, when it suggests the need to evaluate assistive technology resources available to people with disabilities: adapted didactic material; audio-material recorded with human voice in different media; that enable access to various content for blind and low-vision people (INEP, 2016).

4 CONCLUSION

Needless to say, especially nowadays, after a pandemic, the importance of online education. This modality has allowed billions of users around the world to continue their education in this very delicate moment that humanity has faced.

What is worth mentioning is that in this universe there is a significant portion of users who deserve special attention, namely, the blind user.

In Brazil, according to the 2010 Census, conducted by the Brazilian Institute of Geography and Statistics, there were more than 7,000,000 people with great visual impairment and more than 500,000 with blindness.

These people have the same rights of access to education guaranteed, not only by the Brazilian Constitution, but also by specific laws and guidelines, mainly related to Web content.

In the analysis of the data collected, at first with a questionnaire answered by 21 blind users who were students of online courses, we were able to conclude that, despite the existing laws and guidelines, this audience still faces many difficulties when accessing online educational content and reports only an average user experience, which reveals that there is still much to be improved.

Among the problems faced by them, six points stand out: (1) incompatibility of the screen reader with the interface; (2) incomplete or non-existent description of the links; (3) lack of validation of educational content by a blind person before its publication; (4) lack of technological assistance aimed at visual impairment; (5) lack of educational content adapted to visual impairment; and, (6) incomplete or non-existent audio description of graphs, tables and figures.

We have transformed the highlighted problems into six guidelines.

It was evident, after the analyses and reflections in this study, that clarify and raise awareness among the general public, and especially those people directly linked to distance education, about the needs of blind users when interacting with online educational content. In this way, it will be possible to ensure that this user can exercise their right to education fully and on equal terms.

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