



## El desarrollo de indicadores de accesibilidad para el análisis de exposiciones online: un camino para la inclusión social en las actividades de los museos

*The development of an accessibility indicator framework for analyzing online exhibitions: a pathway for social inclusion in museums' activities*

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### Resumen

*Las desigualdades sociales provocadas por el bienestar, las opresiones raciales y geográficas a menudo determinan si una persona tiene la posibilidad y la motivación de visitar museos. Las barreras de accesibilidad también añaden otra capa de distancia entre los museos y las personas con discapacidad. Aunque muchos museos han mostrado un esfuerzo por proporcionar un espacio físico accesible, los aspectos comunicacionales y actitudinales del acceso están menos presentes, un tema preocupante, especialmente cuando se consideran las actividades online. Ante la inseguridad sanitaria provocada por la pandemia del Covid-19, los museos y exposiciones online se suman a las posibilidades de crear y mantener diferentes públicos. Por lo tanto, debemos establecer métodos y herramientas para proporcionar un espacio museístico online accesible para que las personas de diferentes orígenes, incluidas las personas con discapacidades, puedan experimentar una visita remota sin barreras. En este contexto, nuestro objetivo principal en esta presentación es introducir el proceso de desarrollo de la herramienta analítica "Indicadores de accesibilidad para las exposiciones y museos online", con un enfoque específico en las particularidades de los museos online y discutir su usabilidad como marco teórico y práctico. El instrumento fue adaptado de las directrices internacionales, las Directrices de Accesibilidad de Contenido Web (WCAG 2.1) y la información recopilada en la literatura sobre accesibilidad en entornos online y en museos. El trabajo de Inacio (2017), con mayor desarrollo de Norberto Rocha et al. (2020, 2021), llevó a la publicación de indicadores de accesibilidad y su aplicación para investigar los museos físicos y la experiencia de los visitantes con discapacidad. Aunque identificamos aspectos comunes de la accesibilidad en los museos físicos y online, entendemos que las especificidades de las exposiciones online deben cubrirse. La estructura de los indicadores de accesibilidad para las exposiciones online se compone de tres indicadores, cada uno con dos atributos. El primero, "Diseño y navegabilidad", con los atributos "Comodidad, seguridad y flexibilidad de navegación" y "Flexibilidad de acceso, manipulación y presentación", se refiere a la estructura de la plataforma de la exposición online y la acción de desplazarse. El segundo, "Actitudinal", con los atributos "Prácticas inclusivas, recepción y acogida" y "Política institucional", se refiere a los esfuerzos realizados por la institución para incluir tanto a los visitantes como a los profesionales con discapacidad. El tercero, "Comunicacional", con los atributos "Comunicación y difusión a un público amplio" y "Medios de comunicación y recursos diversos*

*para una comunicación plural", se refiere a aspectos informativos e instructivos tanto internos como externos a la exposición en línea. Juntos, creemos que estos indicadores, como herramienta, pueden proporcionar una referencia a la creación, actualización y análisis de exposiciones online, con el objetivo de mejorar el acceso a los museos y la educación para un público variado.*

**Palabras clave:** *tecnologías asistivas; exposiciones online; indicadores; museos; personas con discapacidad.*

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### **Abstract**

*Social inequalities brought up by welfare, racial, and geographic oppressions often determine whether a person has the possibility and the motivation to visit museums. Accessibility barriers also add another layer of distance between museums and people with disabilities. Although many museums have shown an effort to provide an accessible physical space, communicational and attitudinal aspects of access are less present – a concerning issue, especially when considering online activities. In face of the sanitary insecurity brought upon by the Covid-19 pandemic, online museums and exhibitions add up to the possibilities of creating and maintaining different audiences. Therefore, we must establish methods and tools to provide an accessible online museum space so that people from different backgrounds, including those with disabilities, may experience a barrier-free remote visit. In this context, our primary goal in this presentation is to introduce the process of developing the analytical tool “Accessibility Indicators for Online Exhibitions and Museums”, with a specific focus on the particularities of online museums and discuss its usability as a theoretical and practical framework. The instrument was adapted from the international guidelines, the Web Content Accessibility Guidelines (WCAG 2.1), and information gathered in the literature about accessibility in online environments and in museums. The work of Inacio (2017), with further development by Norberto Rocha et al. (2020, 2021), led to the publication of accessibility indicators and their application to investigate physical museums and the experience of visitors with disabilities. Although we identify common aspects of accessibility in physical and online museums, we understand that the specificities of online exhibitions need to be covered. The accessibility indicators for online exhibitions’ structure is composed of three indicators, each with two attributes. The first, “Design and navigability”, with the “Comfort, security and navigation flexibility” and “Access, manipulation and presentation flexibility” attributes, concerns the structure of the platform of the online exhibition and the action of scrolling through. The second, “Attitudinal”, with the “Inclusive practices, welcome and hosting” and “Institutional policy” attributes, concerns the efforts taken by the institution to include both visitors and professionals with disabilities. The third, “Communicational”, with the “Communication, and dissemination to a broad audience” and “Media and diverse resources to a plural communication” attributes, concerns informational and instructional aspects both internal and external to the online exhibition. Together, we believe that these indicators, as a tool, may provide a reference to the creation, update, and analysis of online exhibitions, aiming to improve museum access and education for a varied audience.*

**Keywords:** *assistive technologies; online exhibitions; indicators; museums; people with disabilities.*

## 1. Introduction

Accessibility and inclusion of people with disabilities (PWD) are multidimensional, considering both can be investigated through the lens of social justice, work relations, formal and non-formal education, visitor studies in museums, and so on. Accessibility is the guarantee of equitable access and means of participation to the diversity of people, abilities, and potential, and inclusion is focused directly on the attitudes, efforts, and actions led by institutions and individuals towards improving and providing accessibility (AAM, 2018). A light veil separates both concepts, and it is crucial to fully understand their extension today, especially with museums' activities, which are crossed by almost all investigation lenses mentioned before and more.

As places – which are not necessarily physical – of fruition in sciences, arts, and culture, museums must take part in numerous articles brought by the United Nations' (UN) Convention on the Rights of Persons with Disabilities (CRPD), a document signed by 164 countries or regional organizations, created to ensure equal access, rights and autonomy to PWD (UN, 2006). Whether considering accessibility, discussing primarily the rights to engage in information, education, or to participate in cultural and social activities, we can reflect on multiple ways museums should and could act towards providing access and ensuring the inclusion of PWD.

Online museums' activities, such as online exhibitions, became essential for communicating and interacting with visitors during the Covid-19 pandemic. The development of digital exhibitions in CD-ROM began as early as the 1970s, and the increasing technology led to the ever-growing presence of museums on the web since the 1990s (Schweibenz, 2019); however, a report gathered by the International Council of Museums (ICOM) showed that when 95% of the 1600 respondent institutions were closed in May 2020, 50% did not have any online exhibition available and 26% started or increased their availability after the lockdown (ICOM, 2020). Museums' online presence may not be new, but it is still a field of constant development that many institutions have not explored or recently started. The challenge of appropriating this means of communication should not be interpreted as a limiting factor but as a motivator to investigate and act on creating and refining online exhibitions, especially since they allow museums to broaden their reach. Innovations that emerged with the web environment, and the further presence of museums in it, include the possibility of portraying information using hypermedia, meaning, through non-linear connections between different types of media, in a new way of interaction (Foo, 2008; Povroznik, 2020; Schweibenz, 2019).

The vast room for development is also shown through the extent of access and participation of museums' visitors. The promotion of accessibility and the provision of assistive resources are generally poor in online exhibitions despite the long-term existence of assistive technologies, techniques, and guidelines, as the Web Content Accessibility Guidelines (WCAG), developed by the World Wide Web Consortium (W3C). The WCAG document is structured in four major "Principles" (Perceivable, Operable, Understandable, Robust) and presents 13 "Guidelines" broken down in "Success Criterion" that must be met to ensure the accessibility of web content (W3C, 2018).

The WCAG is a crucial guidance – mainly technical -- for providing accessibility to websites; however, it applies differently to different scenarios and online contexts. The specificities of online museums or exhibitions and the experiences they intend to provide require a contextualized approach to accessibility, guaranteeing that both technical and human features are included. Dubois, Gall and Martin (2014) and Vigo, Brown and Conway (2013) emphasize that evaluating web accessibility using only automated tools that consider the WCAG success criteria may be limiting and lead to errors, not only due to the lack of topics that require human assessment but also due to the different approaches and scopes of each tool. Investigations on the accessibility of museums' online activities indicate that a multidisciplinary, multiprofessional effort is needed to face barriers and challenges fronted in the online world (Flor et al., 2009; Leporini & Norscia, 2008; Rojas et al., 2020).

In this context, we aim to introduce in this paper the process of development of a framework based on indicators to analyze the provision of accessibility in online exhibitions and museums. This framework is intended to be an analytical and evaluation tool that highlights and combines technical norms to unique aspects of museum experiences, mainly focused on including facets that automatic mechanisms cannot evaluate.

## 2. Objectives

We aim to present the analytical tool “Accessibility Indicators for Online Exhibitions and Museums”, developed through the adaptation of previously created indicators, guidelines, and investigations, with a specific focus on the particularities of online exhibitions and museums’ experiences. Also, we intend to present different possibilities for applying the indicators to improve accessibility analysis and the inclusion of diverse audiences in online exhibitions.

This work is under the scope of investigations conducted by the Accessible Science Museums and Centers research group (*Museus e Centros de Ciências Acessíveis – MCCAC*) that investigates accessibility and inclusion in science museums and centers, mainly in the Latin America.

## 3. Methodology

Based on a literature review and the study of norms of online accessibility, we developed the analytical tool “Accessibility Indicators for Online Exhibitions and Museums” grounded on the indicators initially proposed by the MCCAC research group (Inacio, 2017; Norberto Rocha *et al.* 2020, 2021). Indicators are being developed and used by researchers to create analysis frameworks, especially regarding the field of science education, museology, accessibility, and their interconnections (Marandino *et al.*, 2018).

For instance, Norberto Rocha *et al.* (2020) developed a survey based on the “Accessibility Indicators in Museums and Science Centers” tool (Inacio, 2017; Norberto Rocha *et al.*, 2020, 2021) on museum accessibility, presenting a panorama of the provision of accessibility of 109 Latin-American institutions. Fernandes (2020) applied the tool to build codification to analyze the visit of blind people to exhibitions of two Brazilian science museums, *Museu da Geodiversidade e Casa da Descoberta*. Carmo (2020) used the tool to study the experience of deaf people into three different exhibitions in the city of Rio de Janeiro and Silva (2022) applied to investigate how the Museum of Tomorrow provide accessibility for visitors with Down Syndrome.

### *Understanding the development of the new framework*

In its most recent version, the tool “Accessibility Indicators in Museums and Science Centers” (Inacio, 2017; Norberto Rocha *et al.*, 2020, 2021), has three indicators with two attributes each, comprising “physical”, “attitudinal”, and “communicational” aspects. Each attribute has different sets of items that describe the topics to be considered during the creation or assessment of online exhibitions’ accessibility

Despite having elements that are common to both the physical and online environments, we consider it is relevant to incorporate specific aspects of the online museum experience into the existing tool. These aspects were gathered based on the international web accessibility guideline WCAG 2.1, considering the “Perceivable”, “Operable”, and “Understandable” principles, and its Success Criteria (SC) of all three levels of conformance, with further reorganization, merging of items and combination with external elements to better suit interpretation and application to online exhibitions and museums. The following image illustrates the evolution of the proposed framework:

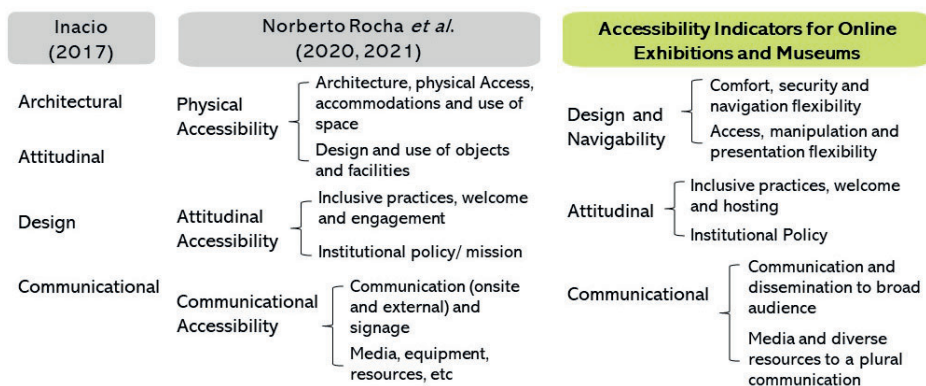


Fig. 1 Accessibility indicators developed for physical and online exhibitions and museums.

Source: Inacio (2017); Norberto Rocha et al. (2020, 2021); the authors (2022)

Since we understand –and intend– that this tool will be applied and used by museum professionals and academics that do not necessarily work with accessibility or web development directly, our primary goal was to integrate the WCAG structure to museum accessibility specificities and not merely create a summarized version of the guideline. Some of the proposed indicator items are a combination of two or more Success Criterion from different Guidelines or even Principles.

To illustrate this process, we present one of the items of the “Media and diverse resources to a plural communication” – which is an attribute of the Communicational Indicator:

31. Instructions are portrayed with at least more than one type of sensory stimuli, such as visual, textual, or audible.

Communicating with diverse visitors means that people with different characteristics, sensory preferences, and abilities will interact with the same information differently. Therefore, the provision of instructions on navigating exhibitions’ activities should follow the diversity premise and be led with the understanding that people may not perceive shape, location, and color the same way. In this specific case, there are two Success Criterion that encompasses the theme placed in two different Guidelines that were merged and adapted (Fig. 2):

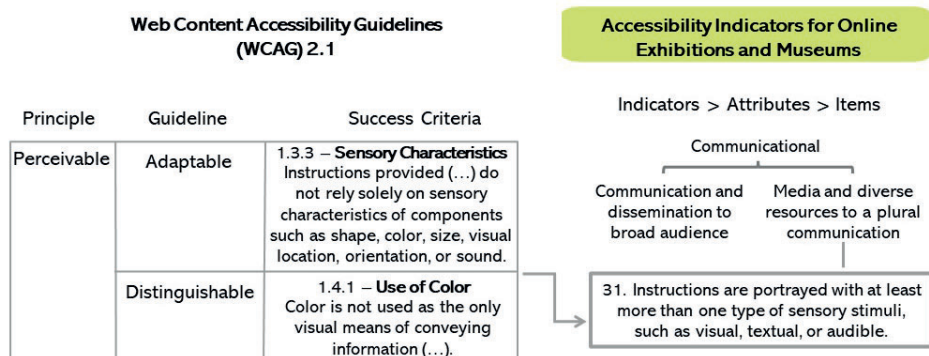
- Success Criterion 1.3.3, “Sensory Characteristics”, intends to “ensure that all users can access instructions (...), even when they cannot perceive shape or size or user information about spatial location (...)” (WCAG 2.1, 2018a). Informational cues such as arrows pointing in different ways and location references such as “on the right” are essential, it is imperative that they are followed by textual identification.
- Success Criterion 1.4.1, “Use of Color”, intends to guarantee that “all sighted users can access information that is conveyed by color differences”, (WCAG 2.1, 2018b). Information assigned by color difference, such as using different colors to indicate “right or wrong”, may not be perceived the same way by all, so other visual references must be applied together.

Although both criteria presented relate to sensory issues on information, we understand they differ in at least three aspects:

1. Use of assistive technology: according to SC 1.3.3, textual identification of elements is important to users of assistive technology such as screen readers. In SC 1.4.1, color is assessed separately because

- the criterion relates to the diversity of visual cues different sighted users can understand and not to information accessed by assistive technology but
2. Available and suitable techniques: to meet SC 1.3.3 requirements, textual identification of sensory information must be provided. However, SC 1.4.1 has a set of techniques that must be applied – and may be combined – depending on the situation, e.g., including text information to accompany information by color difference, providing additional visual cues other than color (such as patterns), and others.
  3. Ways of identifying and interpreting failures to meet the Success Criterion.

Despite their specificities, both share a recommendation we consider to be major on communicational accessibility: to ensure that information is not portrayed in only one sensory characteristic does not mean that exploring different stimuli is discouraged, since certain stimuli such as shape, size, location, and color are imperative to provide a better and more meaningful understanding of various people. Besides the technical differences, these criteria share one main goal: communication. This interpretation led us to combine the two in one item that comprises all sensory stimulation, since the goal is not to evaluate technical aspects - for which we have the WCAG -, but to identify major strengths and flaws in online exhibition accessibility to help museum professionals dictate priorities to work on top of.



**Fig. 2** Development of item 31 of the Accessibility Indicators for Museums' Online Exhibitions.

Source: the authors (2022)

#### 4. Accessibility Indicators for Online Exhibitions and Museums

The Accessibility Indicators for Online Exhibitions and Museums structure consists of: a) *Design and Navigability*, with its two attributes “Comfort, security and navigation flexibility” and “Access, manipulation and presentation flexibility”; b) *Attitudinal*, with the attributes “Inclusive practices, welcome and hosting” and “Institutional policy”; and c) *Communicational*, with the attributes “Communication and dissemination to a broad audience” and “Media and diverse resources to a plural communication” (Fig. 2).

The “*Design and Navigability*” indicator replaces the physical accessibility indicator. Cohen *et al.* (2012) highlight the “walking through” and “wandering” museum spaces as an integral part of promoting accessibility, through which visitors can “walk through, see, hear, feel and touch exposed objects and activities” (Cohen *et al.*, 2012, p. 87). However, considering online museums, the route is not carried out in a concrete physical space but in a virtual space through navigating the hypermedia and interacting with non-linear constructions of information. We then adopted this indicator's aspects related to browsing the online exhibition. We identify the instrumental dimension of accessibility (Sassaki, 2020), which determines barrier-free access to elements such

as assistive, information, and communication technologies. This indicator includes specific aspects of the construction and programming of websites for online exhibitions, as well as sensory accessibility, to enable a free of interruptions, safe, autonomous, and flexible visit.

The “Attitudinal” indicator was mainly adapted from the indicators for physical exhibitions and museums (Inacio, 2017; Norberto Rocha *et al.*, 2020, 2021). To understand attitudinal accessibility, we need to shift our focus from the technical aspects of providing assistive resources to the institutional decisions to discuss, learn and change toward the inclusion of people with disabilities. Prates (2015) emphasizes that attitudinal accessibility comprises a set of changes: our habits, thoughts, and behaviors that add up to the prejudice towards and exclusion of PWD. In this sense, the main goal of this indicator is to assess the institutional efforts – or lack of – to improve inclusivity. This includes not only creating accessible activities but also guaranteeing a staff of diverse professionals, with and without disabilities, that accessibility and inclusion are part of the institutional mission. Achieving this may require what Reich (2014) calls organizational change, describing a movement of an institution to learn, raise awareness and act towards a common goal. Part of the analysis referring to institutional practices may require contact with curators and other museum professionals of the evaluated institution.

The “Communicational” indicator comprises aspects related to the dissemination of the exhibition, the provision of instructions, and the diversity of media and assistive technology resources needed. One of the innovations brought to museums’ exhibitions by the development of the web environment is the possibility to promote a multisensory multimedia activity, with almost unlimited information connections, an aspect that can contribute to the emotional experience and the sense of “being present” of the visitor (Nubani & Öztürk, 2021; Sylaiou *et al.*, 2010). In contrast, museums often offer a limited experience in exploring different media and must reflect on the dependence of a single sensory stimulation, usually visual, and written communication, to interact with audiences (Papadimitriou *et al.*, 2016). Thus, part of this indicator aims to assess the diversity of these actions.

The complete structure of the proposed tool is displayed below in Table 1.

**Table 1. Accessibility Indicators for Online Exhibitions and Museums.** Source: the authors (2022)

Indicator	Attribute	Item
Design and navigability	Comfort, security, and navigation flexibility	<ol style="list-style-type: none"> <li>1. Visitation can be conducted via desktop and mobile devices in both portrait and landscape modes.</li> <li>2. Navigation is compatible with different input devices, such as the mouse and keyboard navigation.</li> <li>3. Navigation and interaction are consistent throughout the activity and clear instructions in case of change are provided.</li> <li>4. Instructions related to navigation or sections' titles can be accessed by assistive technology.</li> <li>5. It is possible to navigate between modules in any order and at all times of the visit, and the mechanisms are accessible through assistive technology.</li> <li>6. Textual information is displayed in textual format, not as images of text.</li> <li>7. The sections can be visited without a predefined time limit, or, if any, the timer can be dismissed.</li> </ol>

		<p>8. The sections can be visited without automatic screen movement, or if any, the movement can be interrupted.</p> <p>9. The visit is free of visual stimuli with flashing lights.</p>
	Access, manipulation, and presentation flexibility	<p>10. The visit is free of elements that open or appear automatically when focused by input devices.</p> <p>11. The visit is free of sounds that start automatically.</p> <p>12. Textual information is customizable in size and contrast without loss of content and functionality, except for captions.</p> <p>13. All links can be identified only by text, regardless of context.</p> <p>14. All textual and visual content, except for decorative elements, are displayed in good contrast between background and foreground elements.</p>
Attitudinal	Inclusive practices, welcome and hosting	<p>15. Professionals with disabilities are part of the institution's staff and are involved in the development of online exhibitions.</p> <p>16. Institutional programs that promote the inclusion of people with disabilities in online activities.</p> <p>17. Different means of contact (e.g., email, social networks, institutional telephones) with accessible communication are provided to the visitors.</p> <p>18. Accessible mediated activities to the online exhibition are provided.</p>
	Institutional policy	<p>19. Accessibility and inclusion are part of the institutional mission and are mentioned in institutional documents.</p> <p>20. Online activities and resources are or will be appropriate to the international parameters proposed by the W3C through the most up to date WCAG.</p> <p>21. Institutional activities regarding online and physical accessibility are promoted to the staff.</p> <p>22. The staff is updated on the appropriate and respectful ways to refer to people with disabilities.</p> <p>23. There is professional and/or financial support to encourage the training of employees in accessibility.</p> <p>24. Forecast specific budget, team and/or line of research for developing, evaluating, and executing actions to promote accessibility.</p> <p>25. Provision of periodic actions of institutional evaluation regarding accessibility in online activities.</p>
Communicational	Communication, and dissemination to a broad audience	<p>26. Communication on websites and/ or social media is accessible according to the platforms' specificity.</p> <p>27. The accessibility features of the exhibition are informed in the communication channels.</p> <p>28. Instruction and/or demonstration of the operation of navigation on the platform are provided with the same accessibility features as the exhibition and are easy to find.</p>
	Media and diverse resources for a plural communication	<p>29. The use of a language is consistent throughout the exhibition and foreign words are translated.</p>



		<p>30. Unusual words, expressions specific to the exhibition's content, and abbreviations are accompanied by a definition and/ or explanation.</p> <p>31. Instructions are portrayed with at least more than one type of sensory stimuli, such as visual, textual, or audible.</p> <p>32. Alternative media accompany all video and audio content with equivalent information.</p> <p>32. All audio content has equivalent caption or transcription.</p> <p>33. Sign language interpretation for audible content and automatic translation software in sign language for textual content are provided.</p> <p>34. All visual information, except for decorative elements, is accompanied by alternative text and/ or audio descriptions.</p>
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The interpretation of the items does not necessarily need to be a “yes or no”, “present or absent” question since accessibility is a multifactor area. The approach, the type of media used, and the exhibition’s structure will dictate the application of each item.

It is relevant to highlight that there are several automatic web accessibility evaluators, but most of the time they present inconsistencies between evaluators and mistakes are often found -- as Dubois, Gall and Martin (2014) and Vigo, Brown and Conway (2013) argue. More importantly, automatic tools cannot assess and analyze attitudinal and communicational aspects, limited to the web development structure.

Also, investigations on museums’ web activities accessibility show that the WCAG 2.1 guidelines alone are limiting to the many specificities of the development of an exhibition, that demand that the assistive resources and communicational strategies are applied in accordance with the information displayed. Leporini and Norscia (2008), when exploring the accessibility of images on museums’ websites, explain that the WCAG recommendations do not meet all of the particularities of the museum universe, and propose a multidisciplinary, cooperative and contextualized work between experts, curators, educators, accessibility professionals and web developers. Flor, Vanzin and Ulbricht (2009) found that the promotion of accessibility in online museums is still a field to be developed since barriers are often seen, and that deeper investigations and specific guidelines to the area are needed.

The investigations on online museums’ accessibility, along with the interpretation of the WCAG 2.1 and constant visits to online exhibitions led us to adopt, as Sloan *et al.* (2006) calls, a holistic approach to web accessibility. The authors propose a framework to help developers meet “quality assurance”: accessibility, usability, local factors, infrastructure, and learning outcomes are all focused on the learner needs. This perspective became our guide to build each one of the items considering multiple inputs of information.

## 5. Concluding thoughts

By proposing this tool, we intend to offer a head start on accessibility in online exhibitions, highlighting significant aspects of museum online activities that are often misplaced or underdeveloped and dictate whether diverse visitors can participate, engage, and are welcomed in meaningful ways. We also expect to provide the means to guide much-needed evaluation processes and the definition of institutional goals and actions to improve the accessibility of current online exhibitions and the ones to come.

## References

- AAM. (2018). *Diversity, Equity, Accessibility, and Inclusion Definitions*. American Alliance of Museums. <https://www.aam-us.org/wp-content/uploads/2018/04/AAM-DEAI-Definitions-Infographic.pdf>
- CARMO, M. P. DE S. DO. (2020). *Experiências museais de sujeitos surdos em três espaços de ciências do Rio de Janeiro Rio de Janeiro* (Issue February) [Universidade Federal do Rio de Janeiro]. <https://doi.org/10.13140/RG.2.2.25560.01287>
- COHEN, R., DUARTE, C. R. DE S., & BRASILEIRO, A. DE B. H. (2012). *Acessibilidade a Museus* (R. Cohen, C. R. de S. Duarte, & A. de B. H. Brasileiro (eds.); 1st ed.). IBRAM.
- DUBOIS, J., GALL, Y. L. E., & MARTIN, A. (2014). Designing a belief function-based accessibility indicator to draw disabled people to the most adapted Web pages. In F. Cuzzolin (Ed.), *Belief Functions: Theory and Applications* (pp. 134–142). Springer.
- FERNANDES, M. P. (2020). *A experiência de pessoas com deficiência visual: A acessibilidade e a inclusão no Museu de Geodiversidade (UFRJ) e na Casa da Descoberta (UFF)* [Fundação Oswaldo Cruz]. <https://doi.org/10.13140/RG.2.2.14129.81767>
- FLOR, C., VANZIN, T., & ULBRICHT, V. R. (2009). INTERFACES DIGITAIS EM EAD. In M. T. de Melo, C. Z. de C. Neto, & F. J. Spanhol (Eds.), *Hiper mídias: interfaces digitais em EAD* (1st ed., pp. 126–152). Laborciência.
- FOO, S. (2008). ONLINE VIRTUAL EXHIBITIONS: Concepts and Design Considerations. *DESIDOC Journal of Library & Information Technology*, 28(4), 22–34. <https://doi.org/10.14429/djlit.28.4.194>
- INACIO, L. G. B. (2017). INDICADORES DO POTENCIAL DE ACESSIBILIDADE EM MUSEUS E CENTROS DE CIÊNCIAS: ANÁLISE DA CARAVANA DA CIÊNCIA. In *Instituto Federal de Educação, Ciência e Tecnologia*. Instituto Federal de Educação, Ciência e Tecnologia.
- LEPORINI, B., & NORSCIA, I. (2008). “Fine Tuning” image accessibility for museum web sites. *Journal of Universal Computer Science*, 14(19), 3250–3264.
- MARANDINO, M., Norberto Rocha, J., Cerati, T. M., Scalfi, G., Oliveira, D. De, & Lourenço, M. F. (2018). Ferramenta teórico-metodológica para o estudo dos processos de alfabetização científica em ações de educação não formal e comunicação pública da ciência: resultados e discussões. *JCOM América Latina*, 01(01), 1–24. [https://jcomal.sissa.it/sites/default/files/documents/JCOMAL\\_0101\\_2018\\_A03\\_pt.pdf](https://jcomal.sissa.it/sites/default/files/documents/JCOMAL_0101_2018_A03_pt.pdf)
- NORBERTO ROCHA, J., MASSARANI, L., ABREU, W. V. DE, INACIO, L. G. B., & MOLENZANI, A. O. (2021). Investigando acessibilidade em museus e centros de ciências latino-americanos. In L. Massarani & I. D. C. Moreira (Eds.), *Pesquisa em divulgação científica - Textos escolhidos* (1st ed., pp. 133–158). Fiocruz - COC.
- NORBERTO ROCHA, J., MASSARANI, L., DE ABREU, W. V., INACIO, L. G. B., & MOLENZANI, A. O. (2020). Investigating accessibility in latin american science museums and centers. *Anais Da Academia Brasileira de Ciências*, 92(1), 1–16. <https://doi.org/10.1590/0001-3765202020191156>
- NUBANI, L., & ÖZTÜRK, A. (2021). Measuring the Impact of Museum Architecture, Spaces and Exhibits on Virtual Visitors Using Facial Expression Analysis Software. *Buildings*, 11(418), 1–19.
- PAPADIMITRIOU, N., PLATI, M., MARKOU, E., & CATAPOTI, D. (2016). Identifying Accessibility Barriers in Heritage Museums: Conceptual Challenges in a Period of Change. *Museum International*, 68(3–4), 33–47. <https://doi.org/10.1111/muse.12134>
- POVROZNIK, N. (2020). Digital history of virtual museums: The transition from analog to internet environment. In S. Reinsone, I. Skadiņa, A. Baklāne, & J. Daugavietis (Eds.), *Digital Humanities in the Nordic Countries 5th Conference - DHN* (Vol. 2612, pp. 125–136). CEUR-WS.
- PRATES, D. (2015). *Acessibilidade Atitudinal* (G. Moreira (ed.); 1st ed.). Gramma.
- REICH, C. A. (2014). *Taking action towards inclusion: Organizational change and the inclusion of people with disabilities in museum learning* (Issue May). Boston College.

- ROJAS, H., RENTERIA, R., ACOSTA, E., AREVALO, H., & PILARES, M. (2020). Application of accessibility guidelines in a virtual museum. In Cristina Ceballos (Ed.), *3rd International Conference of Inclusive Technology and Education, CONTIE* (Vol. 1, pp. 73–79). IEEE Computer Society Conference Publishing Services (CPS). <https://doi.org/10.1109/CONTIE51334.2020.00022>
- SASSAKI, R. K. (2020). Acessibilidade e suas dimensões. In *As Sete Dimensões da Acessibilidade* (1st ed., pp. 127–182). Lavratus Prodeo.
- SCHWEIBENZ, W. (2019). The virtual museum: an overview of its origins , concepts, and terminology. *The Museum Review*, 4(1). [http://articles.themuseumreview.org/tmr\\_vol4no1\\_schweibenz%0Ahttps://www.researchgate.net/publication/335241270\\_The\\_virtual\\_museum\\_an\\_overview\\_of\\_its\\_origins\\_concepts\\_and\\_terminology](http://articles.themuseumreview.org/tmr_vol4no1_schweibenz%0Ahttps://www.researchgate.net/publication/335241270_The_virtual_museum_an_overview_of_its_origins_concepts_and_terminology)
- SILVA, T. P. T. (2022). *Museu do Amanhã: estratégias de acessibilidade para pessoas com Síndrome de Down*. Fundação Oswaldo Cruz.
- SLOAN, D., KELLY, B., HEATH, A., PETRIE, H., HAMILTON, F., & PHIPPS, L. (2006). Contextual web accessibility - Maximizing the benefit of accessibility guidelines. In S. Harper, Y. Yesilada, & C. Goble (Eds.), *Proceedings of the 2006 International Cross-Disciplinary Workshop on Web Accessibility (W4A 2006)* (Vol. 134, pp. 121–131). Association for Computing Machinery. <https://doi.org/10.1145/1133219.1133242>
- SYLAIYOU, S., MANIA, K., KAROULIS, A., & WHITE, M. (2010). Exploring the relationship between presence and enjoyment in a virtual museum. *International Journal of Human Computer Studies*, 68(5), 243–253. <https://doi.org/10.1016/j.ijhcs.2009.11.002>
- VIGO, M., BROWN, J., & CONWAY, V. (2013). Benchmarking Web Accessibility Evaluation Tools: Measuring the Harm of Sole Reliance on Automated Tests. In G. Brajnik & P. Salomoni (Eds.), *W4A '13: Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility* (p. 10). Association for Computing Machinery.
- W3C. (2018). *Web Content Accessibility Guidelines (WCAG) 2.1*. World Wide Web Consortium. <https://www.w3.org/TR/2018/REC-WCAG21-20180605/#use-of-color>
- WCAG 2.1. (2018a). *Understanding Success Criterion 1.3.3: Sensory Characteristics*. W3C Working Group Note. <https://www.w3.org/WAI/WCAG21/Understanding/sensory-characteristics.html#techniques>
- WCAG 2.1. (2018b). *Understanding Success Criterion 1.4.1: Use of Color*. W3C Working Group Note. <https://www.w3.org/WAI/WCAG21/Understanding/use-of-color.html#techniques>

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