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Web accessibility for citizens with reduced capacities on science portals. Evaluation of MCTIC and Ciência Viva

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This investigation aims to study the accessibility of science dissemination web portals, focusing on citizens with some form of disability or limitation. Based on the theoretical framework developed by the Spanish Infoparticipa project and other similar studies that examine Brazil and Portugal, we analyse the two most important science dissemination portals in these two countries. The method is based on the design of a set of indicators that enable access to information by users with various physical limitations or disabilities to be measured, and which are subsequently verified through specific questionnaires. The analysis of the science dissemination portals examined here shows that there is still a deficit in terms of access to science information by all citizens, with the imposition of more specific accessibility rules being desirable.

Keywords: Accessibility; users with disabilities; science websites; ICTs, democracy, dissemination of science, plurality.

1. Introduction

In order to foster dialogue between scientists and the public, in recent decades various programmes and actions have been established with a view to institutionalizing a national policy for the popularization of science and technology in Brazil and Portugal. In this context, the Brazilian Ministry of Science, Technology, Innovation and

Communications (MCTIC), and the Portuguese agency Ciência Viva occupy key positions as leaders in the implementation and execution of national programmes for the dissemination of science in these two countries (Brasil 2016).

Currently, their web portals are the main means to communicate with citizens. MCTIC and the Ciência Viva Agency both provide an array of information on their platforms that focuses on the dissemination of science and technology activities. Their pages include content with news, articles and information about scientific events, programmes and calls for tenders.

Thanks to the implementation of these and other portals, society has access to public information that includes reliable statistical data and studies (Ferrer and Santos 2004). However, it is not enough for the information to be published, even if it is accessible and transparent to the majority; it must also serve a plural citizenship and include as many social classes as possible.

In this regard, the research team from the Laboratory of Journalism and Communication for Plural Citizenship (LPCCP), part of the Faculty of Communication Sciences at the University of Barcelona (UAB), has been actively working in recent years on the development of a theoretical framework to establish criteria and methods for the analysis of web platforms with the aim of stimulating the participation of a plural citizenship in the websites of public institutions (Moreno Sardà *et al.* 2017). Within this line of research, the Infoparticipa project (Moreno Sardà *et al*. 2013) was created in 2012 in order to improve communication between citizens and public administrations. For this purpose, an online platform was created, and web portal analysis indicators and tools were designed based on the different types of users (Sánchez-Labella Martín *et al.* 2017).

Based on the theoretical framework developed within the Infoparticipa project (Moreno Sardà *et al*. 2013, Sánchez-Labella Martín *et al.* 2017) and on other similar studies that focus more on Brazil and Portugal (Brasil 2014, Certic – Utad 2018), this study aims to design indicators that enable web access to scientific information by users with some form of disability or limitation to be measured. In this article we focus on the analysis of the accessibility of the web pages of the MCTIC and Ciência Viva Agency web portals.

1.1 Strategies for the dissemination and popularization of science in Brazil and Portugal

In recent decades, Brazil and Portugal have initiated national policies and programmes for the communication and dissemination of science and technological innovations, involving areas of government such as universities, museums, research centres and the media (Gonçalves 2018). Within this public action framework aimed at promoting dialogue between scientists and the public, various programmes and actions have been established with a view to institutionalizing a national policy for the popularization of science and technology. These policies were channelled through the Ministry of Science, Technology, Innovations and Communication (MCTIC) in Brazil, and the Ciência Viva Agency in Portugal.

The popularization of science in Brazil gained strength as an alternative, not only to contribute to the understanding scientific knowledge, but also to improve education. This relationship has emerged as an opportunity to include less favoured groups in the collective construction of knowledge (Navas and Marandino 2009). With a history of social inequality, reflected in the lack of access to scientific knowledge, actions for the popularization of science in Brazil have focused on the possibility of providing access to basic knowledge about science and its functioning and the conditions to understand its context (Moreira 2006).

Despite the progress made over the years, the heterogeneity between its regions is another barrier to a better dissemination of science in Brazil. The dissemination of science in Brazil has been studied by Almeida *et al*. (2015), Navas and Marandino (2009), Moreira (2006) and Massarani (2002) and it was observed that, historically, structural heterogeneity between Brazil's regions has been perpetuated, something that can only be changed through active policies. The northern, north-eastern and rural areas are considered the poorest areas of the country, where there is a greater lack of access to material and cultural goods, something which is also reflected in less scientific and technological knowledge.

In this scenario, MCTIC occupies the central role in Brazil as it is the institution responsible for scientific dissemination programmes in Brazil. MCTIC has invested heavily in projects to disseminate knowledge and technologies for deprived communities in rural and urban areas, with a focus on the popularization of knowledge for social inclusion (Gonçalves 2018, Brasil 2016).

Currently, faced with a new social reality shaped by technological tools, MCTIC has invested in the use of digital tools for the dissemination of information and for the communication and dissemination of science in Brazil. Their website[1] has thus become one of the main means of communicating to citizens.

The portal includes content with news, publications, documents and services, and users can find scientific events, programmes and calls for tenders. Users can also access a photo and audio gallery that includes content on the activities of the Ministry, science centres, universities and public foundations in the areas of science and technology.

Moreover, the platform has links to databases with documents, budgets, laws, agreements, expenses, tenders, contracts, audits, decrees and MCTIC governmental measures in science and technology in Brazil. Users can also access portals of other public institutions and federal agencies and links to social networks.

As in Brazil, policies and programmes aimed at disseminating science in Portugal have recently been drawn up. Actions for the dissemination of science are channelled through the *Agência Nacional para a Cultura Científica e Tecnológica – Agência Ciência Viva* (National Agency for Scientific and Technological Culture – Ciência Viva Agency). Since its creation in 1995, this institution has organized, coordinated and financed projects and programmes of science dissemination and the promotion of scientific education and experimental teaching in Portuguese schools. Young people and scientific institutions have therefore been chosen as the target audience for the policy of the dissemination of scientific culture, reflecting a perspective of the popularization of science based on cooperation between schools, universities and laboratories (Magalhães and Rodrigues 2000). In addition to these measures, the Agency finances centres, museums, national science festivals and science weeks with the aim of strengthening communication between scientists and the public (Delicado 2006).

Within the framework of public actions organized by the Ciência Viva Agency for the promotion of scientific culture in Portugal, the Ciência Viva portal[2] was created. Powered by the dynamics provided by its digital tools, the portal provides new impetus to the initiatives and projects carried out by the Agency.

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[1] The MCTIC portal can be accessed at: http://www.mctic.gov.br/portal
[2] The Ciência Viva portal can be accessed at: http://www.cienciaviva.pt/home/

The usability of the MCTIC and Ciência Viva portals by the public has been analysed by Gonçalves (2019, 2017). However, web accessibility for vulnerable citizens with any physical, mental or socioeconomic disability was not evaluated. Access to science dissemination portals for people with disabilities is a problem that needs to be examined with greater attention than has so far taken place. Indeed, the main aim of the study presented here is to provide new ideas and analysis on these issues. To achieve this aim, we propose an analysis based on several indicators designed to examine science dissemination websites and focus on the cases of Brazil and Portugal. These indicators will then be applied in the detailed study of the MCTIC and Ciência Viva portals, identifying user profiles based on their access limitations.

1.2 Accessibility on web portals for people with disabilities

In the latest UN report released in 2018, the United Nations Committee on the Rights of Persons with Disabilities publicly warned of the need to make an effort to grant disabled and non-disabled citizens the same rights as regards to integration into society and the use of any product or service (WHO 2018).

This effort towards equality and democracy should be even greater when it comes to the use of technology, as people affected by a physical disability or sociodemographic limitation face numerous challenges in terms of Internet access (Edwards 2008, Karamagioli 2008, Murthy 2010 and Nielsen 2002). Therefore, the accessibility of content on government portals is extremely important to ensure that all citizens fully enjoy the benefits of the information society. It is not enough simply to have the technology; resources must be made available efficiently in order to improve the real and practical web accessibility of these people.

Most of the documents that propose rules and standards for web accessibility are based on the World Wide Web Consortium (W3C) guidelines. The W3C is the world's leading organization for the standardization of requirements for the creation and interpretation of web content. Foremost among W3C's various lines of action is the Web Accessibility Initiative (WAI), whose mission is to promote web accessibility for people with disabilities. To establish standards for website accessibility, the WAI establishes guidelines with rules and regulations for the creation of platforms, browsers and web content. Requirements include, among others, providing equivalent alternatives to visual content, providing context and guidance information to help users with special

needs to understand pages and clearly providing consistent and clear navigation mechanisms (W3C 2018). The W3C guidelines (2018) have thus served as a starting point in the creation of a series of recommendations and obligations for member states of the European Union.

In its stance against digital exclusion and in order to achieve the principle of equal opportunities, the European Commission has pushed for the revision of legislation regarding the information society and accessibility standards. It was established that all public administrations (local, county, provincial, regional, national and European) provided accessible websites. European public administrations therefore need to supervise their institutional web pages based on the development of a code of good practice and the promotion of education and training measures in web accessibility (EU 2016, 2005, Moreno Sardà *et al*. 2013).

Along these lines, Portugal created the *Iniciativa Nacional para os Cidadãos com Necessidades Especiais na Sociedade da Informação* - INCNESI (National Initiative for Citizens with Special Needs in the Information Society). INCNESI's main aims are to ensure that Portuguese citizens requiring special consideration are not excluded from the benefits of the information society. Based on these premises, several studies have emerged that analyse the accessibility of websites. For example, Tomás (2014) and Fernandes and Cardoso (2013) studied the accessibility of official websites and e-learning platforms in public higher education institutions in Portugal. Also worth highlighting are the studies of the *Centro de Engenharia de Reabilitação e Acessibilidade* (Rehabilitation and Accessibility Engineering Centre) of the University of Tras do Montes, CERTIC – UTAD (Certic – Utad 2018), Fernandes and Cardoso (2009) and Accenture (2003), which focused on the evaluation of web accessibility of the contents of Portuguese municipalities. Indeed, CERTIC – UTAD (Certic – Utad 2018) is included in the Portuguese government portal as a reference and accessibility guide for Portuguese web platforms.

The CERTIC – UTAD initiative is very much in line with that carried out in Spain by Sánchez-Labella Martín *et al.* (2017). These authors created a list of 16 indicators to measure the degree of accessibility of Spanish local administration portals for people with physical disabilities or sociodemographic limitations, based on the guidelines of the W3C (2018) and Infoparticipa (Moreno Sardà *et al*. 2013).

Infoparticipa is a project conceived by the team from the Laboratory of Journalism and Communication for Plural Citizenship (LPCCP) at the Autonomous

University of Barcelona (UAB). The project's fundamental idea is to stimulate communication between citizens and Spanish public administrations in order to improve transparency and accessibility to information. With this objective, a set of methodologies and web applications was developed to provide understandable information to all citizens without excluding anyone (Moreno Sardà *et al*. 2013). Specifically, a guide to good practices with 52 indicators and the Infoparticipa Map platform[3] were created. These indicators were based on the Spanish Law 19/2013 on Transparency and Good Governance that imposes the obligation for public administrations to publish, on their websites, periodically and updated, the information whose knowledge is important to guarantee the transparency of their activity related to the operation and control of public action. The degree of compliance with these indicators are used to ensure that information is available to citizens as a first step in achieving citizen participation. In addition, the Infoparticipa Map focuses on municipals, since the city is the natural environment of the idea of good governance.

In this context, the Infoparticipa project starts form the idea that we have to consider citizens of different conditions and with different capacities and needs, as active subjects of the public debate (Moreno Sardà et al. 2013). However, initially this project did not specifically take into account citizens with reduced capacities. For this reason, in 2016 the same team of researchers broaden these indicators in order to consider the specific aspects that affect people with a situation of inequality considering the following criteria: place of origin (foreigners), age (elderly citizens), few economic resources, lack of ICT training experience and physical disabilities (visual, auditory and motor) (Sánchez-Labella Martín *et al.* 2017: 160-161).

Similarly, Latin America has supported various projects with the aim of creating equal opportunities and promoting the digital inclusion of all citizens. In order to promote digital inclusion and reiterating that information is for everyone, the Brazilian government developed the Electronic Government Accessibility Model, or e-MAG (Brasil 2014), for the development and adaptation of government content on the Internet, generating a set of recommendations to be considered as a guide for web developers of Brazil's public administration. Such recommendations will help the

[3] The Infoparticipa Map website can be accessed at: http://mapainfoparticipa.com/index/home/

accessibility tools of government sites to be implemented in a standardized manner consistent with Brazilian needs and in accordance with W3C international standards.

In the dissemination of science by public administrations through web portals, Gonçalves (2019, 2017) presented an analysis of the platforms of Brazil's MCTIC and Portugal's Ciência Viva Agency and studied their effectiveness as tools to disseminate and promote the acquisition of information on science in these countries. The results of both studies showed that, although these platforms offered new routes for the provision of information to citizens, there was still some delay vis-à-vis their structures, especially usability. However, these studies were carried out without taking into account people with limitations. The study presented here was designed with the aim of studying web access to science dissemination portals by citizens with disabilities.

In particular, we focus on the analysis of the portals of MCTIC and the Ciência Viva Agency, adapting the indicators developed in Infoparticipa (Moreno Sardà *et al*. 2013), Sánchez-Labella Martín *et al.* (2017), e-MAG (Brasil 2014) and CERTIC – UTAD (Certic – Utad 2018) in this context. This article can thus be considered a continuation of the works presented by Gonçalves (2019, 2017) to include users with limitations and a natural extension of the studies developed within the Infoparticipa project for a context of public science dissemination websites.

2. Method

2.1 Methodological strategies and aims

In this article we focus on the study of the accessibility of the largest science dissemination portals in Brazil and Portugal, namely MCTIC and Ciência Viva, with a focus on meeting the needs of users with disabilities.

With this purpose in mind, this study had two aims: a) To develop indicators that allow web access to scientific information by users with some type of disability or limitation to be measured, and b) Based on the indicators obtained, to analyse the degree of accessibility of the web pages of the MCTIC and the Ciência Viva Agency portals.

To achieve these objectives, the method of this study is based on the set of indicators proposed by Infoparticipa (Moreno Sardà *et al*. 2013), Sánchez-Labella Martín *et al.* (2017), e-MAG (Brasil 2014) and CERTIC – UTAD (Certic – Utad 2018)

that allowed access to information on Spanish city council websites and public administration portals in Brazil and Portugal, respectively, by users with various limitations or physical disabilities to be measured.

Along that line, we first identified the most relevant general accessibility indicators proposed by these authors. We then developed specific indicators with a focus on science dissemination portals and organized them into evaluation groups according to their similarities. These groups gave rise to four general parameters for evaluating the portals: Page Design, Content/Information, Multimedia, and Forms. Along this line, the parameters and their respective indicators presented in Table 1 were applied to evaluate the MCTIC and Ciência Viva portals.

After establishing the parameters and their respective indicators for this study, following the methodology proposed by Sánchez-Labella Martín *et al.* (2017), user profiles were specified based on their access limitations. Taking into account the aims of this study, priority profiles were specified according to the following criteria: (1) citizens with physical (visual, hearing, mobility) or mental disabilities, (2) elderly citizens (65 years old and above), (3) foreign citizens (citizens of other countries with difficulties in the Portuguese language), (4) non-scientific citizens (lay citizens or with little/medium technical knowledge of science), (5) citizens with few economic resources (difficulty in accessing the Internet, low network connection and problems loading web pages), (6) citizens lacking ICT experience (no knowledge or with very basic knowledge of ICT use).

Following the method proposed by Sánchez-Labella Martín *et al.* (2017), and in order to verify the indicators, we designed a questionnaire that included questions written in such a way that their answer can only be in the affirmative if the required information is present, or negative if this information is not published or is incomplete or inadequate.

The analysis of the MCTIC and Ciência Viva portals was carried out between February and March 2020. The evaluation procedure consisted of inspecting each portal at least twice: the first time to familiarize ourselves with the content, and the second to carry out a more in-depth inspection of the platform based on the accessibility indicators chosen for that study.

The analysis was carried out on the main page of the portals and on two subsequent levels. We chose this procedure as it was impossible to carry out a statistical examination through to the last page level of these portals because this type of survey

would include, in addition to the MCTIC and Ciência Viva portals, pages of other institutions linked to these platforms. The data collected was processed using Microsoft Excel spreadsheets and the SPSS 25.0 Statistics software. In Table 1 we present the indicators and the corresponding results obtained by the evaluation of the web pages of MCTIC and Ciência Viva.

Table 1. Science portal accessibility parameters and indicators and priority user profiles based on their access limitations.

Accessibility indicators of science portals and priority user profiles	**MCTIC**		**CV**	
	Yes	**No**	**Yes**	**No**
Page Design				
A1. The main page includes enough information to determine that the site corresponds to a science platform, the objective of this being clear. Priority profile: (4) non-scientific citizens.		**X**	**X**	
A2. The main page includes enough information to identify which science institution (public or private) the site corresponds to. Priority profile: (4) non-scientific citizens.	**X**			**X**
A3. The website includes graphic elements that identify the entity (public or private science institutions). Priority profile: (4) non-scientific citizens.		**X**	**X**	
A4. Options are provided to return to the home page through indicators such as “Home”, “Portal”, “MCTIC Portal” or “Ciência Viva Portal”. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**		**X**	
A5. The page includes a direct search tool such as a magnifying glass icon or through the verbs “Go” or “Search”. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**		**X**	
A6. It provides spaces for interaction between users, portal managers or members and managers in science and technology through chat group icons or links. Priority profiles: (4) non-scientific citizens.		**X**		**X**
A7. The main page includes a link titled “Site Map” that allows the platform’s overall layout to be seen. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**			**X**
A8. The accessibility symbol is located and identified with this. Priority profile: (1) citizens with physical or mental disabilities.	**X**			**X**
A9. It provides all the page functions through the keyboard. The portals must include this option on the main page through an accessibility icon or through the “accessibility” link. Priority profile: (1) citizens with physical or mental disabilities.	**X**			**X**
A10. The main page provides different ways of accessing the contents and information. Priority profiles: (1) citizens with	**X**			**X**

physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.				
A11. The pages show sufficient contrast between the page background and the contents. Priority profile: (1) citizens with physical or mental disabilities.		**X**		**X**
A12. It does not show a flashing screen or use flashing visual effects. For example: the use of advertising images for science exhibitions, museum/centre logos etc. Priority profile: (1) citizens with physical or mental disabilities.	**X**			**X**
A13. It allows resizing without losing page functionality. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens.	**X**			**X**
A14. Breadcrumb trail navigation; new windows do not open on the platform without user's permission. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**		**X**	
A15. Page elements are visually clear (such as buttons, icons, links, text and images). Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens.	**X**		**X**	
A16. It uses very little colour to differentiate page elements. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens.	**X**		**X**	
A17. Pages have the same structure and components are in the same place. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens.	**X**		**X**	
A18. The main page includes a direct link such an icon to a social media (Facebook, Twitter or Instagram), mobile app and email. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.		**X**		**X**
Content/Information				
B1. It identifies the page's main language. Priority profile: (3) foreign citizens.	**X**		**X**	
B2. It includes the option of choosing the page's language and informs of the change of language. Priority profile: (3) foreign citizens.		**X**	**X**	
B3. Links to news, information and other contents of this or another science institution platform (public or private) are differentiated from the rest of the text. Priority profile: (4) non-scientific citizens.	**X**		**X**	
B4. The use of elements such as colour, bold and italics to highlight some of the information. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**		**X**	
B5. It does not include automatic content update pages. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**		**X**	
B6. It ensures user control over temporary content changes. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**		**X**	

B7. It informs the user about the page's location. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**			**X**
B8. The language used is presented simply, with a focus on the non-scientific citizen. There is no excessive emphasis on technical terms and the contents and information are presented clearly and understandably to the non-scientific citizen. Priority profile: (4) non-scientific citizens.		**X**		**X**
B9. It provides HTML alternative to content. Priority profiles: (1) citizens with physical or mental disabilities, (5) citizens with few economic resources.		**X**		**X**
B10. It provides an audio alternative to texts. Priority profile: (1) citizens with physical or mental disabilities.		**X**		**X**
B11. Availability of documents such as public calls for tenders, projects, meeting minutes or accountability in science and technology in accessible formats, mainly in HTML. If a file is in PDF format, an alternative must be provided for HTML and Microsoft Office. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (4) non-scientific citizens, (5) citizens with few economic resources, (6) citizens lacking ICT experience.		**X**		**X**
B12. The site adapts to the size of the screen, allowing all the content to be seen without using scroll bars. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**		**X**	
B13. It includes the option of enlarging the text size without using scroll bars. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.		**X**		**X**
B14. It provides options for interactivity within the context of web 2.0 such as social media (Facebook, Twitter or Instagram) and mobile app. Priority profiles: (3) foreign citizens, (4) non-scientific citizens, (5) citizens with few economic resources, (6) citizens lacking ICT experience.	**X**		**X**	
Multimedia				
C1. It provides sound or text alternatives to videos. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens.		**X**		**X**
C2. It provides a text alternative to images and graphics. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens.		**X**		**X**
C3. It provides an alternative to audio: audio description/subtitles for videos. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (3) foreign citizens.		**X**		**X**
C4. It includes audio and sound control on the page. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens.	**X**		**X**	
C5. It includes animation control on the page. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens.	**X**		**X**	

Forms				
D1. Offers text alternative to form image buttons. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.	**X**		**X**	
D2. The forms for calls for tenders, science competitions and hearings are understandable. Each field and how to fill it in is identified correctly. Provides instructions for data entry. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (4) non-scientific citizens, (6) citizens lacking ICT experience.	**X**			**X**
D3. It identifies and describes data entry errors and confirms that the information has been sent. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.		**X**		**X**
D4. It includes the option of downloading the forms or filling them in through the same page. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (6) citizens lacking ICT experience.		**X**		**X**
D5. They can be filled in and sent physically to the corresponding MCTIC or Ciência Viva Agency address. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (4) non-scientific citizens, (6) citizens lacking ICT experience.		**X**		**X**
D6. They can be sent to an email address as an attachment. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (4) non-scientific citizens, (6) citizens lacking ICT experience.		**X**		**X**
D7. They can be sent by any other type of complementary telematic attention. Priority profiles: (1) citizens with physical or mental disabilities, (2) elderly citizens, (4) non-scientific citizens, (6) citizens lacking ICT experience.		**X**		**X**

3. Results and Discussion

The results of the evaluation of the MCTIC and Ciência Viva portals revealed that neither portal meets all the accessibility indicators proposed in this study, that is, have failed to meet with the most the requirements of physically disabled. It should be noted that these sites also meet less than half the accessibility criteria, namely indicators A4, A5, A9, A14, A15, A17, B1, B3, B4, B12, C4, C5, D1 and D3. Most of these indicators correspond to the Page Design and Content/Information parameters and focus mainly on

serving specific user profiles: citizens with physical or mental disabilities, the elderly, or those lacking web experience. Next, we describe in detail the most positive aspects.

The data examined for the Page Design parameter indicate that the two platforms provide options to return to the home page (A4) and include direct search tools indicated on the two platforms with a magnifying glass icon and also with the verbs “Go” and “Search” (A5), thereby facilitating web accessibility, especially for users with physical or mental disabilities, the elderly or those lacking Internet experience. Likewise with a focus on these citizen profiles, these portals do not open new windows on the platform without user’s permission (A14), the page elements are visually clear (A15), very few colours are used to differentiate page elements of these portals (A16), and their pages include elements in the same screen location and with the same structure (A17).

The MCTIC portal successfully meets the Page Design accessibility indicators A2, A7, A8, A9, A10, A12 and A13. This allows non-scientific users to recognise that this site corresponds to the MCTIC platform, offering information about the institution to which it belongs (A2). The platform provides citizens with a physical or mental disability, the elderly or those no ICT experience different ways to access content and information (A10) in addition to the possibility of changing the size of the page without losing its functionality (A13). Moreover, according to the needs of the users with these profiles, the “Site Map” link is presented correctly on the main page and on the following pages (A7). This resource is especially important for these citizens because it provides them the option of seeing the platform’s organization at a single glance, thus illustrating in a simple way how the information is structured.

With regard to users with physical or mental disabilities, the accessibility symbol is located on the portal’s main page (A8) and no problems were observed with flashing screens due to flashing visual effects caused by logos, advertising images, etc. (A12).

Regarding the Ciência Viva portal, in addition to the indicators also fulfilled by the MCTIC portal, the platform complies with indicators A1 and A3. Thus, the main page of the Ciência Viva portal provides enough information to determine that this site is a science platform, unlike the MCTIC portal, which does not include this function, as we will see later.

Regarding the second parameter, namely Content/Information, we observed that both portals allow foreign users to identify the site’s main language (B1). We also noted

that it is particularly useful for non-scientific citizens that links to other content (to these and other science platforms) can be easily identified, since they are presented differently from the rest of the text (B3). Moreover, the contents of the two sites adapt to the size of the screen without the need for scroll bars (B12), facilitating accessibility for citizens with physical or mental disabilities, the elderly or those lacking web experience. In our analysis we noticed that both portals make their content available on social networks (Facebook, Twitter, Instagram) and on mobile apps (B14). This makes it easier for diverse groups of citizens such as citizens with few economic resources and citizens lacking ICT experience to obtain information presented by these portals through other types of platforms.

The results suggest that the MCTIC and Ciência Viva websites also complies with indicators B5 and B6, i.e. it does not include automatic content update pages and ensures user control over content changes and, therefore, also takes into account the needs and access limitations of that same user group. The Ciência Viva portal, in addition to fulfilling indicator B1, also meets indicator B2 by providing foreign citizens the option of choosing the page's language and informing users of the language change.

In relation to the Multimedia and Forms parameters, the platforms met two indicators of each parameter. In response to citizens with physical or mental disabilities or the elderly, the presence of audio and sound controls (C4) and animation controls on pages with multimedia content (C5) was noted. Also focusing on the access needs of citizens with physical or mental disabilities, the elderly, and those lacking web experience, the presence of text alternatives for image buttons (D1) and identification errors in the submission of forms (D3) in these portals were also noted.

It should be noted that the MCTIC portal also met indicator D2 of the Forms parameter. This indicator allows the group of citizens with physical or mental disabilities, the elderly, those lacking web experience or non-scientific citizens to understand forms of public hearings, calls for tenders, science competitions, etc. with instructions on how to fill them in and data entry indicators.

By fulfilling these accessibility indicators, the platforms include aspects that are essential for citizens with some limitation in accessing information. However, the vast majority of the indicators that are satisfied mainly take into account only some of the users considered: citizens with physical or mental disabilities, the elderly or those lacking ICT experience. Next, we analyse the most negative aspects that were revealed by our study.

On the MCTIC portal we observed that a number of important indicators for accessibility are left in the background, mainly with regard to the non-scientific citizen. According to the results, the Brazilian platform has accessibility flaws in three Page Design indicators established by this study to meet this priority profile of citizens: indicators A1, A3 and A6.

Although the portal makes it clear to non-scientific citizens that the platform belongs to the Ministry, thus meeting indicator A2, they are not informed that the platform corresponds to a portal for the dissemination of science, as recommended in indicator A1. In our analysis we observed that the contents of the portal's pages focus in particular on information about ministers themselves and the powers of secretaries and officials of the Government of Brazil and less on information from the scientific world. Thus, by focusing on the image of the members and directors of MCTIC, the contents of the platform acquire a personal character and do not meet the objective of disseminating science issues (Gonçalves 2018).

This website also does not include graphic elements that identify the Ministry, nor does it have spaces for interaction between users, managers of the MCTIC portal and directors in science and technology in Brazil. This prevents citizens from interacting with Ministry officials, thereby blocking them from debate on the actions of the institution and contributing to the exclusion of non-scientific users from the control of public actions related to the dissemination of science in Brazil. Similarly, it restricts easier and faster communication between users and the platform's directors, leaving users without the opportunity to obtain information or receive direct online attention (Gonçalves 2019, 2018, 2017).

Our analysis also found that the platform does not satisfactorily comply with indicator A11, which addresses the appropriate contrast between the page background and the contents with attention to citizens with physical or mental disabilities. Regarding this accessibility requirement, we note that an indicator with the same objective is included on the main page of this portal, through the "high contrast" link. However, this resource does not work on the following pages, impairing access for this group of citizens. A direct consequence of this type of failure is that access problems arise mainly for users who use screen readers to view content or who use browsers that can only display text from web pages, such as Linux or Net-Tamer (W3C 2018, Brasil 2014). In our analysis, we also noticed that the MCTIC portal does not meet the A18 criterion. Despite providing icons of social networks on the main page, there is no

information or graphic resource that indicates access to their mobile app. This resource is especially important to citizens with physical or mental disabilities, elderly citizens or lacking ICT experience as they could access to the information of the web portal also through a mobile application.

On the Ciência Viva portal, accessibility flaws with regards to the Page/Design parameter corresponding to non-scientific citizens, or those with physical or mental disabilities, the elderly or those without web experience were also observed.

Regarding the access of non-scientific citizens, the Portuguese platform presents deficiencies in indicators A2 and A6. Unlike the MCTIC portal and despite being clear that the goal of the Ciência Viva portal is to disseminate science, the portal's home page does not provide enough information about the institution, whether it is public or private, to which country it belongs, its directors, etc. On the other hand, like the Brazilian portal, the platform does not have or provide spaces for interaction between the portal's directors or members and directors of the institution in the field of science and technology. During the analysis, no resource was found for that purpose, be it icons, links to groups, discussion forums or chats. A direct consequence of this - in addition to the lack of accessibility to information about the institution - is that by not allowing an opening to the effective dialogue by lay citizens on science and technology issues with the directors of the portal or the Ciência Viva Agency, the user is rendered invisible (Gonçalves 2019, 2018, 2017).

Regarding citizens with physical or mental disabilities, the elderly or those lacking web experience, other shortcomings were observed in the Ciência Viva portal: specifically, in six accessibility requirements, namely indicators A7, A8, A9, A10, A11, A12 and A13. Failure to comply with these indicators represents a major impediment to accessing resources considered essential for this group of users (W3C 2018).

Firstly, the main page of the site does not include a "Site Map" that allows users to see the overall layout of this platform, impairing the navigation of users with physical or mental disabilities, the elderly or those lacking web experience. Another problem that was observed, and one that directly affects citizens with physical or mental disabilities, is that the platform lacks an accessibility icon or any link for that purpose (Certic – Utad 2018).

In addition, this same group of citizens is not provided any options or links to adjust the contrast between the page background and the contents; the absence of alternatives provided through the keyboard and voice resources is also worth noting.

According to e-MAG (Brasil 2014) and W3C (2018), the absence of these resources mainly impairs the accessibility of users with visual and hearing disabilities. For the pages to fulfil their purpose, their navigation should not depend exclusively on a single type of equipment and should be accessible to users who do not use a mouse, touchpad or who use voice or text alternatives. In addition, like the MCTIC portal, the Ciência Viva portal also does not have an icon or any graphic resource that indicates access to its mobile app. This feature is relevant to this type of citizens so that they can have access to the mobile app.

Similarly, the MCTIC and Ciência Viva portals lack accessibility resources that respect the Content/Information parameter. Our results revealed that the two platforms do not meet six indicators: B8, B9, B10, B11 and B13. Firstly, regarding non-scientific citizens, we observed serious failures related to the language used on these portals. On both the MCTIC and the Ciência Viva portals the contents and information include too many technical terms that are not fully understandable to users outside the science world. Consequently, the information is dehumanized through the use of specialized language and is difficult to read and understand (Gonçalves 2019, 2018, 2017). The managers of the two portals should make an effort to simplify the information, making it less technical so that the interaction of all people is possible according to their different interests and abilities (Moreno Sardà *et al*. 2013).

Another problem encountered in our analysis is the lack of accessibility to public documents. Documents such as calls for tenders, minutes of meetings, projects, etc. are provided in only one format (PDF), excluding other types of formats (such as Word, for example), thereby making access difficult. The portals should include HTML and audio alternatives for the content and also the option of enlarging the text size without using scroll bars.

During the evaluation of the Content/Information parameter, the absence of tools for language selection on the MCTIC portal was also observed, thereby denying foreign users the option of choosing another language other than Portuguese. This type of accessibility tool is essential so that all citizens, regardless of their place of origin, can access the contents and services available on the platform (Sánchez-Labella Martín *et al.* 2017).

The last two parameters, Multimedia and Forms, showed the greatest number of failures in terms of accessibility indicators, which directly affects all the priority profiles of that study.

Regarding the Multimedia parameter, neither platform complies with indicators C1, C2 or C3. The multimedia contents do not include transcripts nor are they explained through sound or text language and there is no text alternative to images or graphics, nor audio description alternatives or subtitles for videos. This mainly prevents citizens with visual or hearing disabilities from accessing information presented in this type of content. These platforms must provide, through audio and video functions, resources for users who cannot see or hear, adapting as much as possible to alternative sensory channels (Brasil 2014, Certic – Utad 2018).

Similarly, the MCTIC and Ciência Viva platforms do not provide a range of essential accessibility resources aimed at accessing forms. These failures were observed in the non-compliance of the following indicators corresponding to this evaluation parameter: D4, D5, D6 and D7.

In this regard, the platforms do not include the option of downloading forms, filling them in on the same page or sending them physically to the corresponding public administration. Nor can they be sent through any other complementary telematic attention, nor is an email address provided with the option to attach completed forms. This means that citizens with social or mobility difficulties do not have the option of accessing this type of document.

Regarding the Forms parameter, it should be noted that the Ciência Viva portal also does not meet the indicator D2. Thus, despite having forms for competitions and calls for tenders in science and technology, the platform does not provide clear instructions on how to fill them in. During the evaluation we observed that the Ciência Viva platform does not provide sufficient instructions for data entry, nor identifies all form fields or how to fill them in correctly, therefore preventing transparent information from being obtained (Sánchez-Labella Martín *et al.* 2017). We observed that the data entry errors were prompted when sending information; however, as e-MAG (Brasil 2014), Sánchez-Labella Martín *et al.* (2017) and CERTIC – UTAD (Certic – Utad 2018) warn, this is insufficient for users with little experience in handling these types of documents.

After demonstrating the shortcomings and deficiencies in accessibility of the MCTIC and Ciência Viva portals, it is clear that the managers of these platforms must make their information and content understandable to users with any limitation or disability.

Regarding the accessibility of information and science content for a plural citizenship, it must be taken into account that information management tools that make access for each citizen possible in accordance with their interests but mainly their abilities, must be developed (Moreno Sardà *et al.* 2013). In this regard, information management in these portals must constantly adapt to these new circumstances so that any person, whether scientific or non-scientific (Gonçalves 2018, 2017), with or without disabilities, can compare it with their knowledge in relation to the social positions they occupy, where they live and compared to other citizens (Sánchez-Labella Martín *et al.* 2017).

In a more detailed analysis of each portal, the absence of essential resources for accessibility (W3C 2018) to scientific information by all citizen profiles established was confirmed. Although the platforms include tools for this purpose, there is a deficit in web access with regards to serving the entire plural citizenship. Neither portal gives much attention to the needs of non-scientific citizens, foreigners or those with few economic resources. This reveals that these science dissemination websites should facilitate the understanding of and access to science information by citizens who today are very plural, and not just people from that country with a degree of training and economic power.

4. Conclusions

This study focused on the accessibility of people with some form of disability or limitation to scientific information in science dissemination portals. In particular, based on the set of accessibility indicators proposed by Infoparticipa (Moreno Sardà *et al.* 2013), Sánchez-Labella Martín *et al.* (2017), e-MAG (Brasil 2014) and CERTIC – UTAD (Certic – Utad 2018), specific indicators were developed to measure web access on the MCTIC and Ciência Viva platforms by citizens with reduced capacities.

Along these lines, two main objectives were established. The first objective: (a) to develop indicators that allow web access to scientific information by users with some form of disability or limitation to be measured. And the second: (b) to analyse the degree of accessibility of the web pages of the MCTIC and the Ciência Viva Agency portals.

For the first objective, an index was developed with 41 accessibility indicators organized into four evaluation parameters: Page Design, Content/Information,

Multimedia, and Forms. These parameters and their respective access quality indicators are provided as a benchmark to measure web accessibility on science dissemination portals in Brazil and Portugal. This evaluation instrument was conceived as a tool for managing accessibility to this type of portal, thus facilitating the detection of deficiencies in access to science information by citizens according to their abilities and needs.

Regarding objective (b), the results of this analysis made it possible to detect serious accessibility deficiencies by not meeting a large number of the indicators, thereby affecting different groups of citizens with disabilities or limitations. This study reveals that even though the platforms include tools to facilitate access to information by people with reduced capacities, many fundamental accessibility resources are left in the background on both portals. Regarding this, we observed that compliance with the accessibility indicators proposed in this study is extremely insufficient, mainly with regard to the parameters Multimedia and Forms. A direct consequence of this is that full access to information by these citizens on these platforms does not appear to be guaranteed.

Although some criteria were successfully satisfied, the analysis carried out in this study reveals a deficit in access to science information by all citizens, who today are highly plural and formed by different groups of people in their wide spectrum of diversity. Hence, the portals of science communication established by the Brazil and the Portugal governments considered in this work have not successfully met with all the requirements of physically disabled users, whatever may be the physical disability. In particular, there is a clear need for the managers of the MCTIC and Ciência Viva portals to improve the management of the information on their portals, with the imposition of more specific accessibility rules that adapt to a broader group of users being desirable. Monitoring compliance with such improvements, for example, by using the indicators presented in this study, is necessary for their correct implementation.

Finally, we believe that, for a better and more democratic dissemination of science, it is important that scientific content is accessible to the greatest possible number of citizens regardless of their physical, mental, economic or social status. In this regard, we believe that an improvement in the accessibility of these platforms would stimulate the dissemination and popularization of science in a more balanced way among all citizens.

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