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Can I Give You My Opinion? Building an Accessible Online Survey Tool

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Resumo

Os questionários digitais são um meio fundamental para recolha de informação, podendo ser utilizados em vários contextos. Um desses contextos são os censos, conduzidos de 10 em 10 anos, que consistem em operações estatísticas que permitem obter informações sobre as populações residentes, as famílias, e o parque habitacional. Com esta informação, os governos podem melhor decidir como alocar recursos (por exemplo, financeiros ou humanos) aos vários serviços. Outro exemplo de aplicação dos questionários é o seu uso por empresas, quando estas pretendem conhecer a opinião dos seus clientes sobre os serviços que prestam. Com os dados obtidos, as empresas poderão assim resolver eventuais falhas e melhorar os seus serviços, o que, por sua vez, poderá contribuir para aumentar a satisfação e a fidelização dos clientes.

Contudo, apesar da sua ampla aplicabilidade, a literatura continua a destacar a inacessibilidade dos questionários digitais para pessoas com deficiências. Tal facto faz com que estas pessoas sejam excluídas de pesquisas decorrentes, o que compromete não só o direito das pessoas com deficiências a expressarem as suas opiniões sobre assuntos que lhes dizem respeito, como também a validade dos dados obtidos nestas pesquisas.

Perante este cenário, esta dissertação focou-se na identificação de barreiras relatadas na literatura, com o intuito de informar os requisitos para o desenvolvimento de uma ferramenta digital acessível para o preenchimento de questionários por pessoas com deficiências. Foram também exploradas estratégias de design que incorporassem os conhecimentos e requisitos de acessibilidade identificados.

Assim, começou-se por realizar uma revisão da literatura sobre o tema "acessibilidade em questionários", identificando 12 artigos que foram analisados para determinar os tipos de deficiências abordados, os materiais utilizados, as metodologias de teste aplicadas e os resultados obtidos. Com base nos resultados desta análise, foi construída uma lista de 47 requisitos, organizados sob 12 categorias.

Com exceção de um requisito, os restantes foram implementados no protótipo de uma ferramenta de preenchimento de questionários. Um dos requisitos, que promove a internacionalização da ferramenta desenvolvida, não foi implementado porque, antecipando a realização de testes com participantes portugueses, o desenvolvimento acabou por se concentrar em duas línguas: português e Língua Gestual Portuguesa. A ferramenta suporta dois tipos de utilizadores: criadores de questionários e inquiridos. Os criadores podem descarregar um ficheiro-modelo, preenchê-lo com as questões do questionário e carregá-lo para a ferramenta, e aceder às respostas, mediante

autenticação prévia. Os inquiridos podem completar os questionários introduzindo o respetivo identificador, tendo a opção de preencher o questionário diretamente na ferramenta ou descarregando um ficheiro-modelo, completando-o com as suas respostas e carregando-o para a ferramenta.

A ferramenta construída foi depois testada com sete pessoas com deficiências, com o objetivo de avaliar a sua acessibilidade. Estes testes iniciaram-se com a colocação de questões demográficas aos participantes, nomeadamente, sobre a sua idade, tipo de deficiência, frequência de uso de tecnologias, uso de ferramentas de apoio, e experiência prévia com questionários online. Em seguida, os participantes foram convidados a (1) aceder à ferramenta, (2) completar o questionário, diretamente na ferramenta ou por ficheiro, (3) submeter as respostas, e (4) (opcionalmente) descarregar um ficheiro com as respostas dadas. O questionário incluía dez perguntas sobre entretenimento utilizando diferentes tipos de questões: resposta aberta (1 questão); resposta curta (1 questão); resposta através de uma escala numérica (1 questão); escolha por imagens (3 questões); escolha múltipla (1 questão); escolha única (1 questão); resposta indicando uma data (1 questão); resposta indicando um número (1 questão). Para atender as diferentes necessidades de acessibilidade, todas as perguntas e opções de resposta, quando aplicável, foram apresentadas em texto e em vídeos com traduções para Língua Gestual Portuguesa. Após submissão das respostas, os participantes foram entrevistados sobre a sua opinião sobre a acessibilidade e a sua experiência em geral com a ferramenta, além de possíveis melhorias.

Os testes realizados permitiram identificar problemas, que implicaram não conformidade com alguns critérios de sucesso das WCAG 2.2 e com três dos requisitos reunidos, propor potenciais melhorias e destacar aspetos positivos, tendo os resultados sido divididos consoante estivessem relacionados com o conteúdo do questionário ou com a ferramenta. Com base nesses dados, a ferramenta foi então refinada para melhor atender às necessidades de acessibilidade de pessoas com diferentes capacidades. Estes refinamentos incluíram: Reposicionamento de um dos botões de submissão para uma localização mais intuitiva; Inclusão de mensagens de confirmação ao acionar os botões de submissão; Criação de uma secção de personalização, permitindo ao utilizador selecionar quais elementos (i.e., secção para selecionar a cor de texto e fundo ou vídeos em Língua Gestual Portuguesa) pretende que estejam presentes durante o preenchimento do questionário; Agrupamento de botões de opção e de caixas de verificação; Correção de botões "quebrados"pelo leitor de ecrã; Refinamento da validação feita quando se submete o ficheiro com as respostas ao questionário na ferramenta; Alteração do rótulo do botão de submissão do identificador do questionário; Mudança dos ficheiros-modelo para indicar as questões do questionário; Indicação de recomendações para criação de questionários acessíveis; Resolução de problemas em completar questionários criados através do ficheiro-modelo no formato JSON.

Após as mudanças à ferramenta, o trabalho realizado foi discutido, levando às seguintes conclusões:

- Apesar de a ferramenta não cumprir 3 dos 47 requisitos identificados, tal não impede que a lista de requisitos constitua um guia para promover inclusão e acessibilidade na criação

de questionários. Esta lista deverá ser alterada ou incrementada no futuro, de acordo com a evolução das tecnologias e das normas de acessibilidade.

- Apesar dos problemas identificados e sugestões de mudanças à ferramenta, esta revelou-se, de uma forma geral, acessível a pessoas com diferentes capacidades. Tal é corroborado pela observação dos participantes e pelas suas declarações. Esta ferramenta constitui também um avanço em relação a outras ferramentas mencionadas na literatura, uma vez que é uma ferramenta de preenchimento de questionários na qual foram implementados requisitos que refletem as necessidades de acessibilidade de utilizadores com diferentes tipos de deficiências.

- Durante a execução deste trabalho, tornou-se evidente que endereçar as diversas, e por vezes contraditórias, necessidades de acessibilidade de utilizadores com diferentes capacidades constitui um grande desafio. Inclusive, verificou-se que a maioria dos artigos analisados na literatura focam-se num grupo específico de deficiências. Tendo isto em conta, percebeu-se que o conceito de personalização, ou seja, permitir aos inquiridos escolher quais funcionalidades pretendem que estejam disponíveis durante o preenchimento do questionário, pode conduzir a interfaces mais acessíveis. Tal alinha-se com a literatura existente, na qual a personalização de interfaces surge como uma estratégia para endereçar as diversas necessidades dos utilizadores.

Por fim, foram discutidas as limitações deste trabalho, sendo elas: não endereçamento de todos os problemas detetados ou mudanças sugeridas nos testes; amostra reduzida de participantes envolvidos testes realizados; utilização de artigos publicados até 2023 como base para a construção da lista de requisitos; suporte da ferramenta apenas aos idiomas português e Língua Gestual Portuguesa; embora a disponibilização de meios para personalizar a interface do questionário tenha sido considerada, com base nas análises efetuadas, uma ideia eficaz, tal ainda não foi completamente testado com pessoas com deficiências; e, o processo para criar questionários na ferramenta não foi testado por pessoas com deficiências.

Foram ainda apontadas direções para trabalhos futuros, tais como: após o endereçamento dos restantes problemas detetados e mudanças sugeridas, a ferramenta deve ser testada com uma maior amostra de participantes; avaliação da utilidade e acessibilidade de funções de personalização, exploração de novas funções (por exemplo, ocultar e mostrar imagens) e, ainda, discussão adicional da utilidade destas funções para endereçar necessidades de acessibilidade contrastantes; atualização da lista de requisitos com outros de estudos publicados após 2023; testar a criação de questionários na ferramenta por pessoas com deficiências.

Note-se ainda que as lições aprendidas ao longo deste trabalho, dos requisitos reunidos, problemas detetados, melhorias sugeridas e aspetos positivos destacados ao longo dos testes, podem informar a construção de outros tipos de interfaces, contribuindo para a promoção da acessibilidade no design de interfaces e soluções digitais.

Os questionários são fundamentais para recolher informação, podendo ser, tal como já mencionado, aplicados em vários contextos. Independentemente do contexto, constituem acima de tudo um meio de integração de um indivíduo na sociedade, sendo, portanto, fundamental garantir que todos, sem exceção, podem aceder e completar questionários. Contudo, e apesar dos esforços feitos, ainda é possível notar a sua inacessibilidade a pessoas com deficiências. Assim, espera-se que este trabalho constitua um aliado para promover acessibilidade no preenchimento de questionários por pessoas com diferentes capacidades.

Palavras-chave: Questionários, Acessibilidade, Pessoas com deficiências, Ferramenta de preenchimento de questionários, Requisitos para construir questionários digitais acessíveis

Abstract

Digital surveys are a key method for gathering data. Their application spans various contexts, from national censuses, which provide a comprehensive overview of the population and its living conditions, to surveys conducted by companies to gather clients' feedback on the services provided.

Despite their acknowledged usefulness, the existing literature still highlights the inaccessibility of surveys for people with disabilities. That said, the objective of this dissertation is to develop a survey completion tool that considers the accessibility barriers and requirements identified in the literature.

To this end, we began by compiling the necessary requirements for building accessible digital surveys, obtained through a literature review. These requirements were then implemented in a survey completion tool, which was tested by people with disabilities to assess its accessibility. The tool was then refined based on the problems detected, improvement suggestions, and positive aspects identified during the tests.

Finally, the following conclusions were drawn. Firstly, it was noted that the survey completion tool developed is, in a general way, accessible for people with different abilities. Secondly, the list of requirements gathered can be used as a guide to promote accessibility for people with different abilities when completing surveys. Thirdly, enabling users to select which accessibility functionalities they want to be available when completing a survey can contribute to a more accessible and user-friendly interface.

Future work should involve testing the tool, after further refinements, with a larger sample of people with disabilities. In addition, it is also important to evaluate the usefulness and accessibility of both existing and newly added features, particularly those that allow for personalization of the survey interface. Also, creation of surveys in the tool by people with disabilities should be tested. Furthermore, the list of requirements should be continuously updated to reflect technological advancements and evolving accessibility standards.

Keywords: Surveys, Accessibility, People with disabilities, Survey completion tool, Requirements for building accessible digital surveys

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Chapter 1

Introduction

Surveys are typically defined as a set of questions focused on a specific topic. In today's world, digital surveys have become an essential tool for gathering information, with the use of online surveys having increased constantly over the years [81]. They are used in a variety of contexts, such as national censuses, which aim to count the entire population and housing stock of a country. In addition, censuses gather vital data on geographic, demographic, social, and economic factors, as well as household and family structures, providing a comprehensive overview of the population and its living conditions [30]. Another relevant example is a study conducted across 22 countries, which used surveys to assess the impact of COVID-19 on healthcare provision at frontline health services [66]. These examples illustrate how surveys are a fundamental means of engaging individuals in society and supporting entities such as companies, researchers, and governments in better understanding the impact of various situations (e.g., pandemics) on the services they provide.

1.1 Motivation

Despite their well-recognized importance, surveys still present barriers to inclusion [14, 26, 36, 44, 47, 59, 75]. This issue extends not only to surveys as a whole but also to their individual components. Components such as Likert scales or open-ended text fields are structured elements designed to facilitate data collection and guide respondents through the process. However, when designed and tested exclusively for the general population, these components risk excluding people with disabilities from meaningful participation [56, 59]. In addition, the tools used to create and complete surveys must also be considered. As noted by [34] and [12], many of these tools lack essential accessibility features, rendering surveys inaccessible to a significant portion of potential respondents.

The literature presents some efforts to address these gaps, often based on the Web Content Accessibility Guidelines (WCAG) [24, 34, 36, 38, 42, 51, 55, 56, 59, 67, 68, 70, 75]. However, these approaches are not fully effective [14, 26, 36, 44, 47, 59, 75]. For instance, [75] developed a survey aimed at a large and diverse group, incorporating strategies such as allowing assistance and proxies to help respondents and offering versions in both "Standard English" and "Easy English".

However, participants in their tests raised concerns about the complexity of the introductory text and the ambiguity of certain questions. Another example is the work by [59], which between 2006 and 2019 involved two partnerships – the Academic Autism Spectrum Partnership in Research and Education and the Partnering with People with Developmental Disabilities to Address Violence Consortium – in a participatory research approach to adapt survey components. Although valuable, this work did not consider the entire spectrum of disabilities within the studied population.

1.2 Goals

As can be seen, over time, the literature has identified barriers to the accessibility of surveys and proposed solutions to overcome them. However, these solutions often address only specific barriers or are targeted exclusively at people with certain types of disabilities [14, 16, 20, 24, 34, 36, 38, 51, 54–56, 59, 67, 68, 70, 75].

Given this scenario, this dissertation aims to explore the barriers reported in the literature to better inform the design of accessible digital surveys for individuals with disabilities. In addition, strategies for developing and implementing a survey completion tool that incorporates these insights and addresses the accessibility requirements identified in previous work were explored.

To support this investigation and the broader implications for digital accessibility, the following research questions were formulated:

- RQ1: What are the key requirements identified in the literature for designing a survey completion tool accessible to people with disabilities?
- RQ2: Which features of a survey tool support or make difficult the interaction of people with disabilities with online surveys?

To address these research questions, a literature review on accessibility in surveys was first conducted. The selected studies were analyzed in terms of: materials used, target populations, methodologies, and reported outcomes. An analysis was conducted to understand how the proposed work integrates into the state of the art. Moreover, best practices and limitations identified in the existing literature were also explored.

Based on this analysis, a list of requirements for creating accessible surveys was developed, reflecting the features and techniques identified in the literature. These requirements were then used to guide the development of a prototype survey completion tool.

Finally, the prototype was tested and evaluated with users with disabilities through an in-depth usability study. This process aimed to validate the tool's effectiveness and accessibility and, then, refine it based on the results of the tests.

1.3 Contributions

From the development of this work, we aim to provide the following **contributions**:

- A comprehensive list of accessibility requirements for creating accessible surveys, grounded in literature review and user needs. This list includes:
  - Requirements based on WCAG 2.2 Success Criteria; and
  - Requirements that address survey-specific accessibility aspects not encompassed by the WCAG 2.2.
- A survey completion tool that integrates accessibility requirements for users with diverse abilities. This tool also features an integrated interface that allows surveys creation and another for consultation of responses given.
- Identification of functionalities that promote accessibility in surveys and those that hinder it.
- A set of recommendations to promote the accessibility of survey content.

1.4 Structure of the document

This document is organized as follows:

- Chapter 2 – Background: This chapter explores the concept of web accessibility, describes the types of disabilities considered throughout this work, discusses existing guidelines and legislation on digital accessibility for people with disabilities in Portugal and worldwide, and examines how perceptions of accessibility among web developers have evolved.
- Chapter 3 – Related Work: This chapter presents a literature review on accessibility in surveys, focusing on materials used, target audiences, methodologies employed, and results obtained. In addition, it is explored how the proposed work integrates into the state of the art. Also, it outlines best practices and barriers regarding the development of materials for people with disabilities.
- Chapter 4 - Methodology: This chapter details the methodology adopted to carry out the work presented, from the literature review to the refinement of the survey completion tool.
- Chapter 5 - Requirements Gathering: This chapter begins by describing the methodology employed to gather and categorize requirements for developing accessible surveys. Then, requirements are presented for each category. Good practices to support the accessibility of surveys are also outlined. Finally, the mapping between the gathered requirements and WCAG 2.2 Success Criteria is discussed, as well as the target audiences most addressed by the requirements.
- Chapter 6 - Prototype Implementation: This chapter describes the technical features of the survey completion tool developed, the accessibility features implemented to enhance the user experience, and the tool's workflows from the perspectives of both survey creators and respondents.

- Chapter 7 - User Testing and Evaluation: This chapter describes the tests conducted with users with disabilities. These involved observing participants as they completed a survey using the tool and collecting their feedback regarding its accessibility. More specifically, the methodology adopted for these tests is described, the results obtained are analyzed and conclusions are drawn regarding the tool's accessibility.

- Chapter 8 - Tool Refinement: This chapter outlines the improvements made to the survey completion tool based on the problems identified, suggestions for enhancement, and positive aspects highlighted during the tests. Finally, it concludes with insights on the refinement process of the tool as well as its compliance with the WCAG 2.2 and the requirements previously gathered.

- Chapter 9 - Discussion: This chapter discusses the work conducted, from requirements gathering to tool refinement. It also explores how enabling respondents to personalize the survey interface can enhance accessibility. Finally, limitations, lessons learned, and potential future developments are also discussed.

- Chapter 10 - Conclusion: This chapter summarizes the work presented throughout this document, emphasizing key conclusions. It also presents limitations and future work.

Chapter 2

Background

This chapter aims to introduce the concept of web accessibility, outline the five types of disabilities considered in this dissertation, review existing guidelines and legislation on digital content accessibility for people with disabilities in Portugal and around the world and, finally, examine the evolving perceptions of accessibility among web development professionals.

2.1 Web accessibility

In the context of web accessibility, Tim Berners-Lee, director of the W3C and inventor of the World Wide Web, stated:

> *"The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect."*

In this statement, Berners-Lee emphasizes that access to the web by everyone, regardless of disability, should be granted. Also, in terms of accessibility [41], the definition emphasized that the web was designed to reach everyone, regardless of the hardware or software they use, or their language, location, or abilities. When this design goal is put into practice, it helps eliminate the communication barriers that people with disabilities often face in the physical world. However, if websites, applications, and tools are not properly designed, they risk excluding people with disabilities from the web. Therefore, understanding accessibility is essential for developers and organizations aiming to create high-quality, inclusive digital platforms [41].

In the literature, the definitions of web accessibility also emphasize ensuring equal web access for everyone, including people with disabilities. For instance, [19] states that "Web accessibility means that people with some type of disability can make use of the Web in the same conditions as the rest of the people." Similarly, [8] affirm that "We can define "web accessibility" as making a website navigable and tractable by various user categories especially those who have disabilities and normally face obstacles when interacting with the web via electronic devices (e.g. blindness)."

2.2 Types of disabilities

This section presents the definitions of the five types of disabilities considered in this study, along with the accessibility challenges and needs faced by people with these disabilities.

2.2.1 Hearing disabilities

Hearing disabilities [44] are characterized by a loss of hearing capacity that can range from mild or moderate, in one or both ears, to severe and uncorrectable, typically affecting both ears. In the context of digital accessibility, people with hearing impairments face obstacles such as: the lack of subtitles and transcriptions for audio content; multimedia players that do not offer mechanisms to adjust subtitle size and color; web services that rely solely on voice commands for interaction; and the lack of Sign Language support to complement information [44]. Accordingly, the accessibility needs for people with hearing impairments include: providing important information through sign language, as well as subtitles and transcriptions for audio content; multimedia players with adjustable subtitle size and color; mechanisms to control audio playback; and a clear separation between speech and background noise to facilitate comprehension [44].

2.2.2 Visual disabilities

Visual disabilities [44] are characterized by varying degrees of vision loss, ranging from mild to moderate in one or both eyes, to complete blindness in both eyes. This type of disability also includes visual sensitivity issues, such as reduced or absent sensitivity to certain colors or increased sensitivity to bright colors [44]. Accessibility challenges for people with visual impairments include: images or controls without text alternatives; texts, images or layouts that cannot be resized without loss of information; videos without text or audio alternatives; complex and unintuitive features and navigation mechanisms; insufficient contrast between texts and images foreground and background colors; and websites, browsers, or tools lacking support for custom color schemes or keyboard navigation [44]. Their accessibility needs include: resizing texts and images; customizing fonts, colors and spacing; accessing content through text-to-speech systems and audio descriptions; and reading content via Braille displays [44].

2.2.3 Cognitive and learning disabilities

Cognitive and learning disabilities [44] encompass factors such as neurodiversity, as well as neurological, behavioral, and mental health disorders (the latter two not necessarily being neurological). These disabilities can affect any part of the nervous system, as well as abilities related to speaking, reading, writing, or processing information [44]. However, having a cognitive or learning disability does not necessarily affect a person's overall intelligence [44]. Accessibility barriers may include: complex layouts and navigation mechanisms; unusual or difficult vocabulary; long text passages without aids (e.g.,images or graphics); distracting content or background audio that cannot be turned off; and page designs that are not adaptable [44]. To address these challenges, the

following accessibility needs can be highlighted: well-structured content to support orientation; clear labeling of forms, buttons and other elements; predictable interactions and functionalities; multiple navigation options; the ability to disable distracting content; simple text supported by illustrations [44].

2.2.4 Speech disabilities

Speech disabilities [44] refer to difficulties in producing speech that can be easily understood, either by other people or by voice recognition systems. Accessibility challenges include web services that require voice interaction and company websites that offer contact exclusively via telephone [44]. To address these challenges, alternative communication methods should be provided, such as text chat for support services and keyboard commands for interacting with applications. For websites that only offer phone-based communication, alternatives such as email and feedback forms are recommended [44].

2.2.5 Physical disabilities

Physical disabilities [44] encompass a broad spectrum of conditions, including limitations in muscle control, sensitivity, or joint function. Accessibility challenges for people with physical disabilities include: websites, browsers, and tools that do not support keyboard navigation; insufficient time to complete tasks; controls without textual alternatives; lack of navigation aids; and complex navigation systems and functionalities [44]. Accessibility needs include keyboard compatibility for activating features on web pages; adequate time to complete tasks, with options to correct form errors; support sequential key commands rather than simultaneous ones (to facilitate the use of use shortcuts or special characters); larger clickable areas, offering visual indicators for current focus; and mechanisms to skip repetitive blocks, such as page headers and navigation bars [44].

2.3 Guidelines and legislation in Portugal and around the world

This section discusses digital accessibility guidelines and legislation in Portugal and globally, including the Web Content Accessibility Guidelines (WCAG), the European Standard EN 301 549, Decree-Law no. 83/2018, as well as Sections 508 and 504 of USA legislation.

2.3.1 WCAG

The Web Content Accessibility Guidelines (WCAG) [42] were developed by the W3C (World Wide Web Consortium) to provide a standard for ensuring accessibility of web content and applications. These guidelines address both the structure and content of web interfaces [42]. These guidelines are primarily intended for web developers, content authors, and creators of web accessibility evaluation tools. Below, the five versions of these guidelines are outlined, from its first release to the current draft:

- WCAG 1.0 – The first version of the WCAG, published on May 5, 1999 [73], introduced 14 guidelines and 65 checkpoints, each associated with 1 of 3 priority levels. Compliance levels were defined based on these priorities: “A”, achieved when all level 1 priority checkpoints are met; “AA”, when all level 1 and 2 priority checkpoints are met; and “AAA”, when all level 1, 2, and 3 priority checkpoints are met [21].

- WCAG 2.0 – Published on December 11, 2008, this version [42], which is also an ISO standard (ISO/IEC 40500:2012), introduced a new structure based on success criteria, each directly associated with a conformance level: “A”, “AA” and “AAA”. It includes 12 guidelines organized under four principles (Perceivable, Operable, Understandable, Robust), with a total of 61 success criteria. Conformance is achieved by meeting all success criteria for a given level [17]. Alternative conforming versions of the website may also be used to meet these levels [17].

- WCAG 2.1 – Published on June 5, 2018 and updated on September 21, 2023 [42], this version extends WCAG 2.0 by adding 17 new success criteria, while maintaining the same structure. It includes 13 guidelines and introduces updates in the Conformance section, which describes how to claim conformance and ensure accessibility through reliable use of technologies [74]. It aims to provide better guidance to support users with cognitive and learning disabilities, low vision, and those accessing content via mobile devices [46].

- WCAG 2.2 – Published on October 5, 2023 [42], this version is compatible with WCAG 2.1. It maintains 13 guidelines while introducing 9 new success criteria and removing one from the previous ones. Two new sections, *Privacy Considerations* and *Security Considerations*, were also introduced to highlight success criteria that enhance user privacy and security [18]. WCAG 2.2 was developed to give continuity to the objective established in 2.1 [18].

- WCAG 3.0 (*Draft*) – Now called the *W3C Accessibility Guidelines*, this version of WCAG [43], first released as draft on January 21, 2021, is still under development. It aims to be more comprehensible, address a wider range of user needs (especially for people with cognitive disabilities), and offer more flexibility across digital content, applications, and organizations. While it shares the same core goal – making web content and applications accessible to people with disabilities – it proposes a new structure and conformance model, and goes beyond traditional web content to include applications, tools, publishing (i.e. make content publicly available, including literature, music and more), and emerging technologies.

2.3.2 EN 301 549

EN 301 549 [23] is a European standard first published in 2014 (version 1.1.2), developed through the collaboration of three organizations: the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC), and the European Telecommunications Standards Institute (ETSI). It was created to support the public procurement

of Information and Communication Technologies (ICTs), in response to Mandate 376 from the European Commission.

This standard [23] includes:

- Functional performance statements that describe the functionalities needed for users with different abilities to locate, identify, and interact with ICT features;
- Accessibility requirements organized by product functions or features;
- Provisions for compliance with the European Directive 2016/2102, known as the European Web Accessibility Directive (WAD) [71];
- And a description of the relationship between the requirements and the functional performance statements.

It is important to note that only two versions of this standard, 2.1.2 and 3.2.1, are officially recognized as harmonized European standards [27]. While version 1.1.2, is based on WCAG 2.0, the subsequent versions – 2.1.2, 3.1.1, and 3.2.1– are based on WCAG 2.1. However, the formal standards include also requirements not covered by the WCAG version they are based on [27].

2.3.3 Decree-Law no. 83/2018

Decree-Law no. 83/2018 [10], currently in force in Portugal, was established to:

- Transpose Directive (EU) 2016/2102 on the accessibility of public sector websites and mobile applications into national law;
- Amend Law No. 36/2011 of June 21, which mandates the use of open standards in state IT systems;
- Revise the National Digital Interoperability Regulation.

This decree applies to a range of entities, including the State, Autonomous Regions, Local Autarchies, Public Entities (e.g., foundations, associations, institutes), Independent Administrative Entities, and Non-Governmental Organizations that provide services either to the public or specifically to people with disabilities [10].

It covers "all website content, regardless of the device used to access it, and mobile applications of the entities mentioned in the previous article" [10]. This includes textual and non-textual information, dynamic multimedia content, maps, payment systems, and online forms [10]. However, certain content is exempt, such as:

- Dynamic or pre-recorded multimedia content published before September 23, 2020;
- Live broadcast;
- Electronic maps and mapping services (provided that essential information is available in an accessible digital format);

- Third-party content not developed, financed, or controlled by entities subject to the decree.

Importantly, the decree-law stipulates if compliant with its accessibility requirements, websites and mobile applications also meet the Level "AA" of WCAG 2.1 and conform to the EN 301 549 standard.

2.3.4 Section 508 and Section 504

Section 508 [9], introduced as part of the 1998 amendment to the Rehabilitation Act of 1973 [22], is applicable in the United States. On January 18, 2018, a final rule was implemented to update and reorganize this section, aligning it with market trends, technological developments, European Commission standards, and WCAG 2.0. According to [28], Section 508 requires federal agencies to ensure access to and use of electronic information technologies by people with disabilities.

Section 504 [65], also enacted under the Rehabilitation Act of 1973, is similarly applicable in the USA. A recently proposed rule aims to clarify how Section 504 applies in critical areas, including medical treatment, the accessibility of web content and mobile applications, and accessible medical equipment. It also seeks to align with judicial and legislative developments, such as the Americans with Disabilities Act (ADA), and with recent updates to Section 504 itself. Section 504 requires that agencies ensure people with disabilities have equal access to participate in and benefit from their programs and services [28]. To achieve this, agencies must provide auxiliary aids when necessary, such as Braille or enlarged print materials, qualified interpreters or readers, video captions, or other effective communication methods.

Although an agency may comply with Section 504 by following Section 508 standards, in some cases, auxiliary aids may still be required to fully meet Section 504 obligations, even when Section 508 compliance is achieved [28].

2.4 Perceptions of accessibility in web development

This section aims to reflect on the evolution of knowledge and accessible practices adopted among web development professionals. To illustrate this progression, we first discuss two studies carried out in Brazil [13, 33], published roughly a decade apart (2008-2018).

In the first study [33], a survey was conducted to assess the knowledge of web developers in Brazil regarding accessibility. The questionnaire included six demographic questions covering aspects such as location, area of work, education, and organizational structure. In addition, nine closed questions addressed topics such as familiarity with how people with disabilities interact with the web, awareness of assistive technologies, and knowledge of Brazilian accessibility legislation. Two open-ended questions invited participants to reflect on the importance of accessibility in their organizations' projects and to suggest improvements for web accessibility in Brazil.

The results revealed that few respondents were aware of accessibility issues in web development. One contributing factor was the limited formal training in accessibility among participants. Furthermore, the authors noted that few developers were familiar with, or applied, the accessibility

legislation introduced in Brazil in 2004. They also emphasized that the low level of awareness was not only a reality confined to Brazil, suggesting the need to reinforce the topic of web accessibility among developers around the world.

In the second study [13], a new survey was conducted to explore the perception of Brazilian web developers regarding web accessibility. The questionnaire included 4 open-ended and 23 closed questions, divided into two sections. The first one focused on participant background, and the second investigated accessibility issues – particularly reasons why developers either implemented or neglected accessible features in their websites.

Findings indicate that a limited number of participants had a clear understanding of existing accessibility problems. Additionally, the study [13] revealed that accessibility evaluations were not as frequent as they should be in Brazil, as most participants relied only on HTML and CSS validation tools, and were unfamiliar with more comprehensive mechanisms to ensure the accessibility of their web projects.

The authors also compared their results with those from the 2008 study [33], concluding that while the consideration of accessibility in web development projects in Brazil remains low (35.7%), it had increased by 15.8% compared to the earlier study (19.9%) [33].

Further studies have reached similar conclusions in other regions, including in the United States [49], Turkey [39] and Sweden [32]. These studies highlight ongoing gaps in knowledge and application of accessibility guidelines among people involved in web development, including webmasters [49], user experience professionals [39], and web developers [8, 32].

The literature reviewed indicate limited progress in raising awareness and adoption of accessibility practices among web development professionals. This reinforces the need for greater efforts in promoting accessibility awareness, such as by integrating accessibility into web development curricula [33], and challenging the misconception that accessibility hinders creativity or incur additional costs [13].

Chapter 3

Related Work

This chapter presents a literature review on existing contributions in the field of accessibility in surveys, beginning by focusing on key concepts and themes such as materials used, target audiences, methodologies employed, and results obtained. Additionally, nine selected papers are presented in detail to provide a better view of previous work in this field and comparisons are made between these papers and the present work. The chapter also examines the barriers discussed in prior research regarding the design and evaluation of accessible surveys. Finally, it reinforces that survey inaccessibility for people with disabilities remains a current and pressing issue.

3.1 Concepts

In this section, articles resulting from a literature review on the theme of accessibility in surveys are analyzed across four key points: Materials, Target Audiences, Methodology and Results. These four key points were established considering the objectives of this dissertation: build a survey completion tool accessible to people with different types of disabilities, test it with them to assess the tool's accessibility and, finally, make refinements based on the data obtained. In addition, this categorization has the purpose of (1) mapping common themes across the studies, (2) allowing the observation of the frequency with which these themes are approached in the reviewed literature and (3) facilitate the comparison of the present study with these studies.

Finally, nine selected papers are presented in detail to provide a clearer overview of previous work in this area and, it is explained how the work presented here resembles or advances in relation to it.

3.1.1 Materials

Materials refer to the tangible and conceptual tools used in survey construction [24, 34, 75] (e.g., Survey Monkey in [5]) and completion [38, 56, 68, 70] (e.g., QuestNet in [70]). The discussion also extends to resources that provide recommendations for creating accessible surveys [36, 55], offering guidance on how to design surveys aligned with accessibility standards, such as WCAG. Moreover, studies examine the accessibility of individual survey components [56, 59]. Finally,

surveys as structured set of questions on a specific topic are also discussed in [14, 16, 20, 51, 54, 75].

3.1.2 Target audience

Target audience refers to people with different types of disabilities whose accessibility needs have been considered in the construction of survey materials. These audiences include people with cognitive and learning disabilities [14, 24, 38, 54–56, 59, 68, 70], people with disabilities in general [16, 20, 34, 75], people with visual disabilities [36, 67] and people with hearing disabilities [51].

3.1.3 Methodology

Methodology includes the procedure adopted to carry out the tests performed and reported in the literature, including the number of participants and materials used. There are several studies involving participants from the target audience. Some disclosed the number of participants, which ranged from less than 100 in five studies [14, 20, 24, 36, 70], between 100 and 200 in three studies [16, 54, 67], between 200 and 300 in two studies [51, 68], between 300 and 400 for two studies [38, 56] and between 700 and 800 for one study [75]. The methodologies adopted in the studies included the interaction of participants with the materials [14, 16, 20, 24, 34, 36, 38, 51, 54–56, 67, 68, 70, 75], with the help of researchers, proxies or other people in some instances [14, 16, 24, 36, 51, 54, 56, 67, 68, 75]. In some cases, users participated in training sessions with the materials, before tests, to familiarize themselves with them [24, 38, 51, 56, 68, 70]. After carrying out the tests, in most cases, participants were asked to provide feedback on the experience carried out [14, 24, 34, 36, 56, 67, 68, 70, 75].

3.1.4 Results

Results relates to the participants' feedback on the materials through questionnaires taken after the end of the tests. The feedback provided by the participants was generally positive [14, 24, 36, 51, 55, 56, 59, 67, 68, 70, 75]. However, participants reported some accessibility problems in the materials, such as ambiguous or unclear questions or reduced clicking areas [14, 34, 70, 75]. There are also instances [16, 20, 38, 54] where the feedback the participants gave, i.e., whether it was positive or negative, was not reported.

Finally, some of the studies reported the inclusion of people from the target group as co-researchers [20, 38, 54–56, 59, 68]. It was found that their input on the materials to be used was essential in making the necessary adjustments, thus improving the accessibility of materials and the reliability of the data obtained using them.

3.1.5 Examples from previous work

In this section, some of the aforementioned papers are now going to be discussed in greater detail. More specifically, this discussion aims to more thoroughly approach different materials, types of

disabilities considered when constructing them, methodologies adopted to test these materials and results obtained. Finally, conclusions are provided on the state of the art of accessibility in surveys and it is explained how the work presented here resembles or advances in relation to the papers discussed.

To select the more relevant papers for this discussion, considering one for each of the five types of materials, the following analyses were carried out:

- Survey creation tool - Of the three papers [24, 34, 75] concerning this type of tool, [75] adapts the tool previously built by [34], being for that reason excluded. Of the remaining two, [34] was the most cited and was therefore selected.
- Survey completion tool - Of the four papers [38, 56, 68, 70] covering this type of tool, although the works by [38, 56] are the most cited, it was concluded that the work by [70] presents more relevant information on which mechanisms to include in the tool to be developed. Then, in comparison with the work of [68], for the same reasons and as [70] is the most cited, it was therefore selected.
- Survey components - Of the two papers related to survey components [56, 59], one [59] uses as one of its bases the work developed by the other [56]. The latter was therefore selected.
- Recommendations for creating accessible surveys - Of the two papers that address recommendations [36, 55], [55] uses as one of its bases the work developed by [56], which is already presented in this section. Thus, [36] was selected.
- Surveys - From two of the papers that cover surveys [51, 75], only one of them [75], similarly to what is intended, involved the completion of an online survey, being therefore the one selected.

It is important to note that the remaining four papers [14, 16, 20, 54] covering surveys were gathered at a later stage of the development of this work. This was done since initially only articles published up to 2023 were collected and, as time passed, there was the need to also incorporate the most recent and cited works on the subject of accessibility in surveys. In addition, and to better inform a comprehensive comparison between this work and others in the subject, including both earlier and more recent developments, it was decided that these articles should also be added to this section.

That said, the nine articles selected through the previous analyses are presented below.

Gottliebson et al. [34] have created a customized survey creation tool that complies with a set of guidelines based on WCAG 1.0/2.0 and US Section 508. The tests carried out prove the compliance of the tool with the evaluation criteria and the set of guidelines used. They also carried out tests with users of assistive technologies on a variety of computers and with a sample of people with visual, physical, motor, and intellectual disabilities. To determine who did not feel included in the study, it was spread through user networks offering support (for example, by providing opportunities to contact researchers), which resulted in continuous feedback on the study.

Stock et al. [70] created a survey completion tool called QuestNet, designed to give people with intellectual disabilities greater independence to take online tests and assessments. The participants took two tests, one written and one online, and were assigned one of two versions of the forms, A or B. Before taking the actual tests, both formats were practiced using a sample test until the participant demonstrated mastery. The true/false questions proved to be the most difficult for participants to understand, leading to statements such as "I don't get it" or "I need help with this one". Participants also made comments about the accessibility of the system, such as "It's easier" or "I never did a test by myself before!".

Hakami et al. [36], developed a framework with recommendations to create accessible surveys for people with visual impairments. The research methodology adopted in this study consisted of a literature review, an initial version of the framework evaluated by experts and tested for accessibility by members of the target audience, refinement of the framework according to the results obtained, and then evaluation of the refined framework by experts. The experts evaluation was performed, consisting of classifying the framework in five dimensions (usefulness, clarity, ease of use, need for an additional checklist, and applicability). The accessibility tests began by collecting demographic data and data on the frequency of survey use, followed by the completion of two types of survey, one inaccessible and one accessible (designed using the framework), and finally a questionnaire to determine the participants' satisfaction with the accessible survey. According to the questionnaires given to participants after completing the surveys, the accessible survey components evaluated received average ratings between 3-4 (rating by 4-point likert scales) and relative importance indices equal to or greater than 85%.

Nicolaidis et al. [56] used a participatory research approach to adapt survey components to make them more accessible to people with developmental disabilities and incorporated them into an accessible survey. Three types of studies were carried out: a cognitive interview (to ensure that the participants correctly perceived the components), pilot testing (to solve problems, such as those relating to the user interface and learning how to interact with the survey completion tool), and tests involving the constructed survey. Most of the participants felt that the questions answered in the survey were easy to understand.

Wilson et al. [75] developed a survey as part of the 1 in 4 Poll project, to be completed by a large and varied group of people, considering data collection strategies such as: allowing assistance and proxies to help provide answers to the survey, adapting an accessible survey creation tool and having versions of the survey in "Standard English" and "Easy English". Between October 2010 and September 2011, 1340 attempts were made to respond to the survey, of which only 761 were successful. Based on comments and ratings given to the ease of use of the survey by the participants, they found it relatively easy to use, although they identified problems in it. However, it is mentioned that those who did not find the survey accessible may not have been able to give their opinion, which in turn may have influenced the positivity of the results.

Burns et al. [16] conducted a study to determine trends in the accessibility of public buildings. In this study, people with disabilities or responding on behalf of people with disabilities completed

a survey. This survey contained 23 questions, of which 22 were closed, with the possibility of adding one more option to provide another answer, and 1 was open. The survey's content was developed by a team familiar with the evaluation of buildings' accessibility, the ADA accessibility guidelines and architectural accessibility evaluation tools. Given the online administration of the survey, the development team sought feedback from usability and software accessibility experts who were not involved in survey development. This feedback was used to implement changes to the survey's flow, language, and content. According to the authors, 183 people attempted to complete the survey from which 109 of completed it in its entirety. Burns et al. also noted that the digital survey may have implied a low representativeness of people with disabilities who are unable to access the internet or whose disability limits the ability to complete the survey. Additionally, the authors mentioned as well that the geographical restriction of participants to a single US state hinders the generalization of the findings.

Beck et al. [14] evaluated already existing surveys designed to assess the quality of life of those who answer them, in collaboration with autistic people. To this end, the participants in this study completed the surveys, in paper or online, "at two timepoints with a washout period of two weeks" [14]. Interviews were also carried out with some of the participants to assess their understanding of each question in each survey, in which they revealed difficulties in several questions. Six months later, following the same methodology, the same participants were recruited to evaluate versions of these surveys adapted for people with intellectual disabilities. The authors of these adapted surveys, eliminated confusing phrases, added examples to the questions and visual aids to the answer options. According to Beck et al., the adapted surveys caused less confusion for the participants compared to the non-adapted versions. Additionally, the authors also highlighted the specificity of the sample of participants (i.e., "young adults with a GED or high school diploma, predominantly male, without co-occurring intellectual disability and living away from home with supports from the facility" [14]) which, in turn, for example, prevented them of generalizing of the results to more advanced age groups.

Morris et al. [54] conducted a study in partnership with people with intellectual disabilities as part of a project aimed at understanding and improving the employment experiences of people with intellectual disabilities. In this study, the authors began by conducting interviews with employers, employment specialists, and self-advocates regarding the employment of people with intellectual disabilities. For the interviews, scripts were prepared for each of the three types of participants and, apart of the demographic information requested, these had open-ended questions encouraging participants to share experiences related to the topic. The interview script for the self-advocates was prepared in simpler language. After the interviews began, three online surveys were created, one for each of the three types of participants. These surveys included closed and open-ended questions designed to complement the information already collected and underwent a review process conducted by experts to assess their suitability within the topic and accessibility (i.e. "including plain language refinement and online formatting or technical issues" [54]). According to the authors, of the 198 individuals who initiated the online surveys, 49 were excluded or

completed up to only one question before quitting the survey. This resulted in 149 survey respondents out of a total sum of study participants of 177 (149 survey respondents + 28 interviewees), of whom 71 were self-advocates.

Chapman et al. [20] conducted a study to ascertain how the concept of dignity is understood and experienced by people with disabilities in daily living. To this end, the authors recruited 17 people with disabilities to complete an online survey. The survey contained 21 questions, covering demographic information and the concept of dignity. The latter type of questions was "open ended text responses, where participants could type and upload a word document, audio file, or video recording in response to the question" [20]. Following the analysis of the data collected through the survey, two focus groups comprising people with disabilities were formulated with the aim of sharing experiences, confirming the integrity of the survey findings and discuss the acknowledgment theme (e.g., "How do you know when you're being treated as a human (acknowledgement) and being treated with dignity?" [20]). The study's findings underscore that "the reality experienced by people with disabilities on a daily basis continues to be one of the pervasive barriers and undignified experiences" [20]. Finally, is noteworthy that, according to the authors, preliminary tests were conducted with people with disabilities to assess the research questions and the survey platform.

Final Considerations

Overtime, the literature has mentioned the inaccessibility of surveys, their components, and the tools to build and complete them. As demonstrated by the above articles, there have been efforts to develop materials that are accessible to people with disabilities.

The construction of these materials was informed by accessibility legislation and guidelines [16, 20, 34, 36, 56, 70, 75], existing literature [14, 16, 20, 36, 54, 56, 75] or requirements directly expressed by people with disabilities [20, 36, 54, 56]. In certain instances, these materials were evaluated through pilot tests [20, 34, 36, 56, 70] or by accessibility experts [16, 20, 36, 54, 56] to ensure accessibility, with modifications being made to the materials when necessary. Also, in two studies, participants trained with the materials before the tests [56, 70]. These materials were then used in tests conducted with people with disabilities. Most studies chose to evaluate the accessibility of the materials [14, 16, 20, 34, 36, 56, 70, 75], with some asking participants, after interacting with the materials, to provide feedback on the experience carried out [14, 34, 36, 56, 70, 75]. However, there are recent cases in which the material was mostly used as a means evaluated as accessible for collecting information [16, 20, 54].

However, despite the efforts made, these solutions tend to address only specific barriers or are only aimed at people with specific types of disabilities [14, 16, 20, 34, 36, 54, 56, 70, 75]. In addition, there are other barriers found in the literature reviewed that are discussed in the next section.

That said, the present dissertation focuses in the construction of a survey completion tool which considers the accessibility needs of people with different types of disabilities. This con-

stitutes an advancement, since, despite the fact that four of the papers analyzed [16, 20, 34, 75] are directed to people with disabilities in general, none of them encompassed the construction of a survey completion tool. The construction of this tool will be informed not only by accessibility guidelines, but also by barriers and requirements detected in the literature. As with other studies, the accessibility of this tool will be evaluated with people with disabilities. The feedback obtained in the tests will inform subsequent refinements to the tool to enhance its accessibility.

3.2 Barriers

This section discusses barriers found in the literature reviewed related to the design and testing of materials for people with disabilities and also, more specifically, those these people face when completing surveys.

The barriers pointed out in the literature regarding the construction and testing of materials for people with disabilities include the lack of inclusion of a broader range of age groups [14, 67], changes in the composition of the team involved in building and adapting the materials [55, 59], limited geographical distribution of participants [16, 38, 54], low number of participants involved in tests [24, 36, 54, 70], not covering the entire spectra or degrees associated with the type of disabilities being studied [16, 56, 59, 67, 68] and failure to compare the materials constructed with other existing materials with similar functionalities [38, 56]. Also, articles published over the years [14, 26, 36, 37, 47, 59, 75] have introduced barriers to the accessibility of surveys to people with disabilities, as described below.

For people with cognitive and learning disabilities, barriers include inaccessibility of survey components due, for example, to the use of complex, confuse or unclear vocabulary and sentence structures, difficulties in giving answers according to time intervals imposed in the questions, imprecise answer options, or the use of offensive concepts [14, 59]. In addition, long text passages without images or graphics to highlight their context can constitute a barrier, and distracting content and background audio that cannot be turned off [44].

For people with visual disabilities, barriers can include images with insufficient contrast between the foreground and background colors [44]. Furthermore, according to Hasnain et al. [37], images without alternative text can constitute a barrier for people with visual disabilities when using screen readers.

For people with hearing disabilities, the absence of materials for the provision of informed consent in Sign Language [47] constitutes a significant accessibility barrier.

For people with speech disabilities, answering questions and providing feedback through voice interaction [44] constitutes a barrier. According to Wilson et al. [75], these users may need to resort to alternative and augmentative communication modes, which can include, for example, communicating answers through Sign Language.

For people with physical disabilities, answering options that require scrolling or have a restricted area for mouse interaction can be a barrier to inclusion [26]. Other barriers include the lack of keyboard navigation support, insufficient time to complete tasks, and the absence of navi-

gation aids [44].

Finally, Hasnain et al. [37] in 2014 concluded that survey researchers and web designers should be trained regarding the inclusion needs of people with disabilities and the appropriate methods for making their work accessible to this population. Currently, these conclusions can still be applied since it can be seen that the efforts set out in the literature over time have been insufficient to overcome the existing barriers to survey accessibility. These barriers jeopardize not only the right of expression of people with disabilities but also the reliability of the data obtained using these inaccessible surveys. Therefore, the work presented here is a means of overcoming these barriers by providing researchers and developers with materials from which they can make surveys accessible to people with different abilities.

Chapter 4

Methodology

This chapter describes the methodology used to conduct the work exposed throughout this dissertation.

This dissertation aims to investigate both barriers and accessibility requirements present in the literature so that these can inform the development of a survey completion tool accessible to people with different disabilities. To do this, we went through three phases (P1, P2 and P3), as can be observed in Figure 4.1.

Requirements gathering: In the first phase (P1) the necessary requirements to build accessible surveys for people with disabilities were collected. To do this, a literature review was conducted, in which 12 articles were analyzed, resulting in 47 accessibility requirements that were categorized into 12 themes: Prefaces and context; Navigability; Assistance tools; Audio; Graphics; Clarity and visual adjustments of text; Types of questions; Minimize external influences; Error handling; Internationalization; Data protection, privacy and conformance with accessibility guidelines and legislation; Accessible informed consent.

Prototype implementation: In the second phase (P2), the requirements gathered in P1 were then implemented in a survey completion tool. This tool consists of a web application, whose front-end was developed in HTML, JavaScript and CSS and the back-end in Python using the framework Django. Also, the tool was hosted on a server and can be accessed through browsers with JavaScript enabled or disabled. Moreover, it incorporates accessibility features such as a section to select the background and text colors of the pages and videos with translations of text into Portuguese Sign Language. The tool supports two types of users, namely, survey creators and respondents. The first can upload surveys to the tool and access the responses given to them. The latter can complete surveys in the tool.

User testing: In the third phase (P3), the survey completion tool built in P2 was tested to better understand the accessibility of the implemented features as well as potential areas for improvement. The tool was tested with a small group of people with disabilities with ages between 19 and 45 who use technology very often. Firstly, the research procedure involved collecting demographic information from the participants. Then, they were asked to complete a survey in the tool and submit their responses, while exposing verbally their concerns,

reflections, and actions throughout the process. Simultaneously, notes were also taken resulting from the observation of the participants. Finally, the participants were interviewed to provide feedback on their experience with the tool.

It should be noted that a pilot test was initially carried out to evaluate the procedure to be adopted in the tests.

Following the tests, the data obtained was analyzed through qualitative and quantitative research methods which made it possible to obtain, for example, problems detected, changes suggested and positive aspects denoted. After this, a final refinement phase was conducted to address problems and implement change suggestions, enhancing the tool's accessibility.

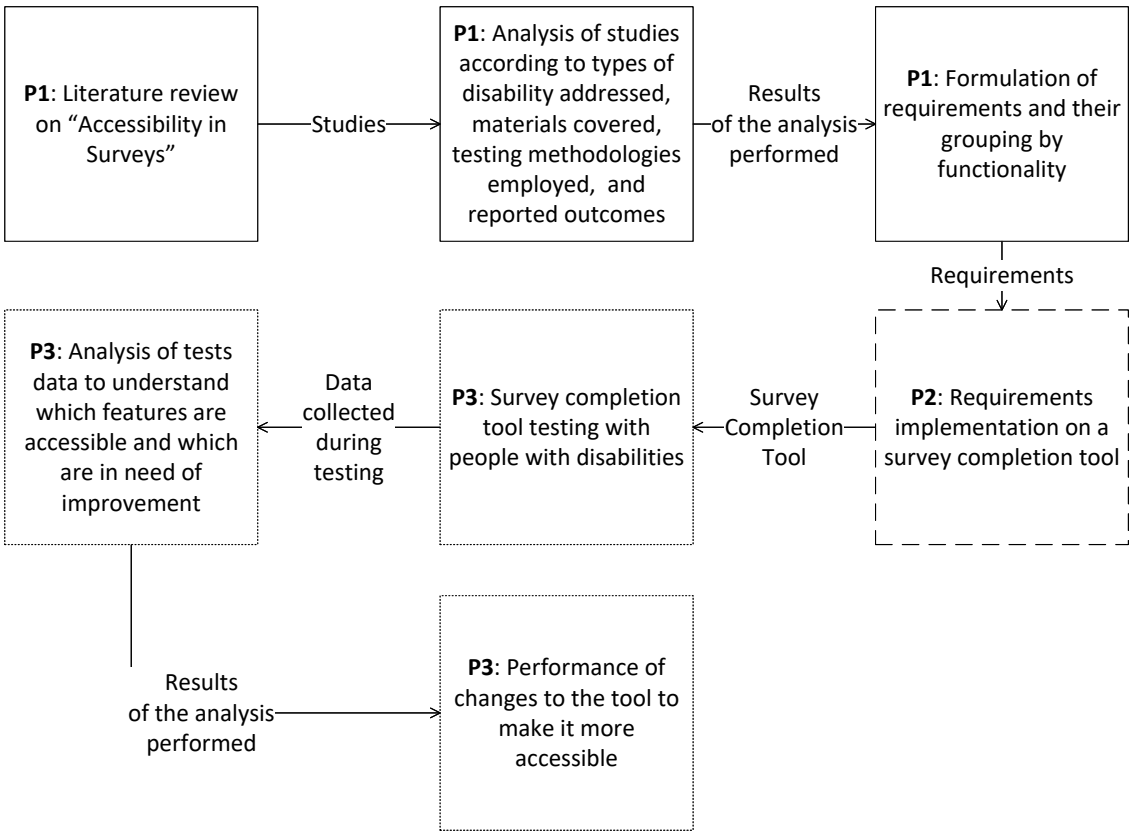


Figure 4.1: Flowchart of the three phases completed.

Chapter 5

Requirements Gathering

This chapter describes the requirements gathered for developing accessible surveys. Building on existing research, we conducted a thorough literature review, selecting key studies to inform the identification of these requirements. We categorized the studies based on the disabilities they addressed and used materials. We also investigated the methodology adopted to test the materials. This process allowed us to identify essential factors that address diverse user needs. Furthermore, we structured these requirements into categories and analyzed their relation with the WCAG 2.2 success criteria (SC).

5.1 Methodology

This section presents the methodology adopted to gather the requirements for constructing accessible surveys. The methodology followed is in line with the "Snowballing" research methodology [76]. In the initial phase of this methodology [76], a first set of articles is identified. In a subsequent phase, through the references listed of the identified articles or by the ones that cite the articles under review, new and relevant articles are identified and kept. This latter phase is iteratively repeated until there are no new articles.

5.1.1 Identification of articles

Firstly, an initial literature review was conducted using Google Scholar[1], with the search term "online survey tools for people with disabilities." Then, after a full reading of an initial set of papers, those considered relevant to the topic were selected, and their bibliographical references were extracted using the Litmaps[2] literature mapping tool.

Following, a thorough review of the abstracts of the papers retrieved through Litmaps was carried out to assess their relevance to the search terms. This process aimed to verify if each paper identified on the search addressed surveys or survey tools and people with disabilities. From this, a total of 32 papers remained.

[1] https://scholar.google.com/
[2] https://www.litmaps.com/

Next, the full papers (retrieved through Litmaps) were thoroughly examined to determine their relevance to the theme. We aimed to identify those that approached surveys, survey tools, or guidelines for building surveys considering the needs of people with disabilities. Papers that did not meet these criteria were excluded. After this selection process, 22 articles remained.

5.1.2 Categorization and analysis of articles

To address our first research question (RQ1) regarding the key requirements identified in the literature for designing an accessible survey completion tool, we first identified relevant factors related to this issue.

As a starting point, we analyzed the types of disabilities addressed in each of the selected papers to understand which user profiles were covered by their proposed solutions. Disabilities were categorized into four groups: hearing disabilities, visual disabilities, cognitive and learning disabilities, and disabilities in general. For instance, Autism was classified as a cognitive and learning disability. The latter category was defined because, during literature review, some papers considered people with various types of disabilities, rather than focusing on a single type. Given the goal of developing a survey completion tool accessible to people with different disabilities, this category was created to include such articles and incorporate in this work the requirements and practices they apply for ensuring broader accessibility.

We also analyzed the materials developed or discussed in the articles to examine their characteristics and the techniques used in their construction. From this analysis, we identified recurring patterns related to their purpose. Based on these findings, we grouped the materials into five types: tools for creating surveys, tools for completing surveys, survey components, recommendations for creating surveys promoting their accessibility, and the surveys themselves.

At this stage, we decided to exclude articles that consisted of literature reviews [19, 26, 29, 37, 48, 72] or contained materials that were ambiguous or irrelevant for analysis [15, 47, 57, 62]. This was done, as it was established as objective to gather only articles that introduced materials, either built or adapted by their authors, and that fit into one of the five types of materials above described. This resulted in 12 articles, from the initial 22, selected to be further analyzed.

Afterward, for each article, the researchers involved in this work analyzed and discussed the methodology adopted to test the materials developed within its scope.

The analysis of these methodologies was crucial to understanding:

1. How the materials were tested;
2. Who participated in these tests;
3. What feedback participants provided on the materials.

These three aspects were used to determine the relevance of each material in improving accessibility for specific user groups.

For instance, regarding the first point, a test protocol that does not provide clear participant demographics (e.g., age group, type of disability) or that fails to explore various usage scenarios

limits the validity of conclusions. Regarding the second point, if the test participants do not represent the intended target audience, the findings cannot be generalized. Lastly, if the participants' feedback on the materials is predominantly negative, it suggests that these materials may not be well received by the target audience.

5.1.3 Formulation of requirements

Considering the results obtained, we systematically organized and categorized the findings into a comprehensive set of requirements for constructing a survey completion tool accessible to people with disabilities.

To achieve this, the characteristics and construction techniques of the materials previously analyzed were discussed to ensure that no requirement introduced new barriers for people with disabilities other than those it was originally designed for. For instance, a requirement that promotes using questions with images as answer options may enhance accessibility for people with cognitive and learning disabilities, but could create difficulties for people with visual disabilities. To prevent this, the implementation must include alternative text descriptions for those images.

5.1.4 Analysis and categorization of requirements

Each requirement was then analyzed to determine its implementation in the tool. Requirements covering the same functionality were grouped to facilitate consultation and provide a comprehensive view of the actions needed to enhance accessibility. These groups were labeled, resulting in the following categories: Prefaces and context; Navigability; Assistance tools; Audio; Graphics; Clarity and visual adjustments of text; Types of questions; Minimize external influences; Error handling; Internationalization; Data protection, privacy and conformance with accessibility guidelines and legislation; and Accessible informed consent.

Next, we examined the origin of each requirement to determine whether it originated from reports by the authors, such as those based on the observation of participants' behavior or prior experiences, or directly from participant feedback. This analysis was essential to understanding how the perspectives of the target audience influenced the formulation of each requirement.

Based on this, we classified the requirements as (1) *Potential*, derived from reports by the authors, based on their expertise or knowledge, without direct participant feedback; (2) *Positive indirect*, based on authors' observation of participants, where feedback is reported indirectly, such as in the passive voice; and (3) *Positive direct*, originated from, or explicitly supported by, comments and evaluations made directly by the participants.

For example, regarding the use of Sign Language consent materials, this practice was considered and applied by Margellos-Anast et al. [51], who observed that two-thirds of participants preferred the Sign Language version of the consent form. From this perspective, this practice qualifies as a positive indirect requirement, as it was validated through participant observation. On the other hand, Nicolaidis et al. [55] also considered this practice but directly collaborated with individuals with cognitive and learning disabilities to implement it. Thus, in this case, it repre-

sents a positive direct requirement, as it was validated through direct engagement with the target audience.

We also examined the target audiences for each requirement, specifically individuals with different disabilities whose accessibility needs were addressed. Additionally, we assessed whether each requirement could be associated with WCAG 2.2 and, if applicable, identified the corresponding Success Criteria.

Finally, we examined where each requirement should be applied - whether in the survey interface, in the tool's processing of responses, or in the formulation of survey questions.

5.2 Findings

To answer our research question, i.e., identifying requirements for accessible surveys, and considering previous work in this context, we developed a list of 47 requirements for building a survey completion tool accessible to people with disabilities. The complete list of requirements can be found in the Appendix.

In addition, each previously identified article was analyzed, and the following information was extracted: Target audience, Feedback, Associated WCAG SC, Requirement for the construction of the survey completion tool, Requirement for the survey provided, and Requirement for completing surveys.

The **Target audience** focus is predominantly on people with cognitive and learning disabilities, represented by 25 associated requirements. This group is followed by those with visual disabilities, for whom 18 requirements were identified. A broader category of people with disabilities is covered by 11 requirements, while people with hearing disabilities are addressed through 10 specific requirements.

In terms of **Feedback**, most of the requirements received a positive direct rating (42 requirements), followed by a positive indirect rating (15 requirements) and, lastly, a potential rating (10 requirements).

Regarding **Associated WCAG SC**, the analysis showed that 21 out of 47 requirements align with one or more WCAG 2.2 Success Criteria.

From this analysis, it was possible to conclude that most requirements must be considered in the **construction of the survey completion tool** (45 requirements) and when **completing surveys** (44 requirements). Additionally, though in smaller number, some requirements must also be taken into account in the **survey provided** (29 requirements).

5.2.1 Categories

The identified requirements have been organized into twelve distinct categories to facilitate understanding and analysis. Below, we explore each category, providing more detailed descriptions of the first three requirements and, due to spatial constraints, more concise descriptions of the remaining ones.

Prefaces and context

This category includes requirements aimed at supporting participants navigating and understanding the survey.

For instance, **Requirement 1.1** suggests placing legends above fields, a practice that has received positive feedback [36]. This approach aligns with WCAG 2.2 SC *2.4.6 Headings and Labels*, facilitating the clear identification of labels and their corresponding fields.

Additionally, **Requirement 1.2** recommends using `<fieldset>` and `<legend>` to group and label related fields, simplifying the experience for visually impaired users [36]. This approach aligns with WCAG 2.2 SC *1.3.1 Info and Relationships* and *3.3.2 Labels or Instructions*, ensuring that related fields are grouped appropriately.

Requirement 1.3 recommends that invalid data should be clearly displayed on an error page, while valid data should be summarized with the possibility to edit it if necessary [24, 36, 67]. This change has received positive feedback from people with visual disabilities [36, 67] as well as individuals with cognitive and learning disabilities [24]. This requirement aligns with WCAG 2.2 SC *3.3.6 Error Prevention (All)*, improving the user experience by allowing users to correct errors before submission.

Additionally, the **Requirement 1.4** recommends placing general instructions at the top of the form, with field-specific instructions provided throughout the form [36, 56, 59, 68, 75]; the **Requirement 1.5** recommends displaying a progress indicator so participants can track their position within the survey [75]; and the **Requirement 1.6** recommends ensuring answer options remain consistent across similar questions [51, 55].

Navigability

This category relates to the requirements that facilitate navigation between survey questions and the selection and modification of answers.

For instance, **Requirement 2.1** reinforces the need to use buttons (e.g., “Back” and “Next” buttons) to navigate between questions, allowing participants to modify previous answers if necessary. This feature, proposed by the authors in [68], and was well received by participants in [24, 70]. This requirement aligns with WCAG 2.2 SC *3.2.3 Consistent Navigation*, ensuring a predictable and structured way to revisit and modify responses.

Additionally, **Requirement 2.2** highlights the need for a mechanism that ensures the button to move to the next question only appears once the current question has been answered, specifically for mandatory questions. This mechanism was well received by participants in [24, 70]. It aligns with WCAG 2.2 SC *3.3.6 Error Prevention (All)*, which emphasizes the importance of allow users to review, confirm, and correct their input before submission [18].

Requirement 2.3 recommends implementing a “Toggle Switch” mechanism that allow users to deselect an answer by clicking on the corresponding box and select a new response by clicking on a different option. In this way, the previously selection is automatically removed when a new one is made. This mechanism was well received by participants with cognitive and learning

disabilities in [24, 70] and in [68].

Additionally, this category includes the **Requirement 2.4**, which states that form fields must be aligned in a single column to ensure that users do not misinterpret fields because of the linear nature of the screen reader [36].

Assistance tools

This category refers to requirements related to tools that assist participants in completing surveys.

For instance, the **Requirement 3.1** ensures that participants with visual disabilities can use assistive technologies such as screen readers or screen magnifiers [67]. This requirement aligns with WCAG 2.2 SC *4.1.2 Name, Role, Value*, ensuring the proper integration of assistive technologies with system functionalities.

Additionally, **Requirement 3.2** refers to allowing the survey to be completed by uploading an external file with the necessary information. According to the authors, this approach "improves the form filling process in a shorter time with higher accuracy", particularly for people with visual disabilities [36]. This requirement aligns with WCAG 2.2 SC *2.5.6 Concurrent Input Mechanisms*, whose intent is to "ensure that people can use and switch between different modes of input" [6].

Requirement 3.3 suggests the placement of buttons below questions to present them in alternative wording via audio [55, 56, 59, 68]. This requirement aligns with WCAG 2.2 SC *3.1.3 Unusual Words*, which emphasizes the need for a mechanism to clarify complex terms or phrases in context.

This category also includes the **Requirement 3.4** which states that read-aloud functionalities should be implemented in surveys [24, 38, 55, 56, 68, 70, 75].

Audio

This category includes a requirement, **Requirement 4.1**, which suggests using recorded voice instead of synthesized voice so that audio can be more understandable. This requirement was well received by participants with cognitive and learning disabilities, as indicated by one of their comments: "It talks to you. I like the computer to read it to me" [24].

Graphics

This category includes a requirement, **Requirement 5.1**, which highlights the importance of providing alternative text for images, a feature that was well received by people with visual disabilities [67]. This requirement aligns with WCAG 2.2 SC *1.1.1 Non-text Content*, which advocates for the use of text alternatives for non-text elements.

Clarity and visual adjustments of text

This category includes requirements related to text simplicity, readability, and visual adjustments, such as font type, color contrast, and text size.

For instance, **Requirement 6.1** reinforces the importance of avoiding complex language, ambiguous terms, or figures of speech, instead promoting the use of clear and direct wording [38, 51, 55, 56, 59, 68, 75]. This requirement aligns with WCAG 2.2 SC *3.1.5 Reading Level*, which advocates for the use of supplementary content or alternative versions that do not require reading skills beyond lower secondary education.

Additionally, **Requirement 6.2** suggests explicitly defining content direction and language in the `<HTML>` tag. This practice was well received by participants, in this case, people with visual disabilities [36]. This requirement aligns with WCAG 2.2 SC *3.1.1. Language of Page*, which ensures that the correct language is identified for assistive technologies.

Requirement 6.3 suggests using a Sans Serif font family, with a 12-point font size for alphabetic writing systems and a 14-point size for complex writing systems [36].

Additionally, this category also includes the **Requirement 6.4** which states that a contrast ratio of 7:1 should be used for normal-sized text and 4.5:1 for larger text [36, 67] and the **Requirement 6.5** which reinforces the need to formulate questions clearly and precisely to minimize ambiguity [51, 75].

Types of questions

This category refers to the requirements that define the types of questions that enhance user comprehension of both the questions and response options.

For instance, **Requirement 7.1** suggests the use of single choice questions with images as answer options. This feature was well received by people with cognitive and learning disabilities [59] and [70].

Additionally, **Requirement 7.2** suggests enabling the provision of a written version of each question and answer options translated into sign language [51].

Additionally, **Requirement 7.3** suggests the use of numerical scales on questions where the user must answer according to scale. This requirement was based on authors' observations that participants with hearing disabilities struggled to position themselves within categories (for example: very important, important, somewhat important, not very important), leading to the replacement of categorical scales with numeric ones [51].

In addition, the **Requirement 7.4** recommends incorporating visual aids, such as images paired with numerical scales, to assist respondents [24, 51], the **Requirement 7.5** suggests adding graphics for response options using Likert type scales [55, 56, 59], and the **Requirement 7.6** reinforces the need of implementing mechanisms that facilitate data entry processes in specific formats [36].

Minimize external influences

This category includes requirements aimed at addressing situations that may compromise the participants' ability to complete surveys. These situations are related with lack of spatial and temporal

context, use of offensive concepts, participants' decision incapacity, influence of proxies or supporters in survey responses and answers not saved before timeout.

For instance, **Requirement 8.1** reinforces the need to specify the spatial or temporal context of a question whenever it influences the answer. This requirement was well received by participants with cognitive and learning disabilities [38, 55, 56, 59]. It aligns with WCAG 2.2 SC *3.3.5 Help*, which supports the inclusion of auxiliary text to provide contextual guidance.

Additionally, **Requirement 8.2** emphasizes the non-use of ableist concepts (e.g., offensive conceptualizations of autism) [55, 59]. This requirement was well received by participants with cognitive and learning disabilities.

Requirement 8.3 reinforces the need to ensure that participants confirm their capacity to complete a survey. This can be done by including questions that assess decision-making capacity throughout the survey (e.g. "Participants who can answer 'yes'/'no' questions correctly about the voluntary nature of the study, what participation entails, and study risks may make their own participation decision." [55]). This requirement was well received by people with cognitive and learning disabilities in [38, 55] and was also proposed by authors for people with cognitive and learning disabilities [24, 68] and hearing disabilities in [51].

Other requirements in this category are as follows: **Requirement 8.4** - Distinguish responses given by proxies, for example by creating a separate survey for them [55, 59]; **Requirement 8.5** - Distinguish between a "supported participant" (i.e., who answers with the help of a supporter) and a "proxy" (i.e., who answers on behalf of someone else with minimal information from them) [55, 59]; **Requirement 8.6** - Ensure answers given by participants until timeout are saved [36, 75].

Error handling

This category refers to the requirements that enhance the accessibility of error messages that are issued when completing the survey.

For instance, **Requirement 9.1** emphasizes the need for clear and informative error messages, specifying where and why the errors occurred and how to correct them. This requirement received positive feedback from participants with visual disabilities [36, 67]. It aligns with WCAG 2.2 SC *3.3.1 Error Identification*, *3.3.3 Error Suggestion*, and *3.3.6 Error Prevention (All)*, which relate to error detection, suggested corrections, and mechanisms allowing users to review and correct inputs.

Additionally, **Requirement 9.2** states that error messages should be available through a combination of client-side and server-side validation. According to the authors, this approach "strikes a balance between providing helpful and accessible information about errors and avoiding overwhelming the user with numerous error messages." This requirement received positive feedback from participants with visual disabilities [36]. It aligns with WCAG 2.2 SC *3.3.1 Error Identification*, which ensures that errors are clearly identified and described when automatically detected.

Lastly, **Requirement 9.3** recommends that error messages should be made available in red. This approach received positive feedback from participants with visual disabilities [36, 67].

Internationalization

This category specifies a single requirement (**Requirement 10.1**): enable the tool to support translations into multiple languages, including Sign Language. This requirement underscores the need for adaptable communication methods to ensure inclusiveness for people from diverse linguistic backgrounds. Nicolaidis et al. [55] highlighted its importance specifically in the context of autistic adults.

Data protection, privacy and conformance with accessibility guidelines and legislation

This category refers to requirements that ensure the confidentiality, privacy, and reliability of participants' responses, as well as compliance with accessibility guidelines and legislation.

For instance, **Requirement 11.1** reinforces the importance of collecting data from participants, avoiding the use of proxies to ensure data reliability [24, 38, 55, 59, 68, 75].

Additionally, **Requirement 11.2** reinforces that the tool must comply with accessibility guidelines (e.g., WCAG) and legislation (e.g., Decree-Law no. 83/2018). Given the goal of creating accessible surveys, this requirement is considered fundamental for the development of any accessible digital product [34, 36, 67, 75].

Requirement 11.3 recommends providing an audio CAPTCHA, when CAPTCHA is required. This requirement received positive feedback from participants with visual disabilities [36]. This approach also aligns with WCAG 2.2 SC *1.1.1 Non-text Content*, that reinforces the use of "alternative forms of CAPTCHA using output modes for different types of sensory perception are provided to accommodate different disabilities" [18].

Lastly, the **Requirement 11.4** states that confidentiality of the answers given by the participants should be guaranteed [24, 51, 55, 68, 75].

Accessible informed consent

This category includes requirements that ensure ease of access when providing informed consent. Informed consent is defined as consent given freely, in an informed manner. It should not involve coercion, undue influence, or the loss of services due to refusal to participate [29]. Studies must obtain informed consent to make participants aware of the objectives of the study, the data collected, and their rights and responsibilities.

For instance, **Requirement 12.1** states that a Sign Language version of the consent form should be available. This requirement was well received by participants with hearing disabilities [51] and with cognitive and learning disabilities [55].

Additionally, **Requirement 12.2** recommends that a text version of the consent form should be provided. This practice was well received by participants with hearing disabilities in [51], and with cognitive and learning disabilities [56].

Requirement 12.3 advocates for obtaining informed consent online, eliminating the need to print, sign, and return a paper forms. This requirement emerged from a community-based participatory research process involving people with cognitive and learning disabilities [55]. The authors

highlight how traditional consent procedures relying on executive functioning can be exclusionary. Although initially discussed in the context of autistic individuals, this barrier may also affect individuals with other disabilities.

Additionally, the **Requirement 12.4** states that consent form templates should be adapted by eliminating sections that may unnecessarily hinder participants' understanding [55], the **Requirement 12.5** advocates that consent forms should be supplemented by adding images to increase accessibility for people with cognitive and learning disabilities [55], and the **Requirement 12.6** states that online consent forms should be adapted by providing audio versions of them [55].

5.2.2 Good practices

While not all recommendations found in the literature met the criteria to be formalized as requirements, several still offer valuable guidance for improving survey accessibility. This subsection presents a curated list of good practices identified in the reviewed studies. These practices, although not adopted as formal requirements - due to limited recurrence, specificity to certain contexts, or lack of broad applicability - highlight important strategies that can enhance inclusive survey design.

- Use Yes/No answer variations whenever possible - According to [70], "questions with variations of the yes/no responses, appeared to be the most familiar and easiest to respond to by participants.";

- Avoid using scales that, although commonly used in research (e.g. excellent, very good, good, regular, bad), may be unfamiliar or unclear to certain participants - As noted by [51], pilot tests with people with hearing disabilities revealed difficulties in interpreting these categories, leading to subsequent adaptations in the survey built within the scope of the article.

- When designing questions in ASL (American Sign Language), prefer yes/no questions over true/false statements - As [51] identified during pilot tests with people with hearing disabilities, true/false questions often lead to confusion, due to limitations in how these constructs are expressed in ASL. In response, the authors replace them with yes/no questions, which proved to be more easily understood. While this recommendation is based on ASL, it highlights the broader need to evaluate how question formats are perceived in the target language and adjust accordingly.

- Ensure a balance between the number and complexity of questions and the time required to answer them - This practice was informed by participant feedback regarding the accessibility of the survey they completed in the scope of the article [75].

5.3 Discussion

In this chapter, were identified in the literature key requirements that should be taken into account when building accessible digital surveys. Following the methodology described, a total of 47 requirements were compiled (Appendix) and categorized into 12 themes, summarized below:

Prefaces and context covers the use of legends for fields and field groups; the ability to review and modify responses; the provision of instructions; and the indication of progress throughout the survey. **Navigability** emphasizes the use of buttons to navigate between questions; mechanisms ensuring that mandatory questions are answered and simplifying answer selection in single-choice questions; and the alignment of form fields in a single column. **Assistance tools** reinforces that it must be ensured that assistive technologies can be used by participants with visual disabilities; allow surveys to be completed via external file uploads; and presentation of questions in a alternative wording via audio. **Audio** advocates the use of recorded voice for improved clarity and comprehension. **Graphics** supports the use of text alternatives for images. **Clarity and visual adjustments of text** recommends the use of clear, direct language, avoiding complex terms or figures of speech; specifying text direction and language; selecting appropriate font types and sizes for different writing systems; and maintaining adequate contrast ratio for normal-sized and large-sized texts. **Types of questions** advocates for incorporating graphics in multiple-choice questions; enable the provision of a written version of each question and answer options translated into sign language; the use of numerical scales; and the use of mechanisms to facilitate data entry. **Minimize external influences** reinforces the importance of specifying the spatial or temporal context in which a question is asked; ensuring the non-use of ableist concepts; assessing users' decision-making capacity; distinguishing between participants and supporters; and ensuring that answers are saved until timeout. **Error handling** stresses the importance of providing clear, explicit, and sensitive error messages, including information on what went wrong, where the error occurred, and how to correct it; use client and server side validations to maintain a balance between providing useful information and avoiding sending too many error messages; and the use of red for presenting error messages. **Internationalization** advocates the importance of supporting multiple language translation, including Sign Language. **Data protection, privacy and conformance with accessibility guidelines and legislation** supports the collection of reliable data by avoiding proxy responses; compliance with accessibility guidelines and legislation; the use of audio CAPTCHA; and the confidentiality of participants' data. **Accessible informed consent** reinforces the need for sign language, audio, and text versions of consent forms; and eliminate complex sections from consent form templates and using images in consent forms to increase accessibility for people with cognitive and learning disabilities.

5.3.1 WCAG 2.2 SC

Based on the data collected, it was possible to observe that 21 of the 47 requirements identified can be associated with one or more WCAG 2.2 Success Criteria.

Most of these criteria fall under the Understandable principle, which states that "Information

and the operation of the user interface must be understandable" [18]. This principle is particularly relevant in the context of surveys, as users must comprehend the content of instructions, questions, and respective answer options, and how to interact with them.

Additionally, it was possible to observe that there is a lesser number of references to the success criteria under the Robust principle, which emphasizes the need for content to be interpretable by various user agents, including assistive technologies [18]. This lower association is expected, given this principle contains fewer criteria overall. Technological advancements have effectively addressed many requirements through assistive technologies and user agents. For instance, in the recent transition from WCAG 2.1 to 2.2, criterion *4.1.1 Parsing* was deprecated, further reducing the number of criteria under this principle [7]. On the other hand, 26 out of 47 requirements could not be directly associated with any WCAG 2.2 success criteria. These requirements address various crucial aspects of digital accessibility not explicitly covered by the WCAG standards. Among them are functionalities such as "Toggle Switch" mechanisms (**Requirement 2.3**), read-aloud capabilities (**Requirement 3.4**) and the use of recorded voice for audios (**Requirement 4.1**). Additionally, typographical considerations were also examined, like font type and size adjustments based on the writing system adopted (**Requirement 6.3**), as well as ensuring clarity and non-ambiguity in question formulation (**Requirement 6.5**).

Additional accessibility needs were also identified, such as the use of diverse question types and mechanisms to support their representation (**Requirements 7.1-7.6**), the non-use of ableist concepts (**Requirement 8.2**), the assessment of users' decision-making capacity (**Requirement 8.3**), and the differentiation of users' own responses and those provided by their proxies (**Requirements 8.4, 8.5, 11.1**).

Additionally, requirements related to error messaging, indicated through the use of red text (**Requirement 9.3**), internationalization (**Requirement 10.1**), compliance with accessibility guidelines and legislation (**Requirement 11.3**), confidentiality of user responses (**Requirement 11.4**), and the provision of accessible informed consent (**Requirements 12.1-12.6**) were also identified.

These findings suggest that WCAG 2.2, while addressing web accessibility in general, does not fully cover the specific requirements for accessible digital surveys. Therefore, the requirements not mapped to WCAG 2.2 can be a useful additional resource when building accessible digital surveys.

5.3.2 Target audience

Analysis of gathered requirements (in Appendix) indicates that the most frequently addressed group is people with cognitive and learning disabilities, followed by people with visual disabilities, a broader category of people with disabilities and, lastly, people with hearing disabilities.

This distribution aligns with previous research, as discussed in the related work, where a predominance of articles focused on at people with cognitive and learning disabilities was observed.

Finally, it is essential to emphasize that, while our list of requirements draws from the existing literature, undertaking a more comprehensive analysis on survey accessibility is crucial. A

broader examination should not only further explore the diverse needs of various user groups but also expand current knowledge on different aspects such as the types of survey questions and the specific functionalities of survey tools.

Chapter 6

Prototype Implementation

This chapter details the development of the prototype, describing its technical features as well as the accessibility enhancements incorporated, based on the gathered requirements. Additionally, it outlines the tool's workflows, structured around the two types of use cases considered.

6.1 Technical features

Given the requirements gathered, we implemented them in a prototype of a survey completion tool. This prototype is a web application with a back-end developed in Python using the Django framework and a front-end in HTML, JavaScript, and CSS. It should be noted that the prototype works whether JavaScript is enabled or not in a browser, however, in the latter case, some non-essential features are not available as they depend on JavaScript code to work.

Following the development, the application was hosted on a server running Ubuntu 22.04.4. The server configuration includes:

- Nginx, which assumes the role of HTTP web and proxy server [3];
- Gunicorn, which is a "Python WSGI HTTP Server for UNIX" [2], more specifically, it establishes a bridge between the web server (in this case, Nginx) and the application developed, for the passage of requests [53];
- and PostgreSQL, which is an "open source object-relational database system" [35], used to store the data of this application.

Figure 6.1 presents a flowchart illustrating the connection between these elements in the survey completion tool implementation architecture.

6.1.1 Accessibility features

While there is adherence to the gathered requirements to enhance accessibility, this subsection highlights two specific features that required additional technical considerations and contribute to improving the user experience.

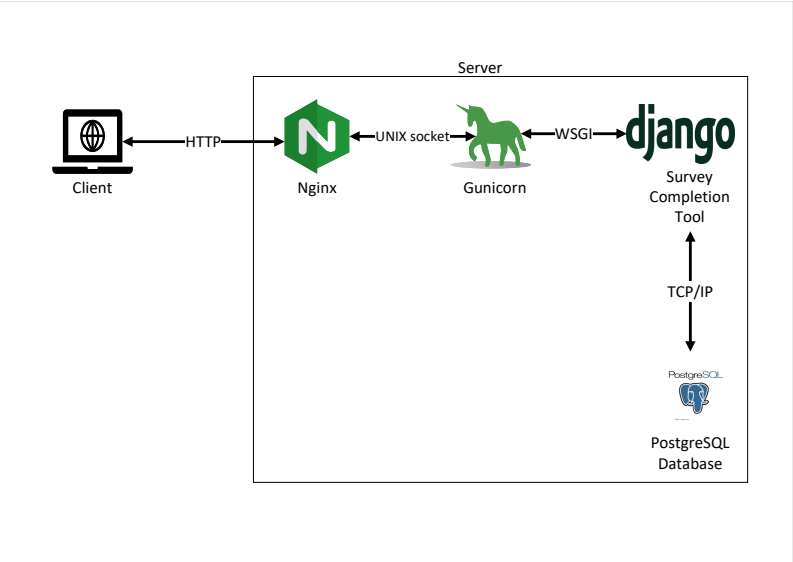


Figure 6.1: Flowchart of the survey completion tool implementation architecture.

Selection of background and text colors

When the tool is running in a browser with JavaScript enabled, the first section of each page allows users to change the text and background colors. Users can select colors using a color picker for each or choose from the pre-formulated color sets. Each color set contains two colors, one for the text and one for the background, which have a contrast level compliant with the requirement 6.4 (i.e., Use a contrast ratio of 7:1 for normal-sized text, and a contrast ratio of 4.5:1 for larger text, both in relation to the background) and with the WCAG 2.2 SC 1.4.6 Contrast (Enhanced). The color sets are a faster alternative if the user does not want to use color pickers to search for colors. These settings can be modified at any moment during the interaction with the tool.

Videos in Portuguese Sign Language

To make the tool more accessible for Sign Language signers, the tool supports videos containing translations of survey questions and answer options into Portuguese Sign Language. In addition, videos with translations in this language have also been placed throughout the tool for the translation of inputs and paragraphs that are present in this tool by default. The videos are displayed directly on the interface and users can play them at any time. However, to enhance the interaction experience for screen reader users, these videos are hidden (i.e., `aria-hidden` attribute is set to `true`) for this technology.

6.2 Workflows

The tool aims to improve the accessibility of surveys for people with disabilities, addressing barriers and ensuring a more inclusive experience when completing surveys. In this context, two types of users are considered: **survey creators** and **respondents**.

6.2.1 Survey creators

To create a new survey, **survey creators** upload a template with survey questions and, after authentication, access the answers provided to the surveys created. The following sections describe this process in detail.

Creating a survey

Once survey creators access the page to create a survey (currently available at `http://194.117.20.241/loadSurvey/`) (Figure 6.2), they can download a template file to enter the survey questions. The template is available in txt or JSON format.

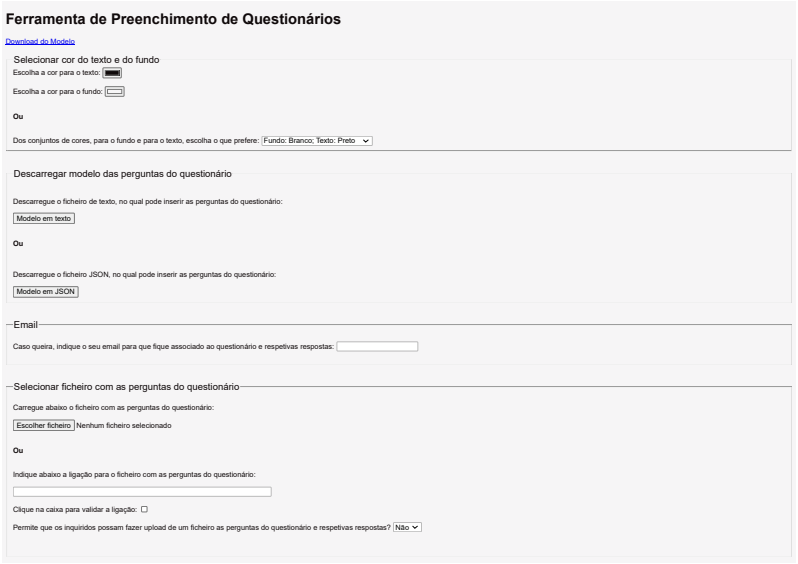


Figure 6.2: Page to upload the template with the survey questions.

Beginning with the survey introduction, the following fields must be indicated in the template:

- Introductory text (e.g. introduction_ Welcome to our study about entertainment preferences!)
- Indication of multimedia (e.g. type_ video with introduction or type_ audio with introduction) or not (e.g. type_ introduction)
- Multimedia file URL (if applicable) (video or audio, e.g. multimedia_ link for video with introduction).

Next, survey creators must define the survey questions. Each question is accompanied by the following fields:

Type of question

Each question type has different format options:

- Choosing between images - “choose one of the digital images”; “video with choose one of the digital images”; “audio with choose one of the digital images”;

- Choosing between images, each associated with a number of a numerical scale - “images with numerical scales as visual aids”; “video with images with numerical scales as visual aids”; “audio with images with numerical scales as visual aids”;
- Choosing between images, each associated with a Likert-type scale element - “graphics for response options using likert-type scales”; “video with graphics response options using likert scales”; “audio with graphics response options using likert scales”;
- Answering through a numerical scale - “numerical scales”; “video with numerical scales”; “audio with numerical scales”;
- Multiple choice - “multiple choice”; “video with multiple choice”; “audio with multiple choice”;
- Single answer choice - “single option answer”; “video with single option answer”; “audio with single option answer”;
- Answering with a date - “date”; “video with date”; “audio with date”;
- Answering with a number - “number”; “video with number”; “audio with number”;
- Short answer - “short written answer”; “video with short written answer”; “audio with short written answer”;
- Open-ended answer - “long written answer”; “video with long written answer”; “audio with long written answer”.

It should be noted that the question and type of question must be always indicated.

Answer options

For certain question types, answer options must follow a specific format:

- Numerical scale - `[min. number-max. number]`
- Multiple choice - `Option1; Option2; Option3`
- Single answer choice - `Option1; Option2; Option3`

Associated multimedia files (videos, audios or images)

For questions incorporating multimedia, formats must follow these structures:

Note that “video/audio for the question” appears between brackets {} because this is only required for types of questions starting with “video with” or “audio with”. This tool accepts videos or audios in formats “.mp3”, “.mp4” and “.ogg”

- Choosing between images - {video/audio for the question}; link for image, description of image; link for image, description of image;

- Choosing between images, each associated with a number of a numerical scale - {video/audio for the question}; link for image, number for image in the correct order; link for image, number for image in the correct order;
- Choosing between images, each associated with a Likert-type scale element - {video/audio for the question}; link for image, alternative text for image, likert-scale text for image in the correct order; link for image, alternative text for image, likert-scale text for image;
- Numerical scale - {video/audio for the question}
- Multiple choice - {video/audio for the question}; {video/audio for Option1}; {video/audio for Option2}; {video/audio for Option3}
- Single answer choice - {video/audio for the question}; {video/audio for Option1}; {video/audio for Option2}; {video/audio for Option3}
- Answering with a date - {video/audio for the question}
- Answering with a number - {video/audio for the question}
- Short answer - {video/audio for the question}
- Open-ended answer - {video/audio for the question}

Additionally, for **grouping questions**, the creator must specify the **group name**. For **tips on answering**, the creator must specify a **short instruction**. For **mandatory responses**, the creator must write `True` or `False`.

It should be noted that, after writing the value for a field, in the txt template, a line break must be indicated.

In conclusion, the mandatory fields are: question, type of question, and, if applicable, answer options and associated multimedia files.

As an example of the application of the fields described above, if the survey creator wants to determine which is the favorite movie genre of the person answering the survey, the creator should indicate:

- Question: question_ Which of the following is your favorite movie genre?
- Type of question: type_ video with single option answer
- Answer options: option_ Action; Adventure; Comedy; Drama; Horror; Science Fiction; Romance; None of the above
- Associated multimedia files (videos, audios or images): multimedia_ link for video for the question; link for video for the option action; link for video for the option adventure; link for video for the option comedy; link for video for the option drama; link for video for the option horror; link for video for the option science fiction; link for video for the option romance; link for video for the option none of the above

- Group name: group_ Cinema
- Tip on answering: hotlink_ Choose one of the following genres
- Mandatory response: mandatory_ False

The tool also allows creators to associate an email address with the survey, enabling them to access the responses later.

To create the survey, creators can either upload the completed template file directly or provide a link to the template. If they provide a link and only when the application is running on a browser with JavaScript enabled, they must check a box to validate the link. This validation is done through the JavaScript constructor new URL(), passing as argument the given link to check its validity. When JavaScript is disabled, this checkbox does not appear in the interface. In both cases, link validation is also performed in the back-end, with error pages sent if errors are detected. Also, creators can specify whether respondents are allowed to upload a text file with the answers. Finally, they complete the process by clicking the "Submit file" button.

Once the template is submitted and no errors are detected, survey creators are sent to a page indicating the survey has been successfully created. If errors are detected, error pages are returned according to the errors committed. This page also prompts creators to download a text file containing the survey identifier and an automatically generated password to access the responses, as illustrated in Figure 6.3.

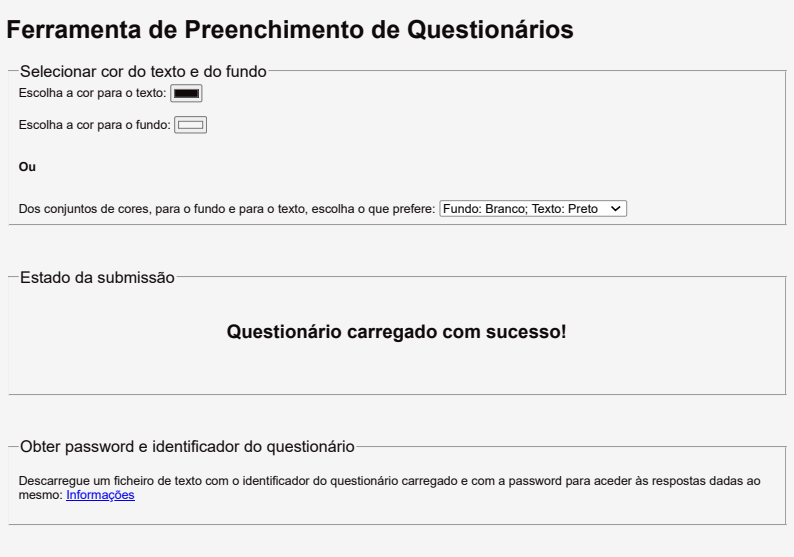


Figure 6.3: Page after submitting the survey template.

Accessing survey answers

To access surveys responses, creators must log in through a dedicated login page (currently available at `http://194.117.20.241/login/`). On this page (Figure 6.4), they are required

to enter the email provided during the survey creation and the assigned password. Finally, they complete the process by clicking the “Login” button.

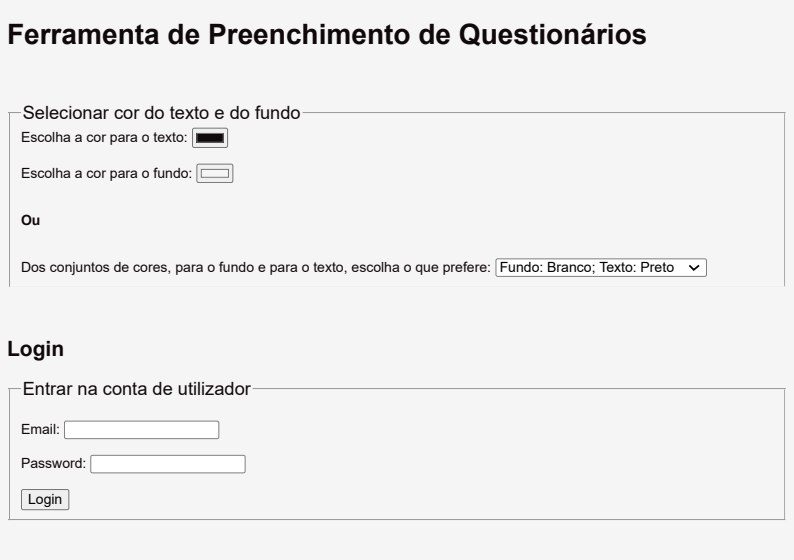


Figure 6.4: Login page to access the answers given to the survey.

After signing in, survey creators are directed to a page where they can consult the responses to all surveys associated with their email (Figure 6.5).

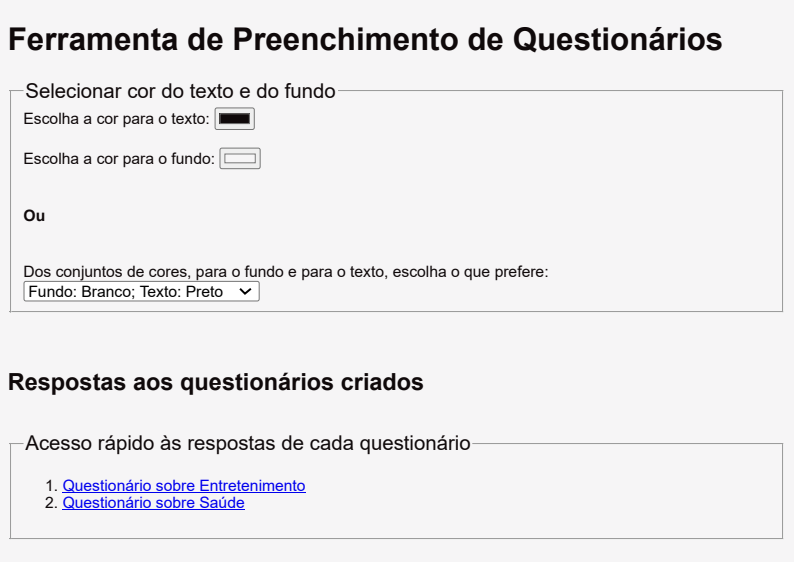
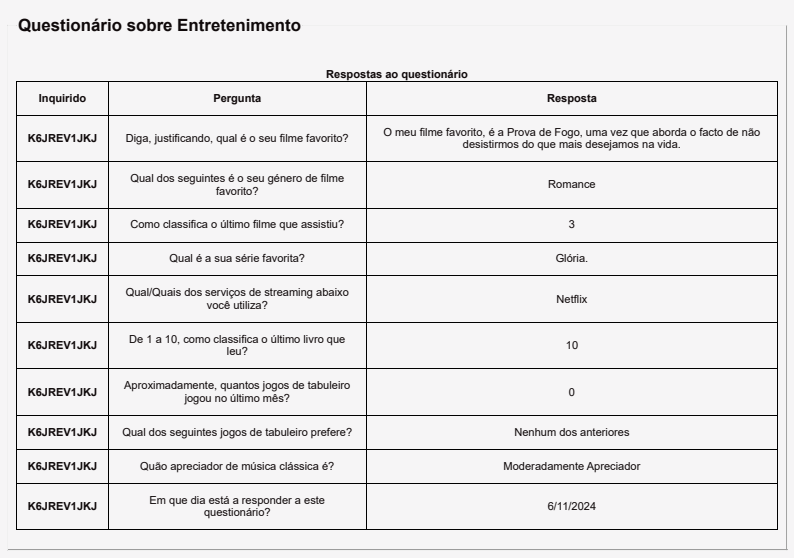


Figure 6.5: Page displaying responses to created surveys.

This page provides quick access to surveys responses, organized in different tables. Each table contains columns for the respondent’s identifier, the question, and the corresponding answer (Figure 6.6).



Questionário sobre Entretenimento

Respostas ao questionário

Inquirido	Pergunta	Resposta
K6JREV1JKJ	Diga, justificando, qual é o seu filme favorito?	O meu filme favorito, é a Prova de Fogo, uma vez que aborda o facto de não desistirmos do que mais desejamos na vida.
K6JREV1JKJ	Qual dos seguintes é o seu género de filme favorito?	Romance
K6JREV1JKJ	Como classifica o último filme que assistiu?	3
K6JREV1JKJ	Qual é a sua série favorita?	Glória.
K6JREV1JKJ	Qual/Quais dos serviços de streaming abaixo você utiliza?	Netflix
K6JREV1JKJ	De 1 a 10, como classifica o último livro que leu?	10
K6JREV1JKJ	Aproximadamente, quantos jogos de tabuleiro jogou no último mês?	0
K6JREV1JKJ	Qual dos seguintes jogos de tabuleiro prefere?	Nenhum dos anteriores
K6JREV1JKJ	Quão apreciador de música clássica é?	Moderadamente Apreciador
K6JREV1JKJ	Em que dia está a responder a este questionário?	6/11/2024

Figure 6.6: Table displaying survey responses.

6.2.2 Survey respondents

Survey respondents can complete a survey by entering the survey identifier provided by the survey creator. Surveys can be completed either directly in the tool or by uploading a text file with the answers. After submission, respondents can download a text file with their responses for reference. The process is detailed below.

To access a survey, respondents must navigate the survey selection page (currently available at `http://194.117.20.241/selectSurvey/`). On this page (Figure 6.7), they are prompted to enter the identifier provided by the creator. Once entered, they submit the identifier to proceed.

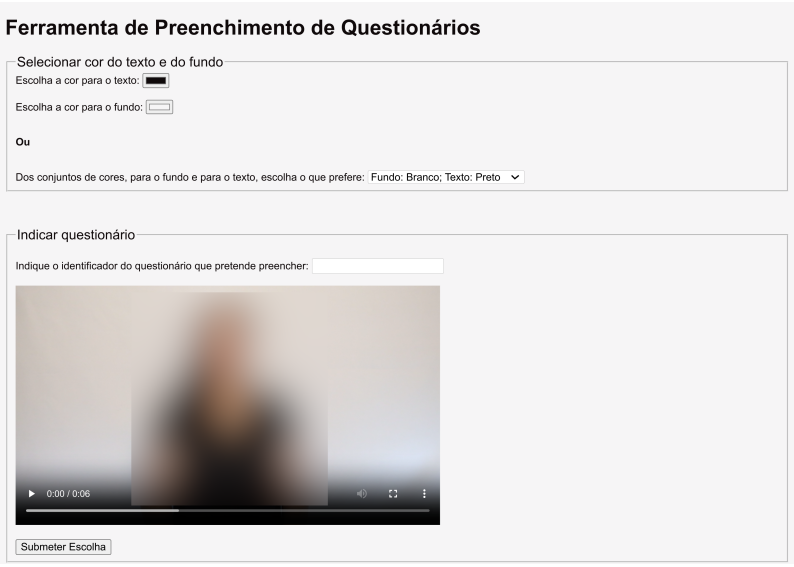


Figure 6.7: Page for selecting the survey to complete.

After submitting the survey identifier, respondents are directed to the first page of the survey, where they can find its introduction (Figure 6.8).

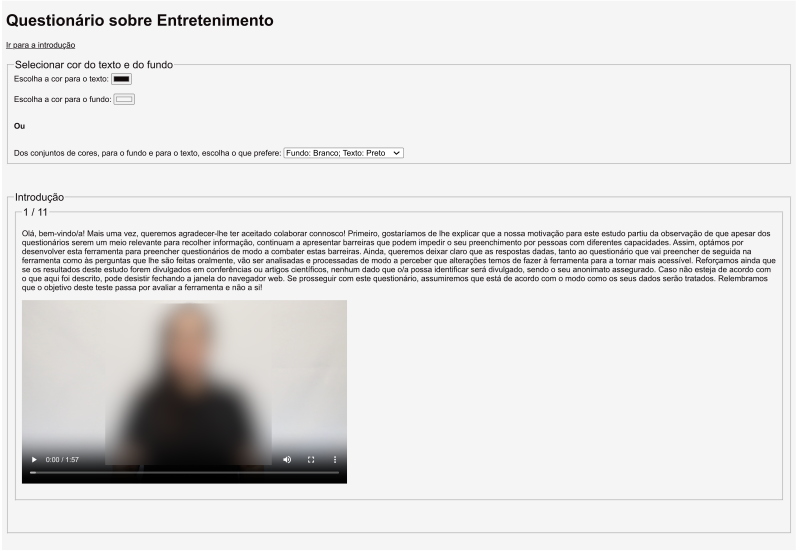


Figure 6.8: Survey introduction in text and Portuguese Sign Language.

If enabled by the survey creator, this first page also provides an option to complete the survey using a downloadable txt file. This file (Figure 6.9) contains the survey questions, answer options (if applicable), and fields for respondents to input their answers. Once completed, the file must be uploaded and submitted to the tool.

As mentioned, respondents can either upload a text file or complete the survey directly within the tool. When answering within the tool, they use the navigation buttons at the bottom of each page to navigate through survey questions. On the first page, respondents should press the “Start Survey” button to proceed to the first question (Figure 6.10).

Similarly, if they need to revise a previous response, they can use the “Previous” button (Figure 6.11).

If an error occurs, an error page (Figure 6.12) provide instructions for resolution.

Upon reaching the last question (6.13), respondents can also finalize and submit their responses to the survey using the “Submit Answers” button.

An analysis of the initial page of the survey revealed that the “Previous” button there present could be confusing to the users, as it was unclear where the button would direct them. To ensure compliance with WCAG 2.2 SC *3.2.3 Consistent Navigation* and provide a predictable and structured way to revisit and modify responses, the “Previous” button on this page was renamed “Go to the last question” (Figure 6.14). It was also observed that the “Next” button could lead to confusion among users on the final page of the survey, for the same reasons already mentioned. Consequently, also aligning with the WCAG 2.2 SC *3.2.3 Consistent Navigation*, the “Next” button on this page was renamed to “Go to the first page” (Figure 6.15).

After submitting their responses, and if there are no errors, respondents are redirected to a

```
"   Questionário sobre Entretenimento "




---  CINEMA---
Q:  Diga, justificando, qual é o seu filme favorito?*


R:


Q:  Qual dos seguintes é o seu género de filme favorito?

Ação
Aventura
Comédia
Drama
Terror
Ficção Científica
Romance
Nenhum dos anteriores

R:
```

Figure 6.9: Example of the text file for answering survey questions.

confirmation page (Figure 6.16), indicating that the survey has been successfully completed. If errors are detected, error pages are returned according to the errors committed. This page also provides an option to download a text file containing their responses.

Finally, it should be noted that, of the 47 requirements listed in the Appendix, 27 were implemented in the tool. Of these 27 requirements, nine (1.3, 2.2, 2.3, 6.2-6.4, 7.2, 8.6, 9.3) were implemented with adaptations to adjust with the workflows and front-end elements used in the tool. In addition, for 17 of the requirements (1.4, 1.6, 3.3, 3.4, 4.1, 5.1, 6.5, 8.1, 8.3-8.5, 11.3, 12.1-12.3, 12.5, 12.6), their implementation is dependent on the survey creator' action. However, compliance with these requirements is supported by the tool. There are 2 requirements (11.1 and 12.4) not related to the tool, being exclusively dependent on the creator' action. Finally, requirement 10.1 was not implemented because, in anticipation of the execution of tests with Portuguese participants, the development ended up focusing on two languages: Portuguese and Portuguese sign language.

To evaluate the accessibility of the prototype developed, the QualWeb [4] tool was used. This tool evaluates the accessibility of web pages, taking into account the ACT Rules - each of which describes how to test a certain aspect of a WCAG success criterion or other requirement [40]; and

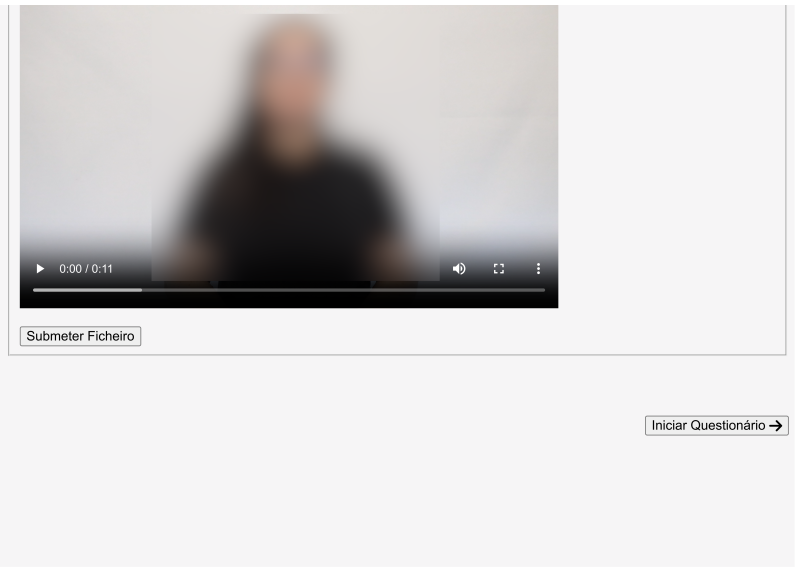


Figure 6.10: "Start survey" ("Iniciar Questionário", in Portuguese) button at the bottom right corner of the page.

the WCAG 2.1 [46]. The results of this evaluation led to the inclusion of quick access links in the tool, so that the user can go more quickly to the area of the page directly related to the survey. For example, Figure 6.17 shows the "Go to the introduction" link, which takes the user straight to the section in the page where the introduction to the survey is.

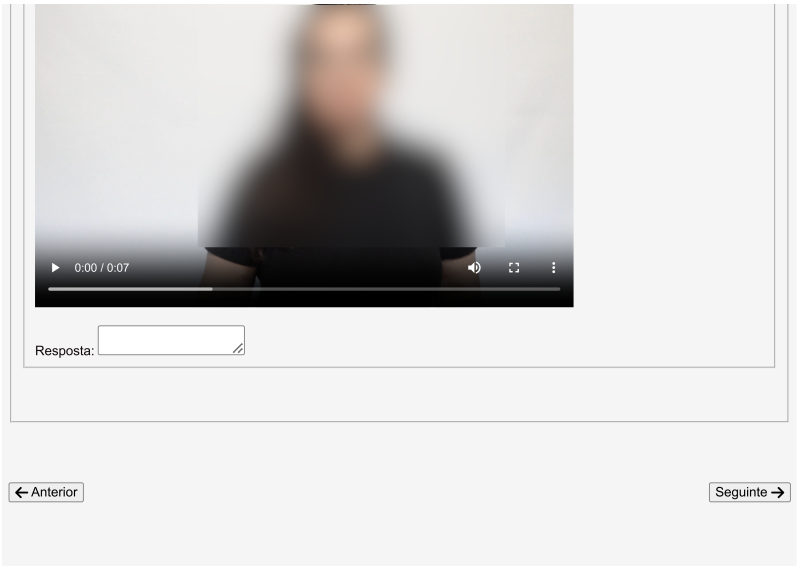


Figure 6.11: “Previous” (“Anterior”, in Portuguese) button at the bottom left corner of the page.

Figure 6.12: Example of an error page. This page indicates that the provided survey identifier is not associated with a survey.

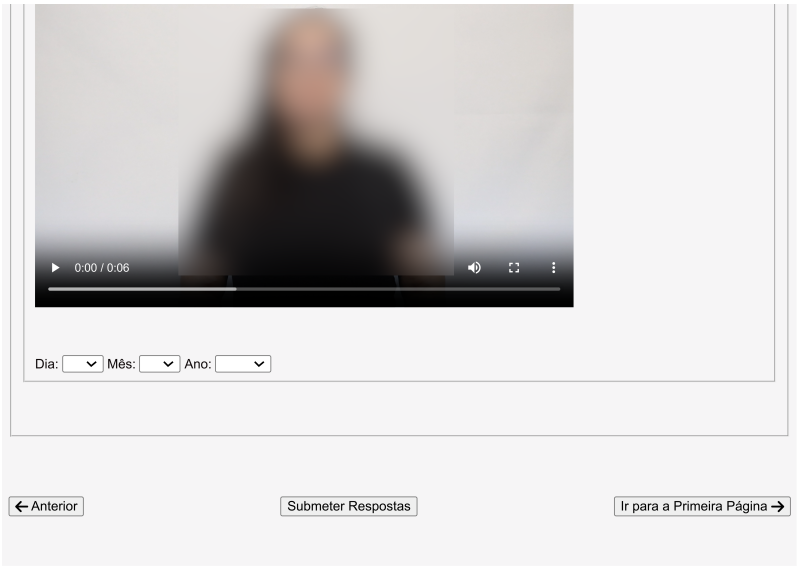


Figure 6.13: “Submit Answers” (“Submeter Respostas”, in Portuguese) at the bottom center of the page.

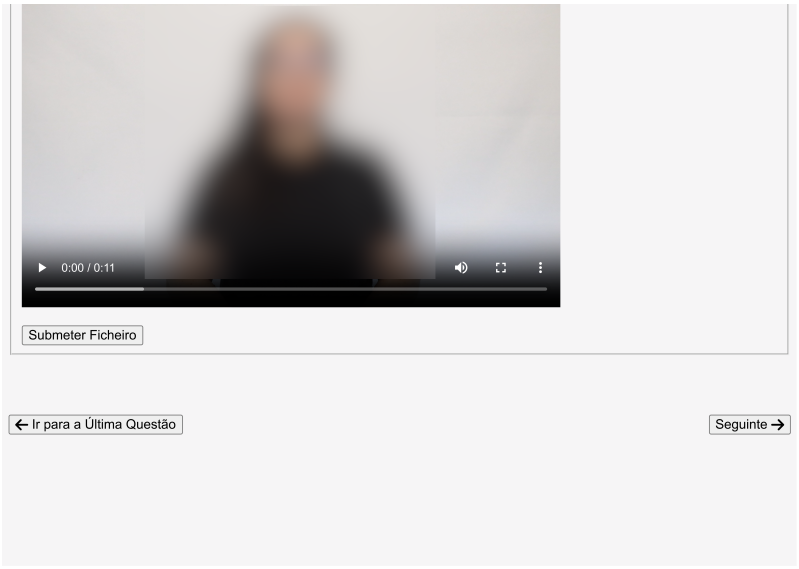


Figure 6.14: “Previous” (“Anterior”, in Portuguese) button as “Go to the last question” (“Ir para a Última Questão”, in Portuguese) button in the bottom left-hand corner of the page.

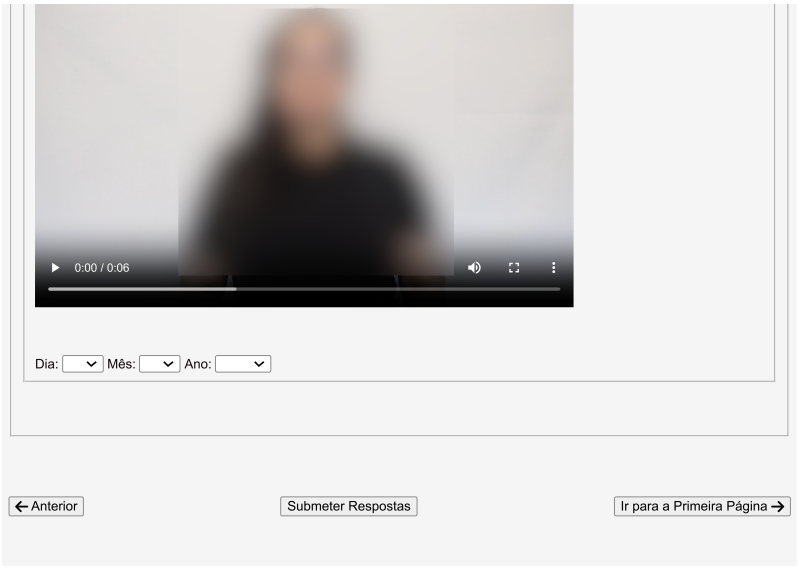


Figure 6.15: "Next" ("Seguinte", in Portuguese) button as "Go to the first page" ("Ir para a Primeira Página", in Portuguese) button in the bottom right-hand corner of the page.

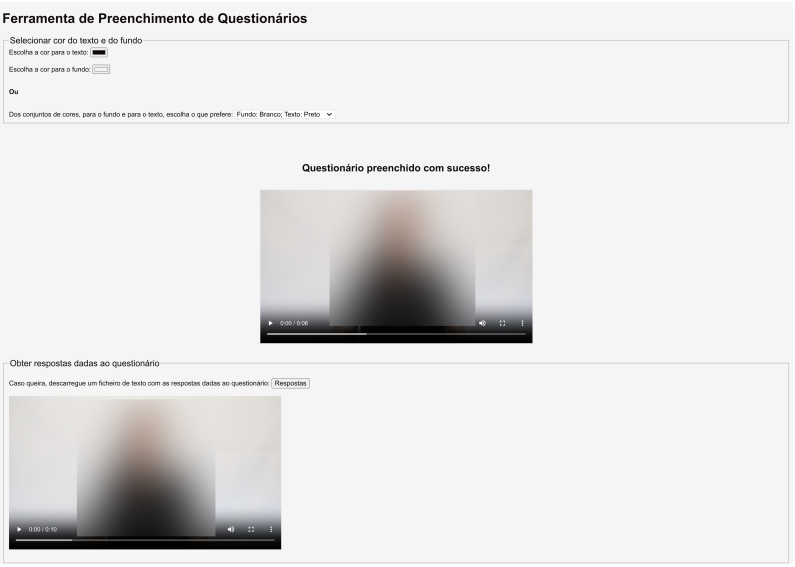


Figure 6.16: Page where the respondent can download their submitted answers.

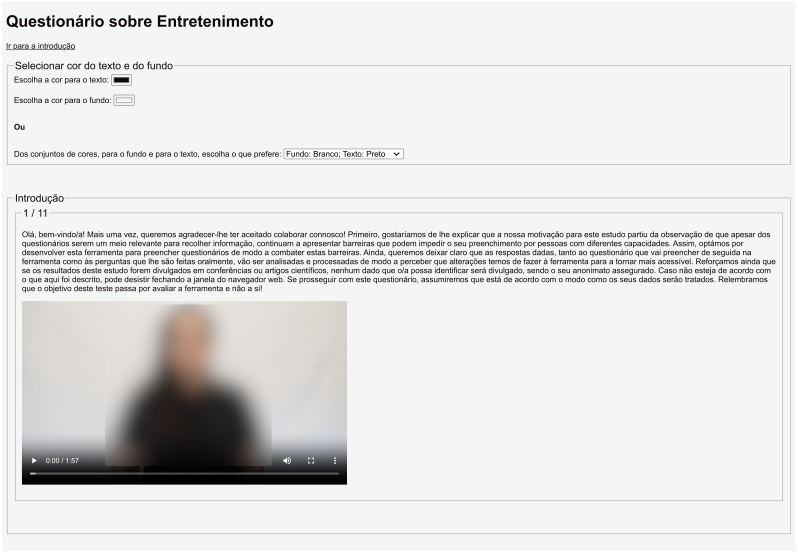


Figure 6.17: “Go to the introduction” (“Ir para a introdução”, in Portuguese) link that takes the user straight to the section in the page where the introduction to the survey is.

Chapter 7

User Testing and Evaluation

Following the development of the survey completion tool, an in-depth study was carried out to evaluate its accessibility. The study involved observing people with disabilities as they performed tasks within the tool and collecting their feedback on its accessibility.

This chapter outlines the methodology adopted, analyses the results obtained, and draws conclusions about the tool's accessibility.

7.1 Methodology

This section presents the methodology adopted for the in-depth study of the tool with people with disabilities.

This methodology builds on methods of testing and interviewing that have been analyzed in the related work. More specifically, practices observed in the literature that involved recruiting participants from the target audience to interact with the materials developed [14, 16, 20, 24, 34, 36, 38, 51, 54–56, 67, 68, 70, 75] and, after carrying out the tests, provide feedback on the experience carried out [14, 24, 34, 36, 56, 67, 68, 70, 75], were considered for this study.

Additionally, the Formative Study research methodology, which is "conducted during the development process in order to understand user behavior, diagnose specific problems, and improve design" [77], was also considered in the methodology adopted.

7.1.1 Participants

The recruitment criteria required participants to be at least 18 years old and use technology regularly. Seven participants were recruited through the research team's network, primarily consisting of people who have previously participated in other studies, as well as through associations supporting people with disabilities. Each participant received a 10 euros voucher as compensation for their participation in the study. This study was approved by the Ethics Committee of the Faculty of Sciences of the University of Lisbon. Most tests were conducted remotely, though some were held in person when more convenient for the participant.

Participants were aged between 19 and 45 years, with three under 30, two between 30 and 40, and two over 40. Of these participants:

- two have visual disabilities. One described themselves as practically blind, while the other did not specify their vision level. Both used a screen reader in the tests.
- two have motor disabilities. One had a personal assistant during the test, who helped clarify their speech, and also used the on-screen keyboard. The other participant completed the survey using a physical keyboard and touchpad, and was able to communicate verbally without assistance.
- two have cognitive and learning disabilities, specifically in terms of intellectual functioning.
- the remaining one has a hearing disability, explicitly a profound hearing loss, and is proficient in reading and writing in Portuguese. The test with this participant was conducted with the assistance of a Portuguese Sign Language interpreter.

All participants reported using technology very often.

Of the seven participants, six reported having completed online surveys before. Among them, four mentioned not encountering any problems that made it difficult or even prevented them from filling out online surveys. On the other hand, two participants identified barriers in online surveys, such as redundant information; drag and drop answer formats; unlabeled buttons; radio buttons not associated with the corresponding text; ambiguous or unfamiliar words. Only one participant reported never having completed online surveys. When asked why, they said that they were unable to do so, without providing further details.

7.1.2 Tasks

For the tests, a survey was created on the tool developed. This survey contained ten questions about entertainment in general. More specifically, it had one open-ended and one short answer question. Additionally, it included one question to be answered through a numerical scale, three questions to be answered choosing between images (i.e. Choose between images; Choose between images, each associated with a number of a numerical scale; Choose between images, each associated with a likert-type scale element), one question with a single answer choice, one multiple-choice question, one question to answer with a date, and one to answer with a number. Each question and respective answer options, when applicable, were presented in text and in videos translating them into Portuguese Sign Language, to meet the accessibility needs of a wide range of users.

During the tests, participants were asked to perform the following tasks:

1. Access the online survey within the tool;
2. Complete the survey using one of the two available methods: filling out the online form within the tool, or uploading a text file with their answers. Participants could choose their preferred method;
3. Submit their completed survey;
4. (Optional) Download a text file summarizing their responses.

7.1.3 Procedure

Before the tests, participants received an informed consent form, which they had to complete and sign, an information leaflet detailing the objectives of the study, tasks involved, and the data that would be collected. This allowed participants to review the documents at their own pace and make informed decisions about their participation. They were also provided with the application link they had to access to perform the test, and informed that they would need a computer or a smartphone to take part in the study.

During the test sessions, participants were first welcomed and thanked them for their participation. They were asked for permission to record the study session and given an overview of the motivation behind the study, how their data would be processed, and how their confidentiality would be ensured. If this was not completed beforehand, they were asked to complete and sign the informed consent form. Next, demographic questions were asked (e.g., age, type of disability, frequency of technology use, use of assistive tools, and prior experiences completing online surveys).

Before beginning the tasks, participants were asked to verbalize out loud their thoughts, actions, and difficulties while interacting with the tool, following the Think Aloud protocol [11].

Participants were then asked to access the online survey. As previously mentioned, the tool allows for survey completion through the online form within the tool itself or by uploading a text file with responses.

After 25 minutes, if the participants had not completed the survey, they were notified of the elapsed time and asked if they would like to continue. This time limit was set to prevent fatigue and ensure the complete test session did not exceed the allocated one hour duration.

Finally, after completing the survey, participants were interviewed to share their feedback on the accessibility and general experience with the tool.

A pilot test was carried out to evaluate the procedure to be adopted in this study. To this end, a person with a visual disability was recruited. The pilot test started with an introduction to the study (i.e., motivation, data treatment procedure and participant confidentiality assurance). Following the provision of informed consent, the participant was requested to perform the tasks described in the section above and, finally, to provide opinion on the accessibility of the tool. The pilot test yielded some modifications to the procedure, including:

- sending, prior to the tests, the link to the tool and, the information that (1) the participant would need a computer or a smartphone to participate in the study and (2) the participant would be asked share the screen during the test;
- provision of a brief explanation, before survey completion, of what participants had to do in the tool and about the survey; and
- verbal provision of the identifier of the survey to the participant, to avoid them having to look for it during the test.

Additionally, the tool underwent the following modifications: Reduction in the size of the identifiers, to simplify the process of inserting them in the tool by the participants; Addition of the attributes aria-label (i.e. aria-label="Video with a translation of the previous text in Portuguese Sign Language") and aria-hidden (i.e. aria-hidden="true") in the videos in Portuguese Sign Language.

7.1.4 Data analysis

Following the tests, the data obtained was analyzed using both qualitative and quantitative research methods [52].

Firstly, a thematic analysis was conducted, categorizing data into the following groups:

- Problems detected in the text of the survey questions and answer options.
- Problems detected in functionalities of the tool.
- Suggested changes to be made to the tool.
- Positive feedback concerning the text of the survey questions and answer options.
- Positive feedback concerning tool functionalities.
- Positive feedback concerning the alternative method of completing the survey using a text file.
- Cases where participants misinterpreted a question (and its answer options, if applicable), leading to an inadequate response.

After identifying the issues and suggestions, they were grouped by affected element (i.e., tool feature or survey content). Then a priority scale was built, in which elements whose detected problems or suggested changes could have a greater impact on the tool's accessibility occupied higher positions in relation those that did not meet this criterion. Within the elements in the higher positions, those whose identified problems or suggested changes were related to more than one participant occupied higher positions in relation to those that did not meet both criteria. Furthermore, an analysis of the positive feedback was conducted for each of the three categories of positive feedback, with the objective of grouping these feedback according to the element they cover to facilitate their consultation. Finally, it was also analyzed why participants chose to respond to the survey in the tool or by uploading a text file containing their answers.

Then, a quantitative analysis was conducted to determine the number of participants who selected an unintended answer or misunderstood the question but still provided an answer, as well as the number of participants who answered all the questions with a clear understanding of their purpose, possible answers, and their own answers. This analysis was based on participants' observation while they completed the survey and the information they provided in the interviews. Additionally, it was also analyzed the number of participants who were aware of the possibility of obtaining a text file with their answers to the survey.

7.2 Findings

This section presents the results of the analysis performed on the data collected during the tests. These results were separated according to whether they refer to the tool (Tool findings) or to the survey content (Survey content findings).

In the tests performed, three out of seven participants used assistive tools to complete the survey. Two, both with visual disabilities, used a screen reader, and the other participant, with a motor disability, used an on-screen keyboard.

7.2.1 Tool findings

Problems detected and changes suggested to features

The thematic analysis identified issues and improvement suggestions for the following features:

Survey submission: Two participants who completed the survey directly in the tool had difficulty finding the button to submit the answers, instead focusing their attention on the "Go to the first page" button. One participant has a cognitive and learning disability, and the other has a motor disability. The first required assistance from a researcher to find the button, while the second was guided by his personal assistant. Additionally, one participant, with a visual disability, said that the button for submitting the file with the answers to the survey questions should be disabled until the file is uploaded.

Section to select background and text colors: Two participants, both with visual disabilities, expressed their dissatisfaction with the placement of the text and background colors selection section, which was present on the top of every page. One participant suggested that this section should only appear on the initial page, as its current placement made it required to always navigate through it before reaching the question, complicating the interaction. The other participant proposed that this section should also be limited to the initial page, and, when needed, accessible via a button.

Portuguese Sign Language videos: Two participants, one with a motor disability and another with a hearing disability, shared their thoughts regarding the presence of the videos with Portuguese Sign Language translations. The first found the presence of these videos among the answer options made interaction with them cumbersome and impractical. This participant also suggested that the videos should be hidden for users who do not require them but remain easily accessible for those who do. In contrast, the participant with a hearing disability proposed repositioning the videos closer to the corresponding question and answer options, a change that, according to this participant, would enhance the intuitiveness of the experience for deaf people. When observing two other participants, both with cognitive and learning disabilities, it became evident that the videos in sign language made it difficult for them to find the questions and answer options. Additionally, most participants required an initial explanation to understand why these videos were integrated throughout the tool. This suggests that hiding them by default for users who do not need them might contribute to enhance interface usability.

Missing HTML headings: One participant with a visual disability said that HTML headings should be included throughout the survey pages to facilitate navigation. Specifically, the participant said that: H1 should be for the survey title, H2 for the group each question belongs to, the introduction section title and the title of the section with an alternative method for responding and H3 for the question itself.

Buttons being "broken" by the screen reader: One of the participants, who has a visual disability, noted that two of the tool's buttons, "Start Survey" and "Next", were being "broken" when read by the screen reader. Consequently, for each button, the screen reader transmitted to the participant that there were two buttons instead of just one. This participant said that this could be due to the existence of blank spaces before these buttons.

Associate the question with the field for giving the response: One of the participants, with a visual disability, said that the fields to give the answers should be linked to the respective question, so that when going to them the question is read again.

Answer options and answer fields need to be highlighted in the alternative method for responding to the survey: One of the participants, who has a motor disability, completed the survey using the alternative response method. In two questions, this participant, instead of indicating one of the existent answer options, ended up writing an alternative response. This observation underscores the importance of enhancing the visibility of the answer options in this file. Additionally, this participant sometimes had trouble finding the field (i.e. "R:") in front of which should be placed the answer to the question. This underscores the need to better highlight this field in the file.

Alert the respondent about the presence of checkboxes or radio buttons: One participant, who has a visual disability, suggested informing screen reader users, before they interact with response options, whether they are about to interact with a group of checkboxes or radio buttons, so that they can, for example, press the "r" key to navigate radio buttons.

Radio buttons not grouped: One of the participants, who has visual disability, noticed that in the questions to answer through radio buttons, these were not grouped together (i.e., role="group").

Screen reader reading the question from the middle: One of the participants, who has a visual disability, mentioned a few times that when moving from one question to another, the screen reader started reading from the middle of the question.

Unexpected navigation when the "enter" key is pressed: One of the participants, who has a visual disability, mentioned that, when pressing the "enter" key after answering one of the questions, the tool went back to the previous page and not to the next one.

Allow different survey views: One of the participants, who has a visual disability, suggested creating different views of the survey for users with different needs, with the preferred view being indicated before completing the survey.

Implementation of an alternative mode for interacting with the survey when it is completed within the tool itself: One of the participants, who has a visual disability, suggested an

alternative mode for interacting with the survey when completed within the tool itself. In this mode, the respondent listens to the question and the answer options, with each option corresponding to a letter. Then, presses a letter corresponding to the intended answer. Finally, the respondent presses the “enter” or the “space bar” keys to move forward.

Positive aspects pointed out to features

Moreover, the thematic analysis also revealed the positive aspects for the following features:

One question per page: Three of the participants, one with a visual disability, one with a motor disability, and one with a cognitive and learning disability, found the one-question-per-page format positive.

Portuguese Sign Language videos: The participant with a hearing disability valued the inclusion of videos in Portuguese Sign Language, due to the existence of words that the participant considered to be possibly incomprehensible to other deaf individuals. Furthermore, the participant noted that these videos were clear.

Alternative survey completion method: A participant with a motor disability opted to submit responses via a text file rather than completing the survey directly in the tool. This participant reported that the file to answer the survey questions was correctly structured.

In addition, three participants, one with a visual disability, one with a cognitive and learning disability, and one with a hearing disability, reported having no difficulty completing the survey using the tool.

Participants’ choice of method for survey completion

The thematic analysis also revealed that five out of seven participants chose to answer the survey questions in the online form within the tool itself. When asked about their choice:

- One participant (with a visual disability) stated they wanted to test the tool’s accessibility.
- Two participants, one with a cognitive and learning disability and another with a motor disability, considered this option to be more interactive.
- One participant (with a hearing disability) decide to use the tool after learning about the availability of videos in Portuguese Sign Language.
- The last participant (with a cognitive and learning disability) did not provide a specific reason.

Meanwhile, one participant (with a motor disability) opted to complete the survey by uploading the text file, explaining that this format was more practical and easier to use.

Finally, the remaining participant (with a visual disability) initially intended to use both methods but encountered a formatting issue with the text file when opening it in the Windows notepad. This issue was due to the fact that the entire content of this file was on a single line, which made it

very complex to read and also impossible for the tool to process any response given in this file. As a result, the participant ultimately completed the survey within the tool. Subsequently, the research team observed that this problem was not associated with the tool, as the text file was opened in a correct format in the notepad of other Windows devices.

Participants awareness of the possibility of obtaining a text file with their answers to the survey

Most of the participants understood that they could download a text file with their answers to the survey. One participant, with a cognitive and learning disability, did not fully understood this option.

7.2.2 Survey content findings

Positive aspects pointed out to the survey content

The thematic analysis also revealed the following:

Clarity and formulation of questions: One of the participants, who has a visual disability, said that the questions (i.e., the wording of the questions) were clear. Additionally, the other two participants with motor disabilities emphasized that these questions were objective and correctly formulated.

Participants' understanding of the questions

The quantitative analysis revealed that three out of seven participants misunderstood some survey questions.

For instance, one of these participants, who has a cognitive and learning disability, instead of reading "Required Response" ("Resposta Obrigatória", in Portuguese) the participant read "Respond thank you" ("Responde obrigado", in Portuguese), and ended up answering "Thank you" ("Obrigado", in Portuguese) to the question. In addition, this participant had difficulties with the question "Which one/ones of the streaming services below do you use?", more specifically with the term "streaming" since the rest of the question was written in Portuguese. This situation was caused by noncompliance during the question formulation with requirement 6.1, which advocates for the avoidance of complex language and confusing terms. Moreover, this participant also suggested adding images to more questions to make them more understandable.

As another example, another participant with a motor disability, who completed the survey using the text file, when answering the question "How fond are you of classical music?", instead of selecting one of the three predefined options ("Not fond", "Moderately fond", "Very fond"), they responded by indicating their preferred music genre. In addition, this participant, when answering the question "How would you rate the last movie you assisted?", which was accompanied by the tip "1 means the movie is terrible and 3 means the movie is excellent", instead of answering by selecting one of the predefined options ("1", "2", "3"), ended up answering with "excellent" to the question. Finally, to the question "Approximately how many board games have you played in the

last month?", instead of answering with a number, the participant said that they do not play board games.

Finally, for the remaining participant, who has a cognitive and learning disability, in some of the questions it was necessary a researcher help to establish a bridge between what the participant wanted to answer to the question and the response options available. In addition, this participant also had problems with the introduction, claiming that it was too long, and asked a researcher to read it. Furthermore, this participant also revealed difficulties with the question "Which one/ones of the streaming services below do you use?", more specifically with the use of the term "streaming", as the participant did not know what it meant. Moreover, the participant revealed difficulties with the question "How fond of classical music are you?", since the participant did not understand the meaning of the term "Quão", in Portuguese, which translates to "How", in english.

In addition, the observation of the remaining four participants (two with visual disabilities, one with a motor disability, and one with a hearing disability), despite some difficulties and doubts exposed by two of them related to some questions, revealed an overall good understanding of the questions.

For instance, one participant, who has a visual disability, exposed some difficulties and doubts with two survey questions. First, this participant noted that expressions such as "Which one/ones" ("Qual/Quais", in Portuguese) are not adequate with screen readers. Then, the participant revealed difficulties in understanding the question "Approximately how many board games have you played in the last month?", asking if it was referring to how many games or how many times the participant played in the last month.

Furthermore, another participant, also with a visual disability, exposed difficulties with the question "Say, justifying, what is your favorite movie? (Mandatory answer)", asking if it was, in fact, to write an answer to the question.

Finally, the two remaining participants, one with a motor disability and the other with a hearing disability reported no challenges with the content of the questions.

7.3 Discussion

The findings concerning the tool revealed various problems and suggestions for changes to features.

Worth of particular note are the features "Survey submission", "Portuguese Sign Language videos" and "Section to select background and text colors", whose problems detected or changes suggested are related to more than one participant. In the first two features were detected problems which imply a non-compliance with the WCAG 2.2 SC 3.2.3 Consistent Navigation and 3.3.6 Error Prevention (All). These problems also imply non-compliance with the requirement 11.2, which reinforces that the tool must comply with accessibility guidelines and legislation.

Additionally, there are mentions to problems detected or changes suggested to features by a participant with a visual disability, which imply non-compliance with WCAG 2.2 SC such as 2.4.6 Headings and Labels, 4.1.2 Name, Role, Value, 3.3.2 Labels or Instructions, 1.3.1 Info and

Relationships and 3.2.3 Consistent Navigation. These problems also imply non-compliance with the requirements 3.1 and 11.2. It should be noted, however, that, despite the problems detected and changes suggested, the participant was able to complete and submit the survey.

Conversely, there are aspects of the tool that were positively highlighted by participants, such as the presence of one question per page, the Portuguese Sign Language videos, and the alternative survey completion method. Also, three participants reported having no difficulty completing the survey using the tool.

The various problems and suggestions for changes, related to users with different needs, are acknowledged, and as such, it is not possible to claim the full accessibility of this tool. Nevertheless, it is believed that, subsequent refinements of the tool informed by these data will contribute a more accessible tool for people with different abilities to complete surveys.

Finally, concerning the findings related to the content of the survey, these revealed that three of the participants found the questions to be clear, objective, and correctly worded. However, there were still interpretation problems and doubts related to some of the questions. Given that this dissertation will not focus on the refinement of the content of the survey, and to better inform the construction of surveys whose content is accessible to people with different abilities, a set of recommendations for the construction of accessible surveys, based on the survey content findings, is going to be presented in the next chapter.

Chapter 8

Tool Refinement

Taking into account the identified problems, suggested changes, and positive aspects related to the elements of the tool, modifications were made to enhance its accessibility. This chapter presents and analyzes these modifications based on affected elements, exposes a set of recommendations for the construction of accessible surveys and concludes with insights on the refinement process and the tool's compliance with the WCAG 2.2 and requirements gathered. The modifications are structured into five main sections: (1) Survey Submission, addressing issues related to locating the submission buttons and preventing accidental submissions; (2) Survey Personalization, introducing customization options for accessibility features; (3) Grouping of radio buttons and of checkboxes, specifying for screen reader users whether they are about to interact with a "radio-group" or a "group", respectively; (4) Fixing of buttons "broken" by the screen reader, so that users of this technology can be correctly informed about these buttons and (5) Additional Modifications, covering further refinements performed in the survey completion and creation processes, resulting from other problems detected during the refinements performed in the other four sections and further discussions about the tool.

8.1 Survey submission

8.1.1 Difficulty locating the Submission Button

Two participants struggled to locate the button to submit all the responses given to the survey. This submission button, which is located in the last page of the survey, was initially positioned in the bottom center, between the "Previous" button on the bottom left and the "Go to the first page" button on the bottom right (Figure 8.1). Since, on previous survey pages, the "Next" button was located on the bottom right, participants instinctively focused on that area, mistakenly selecting the "Go to the first page" button.

To address this, the button layout was adjusted: the "Submit Answers" button was moved to the bottom right (i.e., style="float: right"), where users naturally expected it based on previous interactions, while the "Go to the first page" button was repositioned (i.e., style="display: inline-block") as can be seen in Figure 8.2. These measures were implemented to align navigation consistency across the survey.

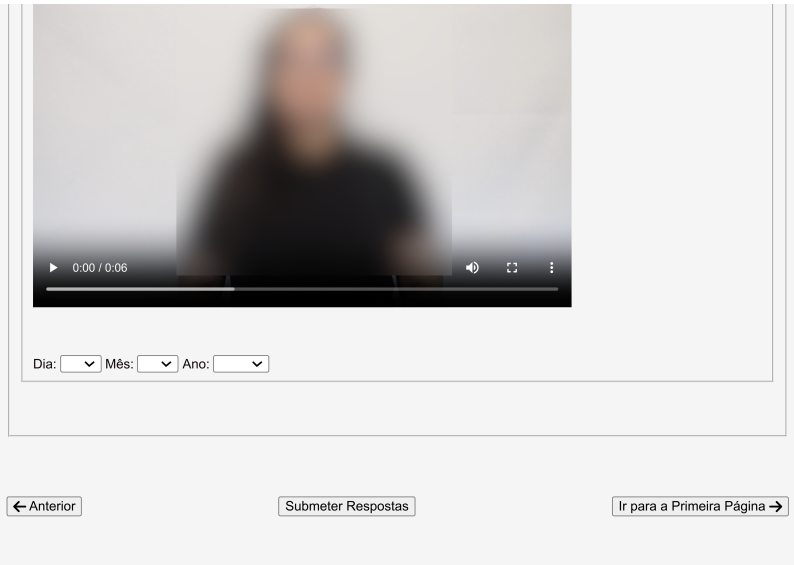


Figure 8.1: “Submit Answers” (“Submeter Respostas”, in Portuguese) button at the bottom center of the page on tool’s version tested.

Additionally, it was also placed a icon representing a send arrow in the submit answers buttons (e.g. Figure 8.3), with the intention of reinforcing the action triggered by those buttons.

8.1.2 Unintentional submission of answers

Another concern was the risk of users unintentionally submitting their answers by pressing the buttons to submit answers, namely, the “Submit file” and “Submit Answers” buttons, before completing the survey.

Such concern was also shared by one of the participants, who said that the button for submitting the file with the answers to the survey questions should be disabled until the file is uploaded.

To mitigate this issue and, at the same time, find a solution that worked with JavaScript enabled or disabled, a confirmation pop-up was introduced, which appears when the submission buttons are pressed. This pop-up (Figure 8.3) prompts the users with a message asking them to confirm their intent before proceeding. The user can click the “Submit” button to confirm the action or the “X” button to close the pop-up. This interaction ensures that accidental clicks or pressings do not finalize the survey without user consent.

8.2 Survey personalization

Feedback from the two participants indicated that the section for selecting the text and background colors was disruptive when displayed on every page. They suggested limiting it to the initial page, with one participant proposing that it should only appear when explicitly requested.

Furthermore, concerns were raised about the placement of Portuguese Sign Language videos. One participant found their integration between the answer options to be cumbersome and suggested hiding them for users who do not need them - corroborated by another two participants’

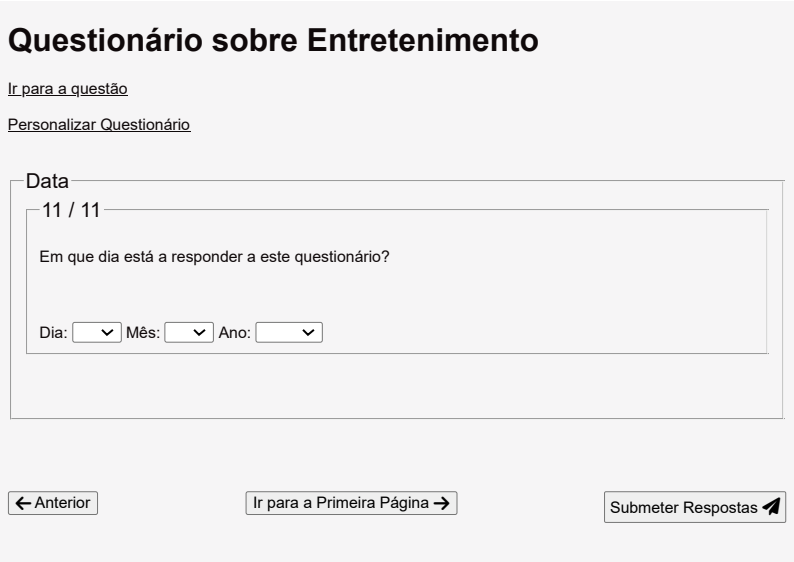


Figure 8.2: "Submit Answers" ("Submeter Respostas", in Portuguese) button at the bottom right of the page.

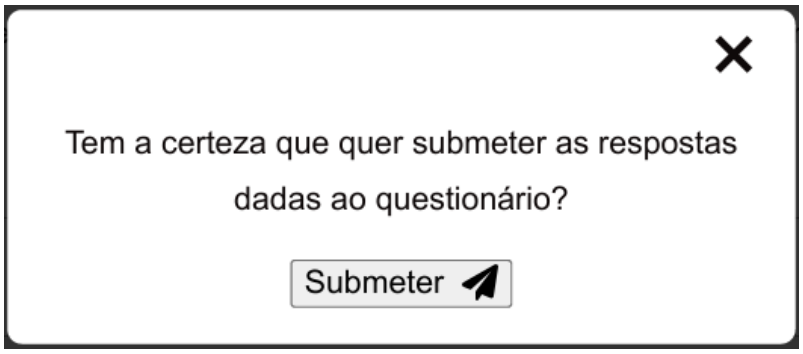


Figure 8.3: Confirmation pop-up presented to the user when the submission button is pressed.

interactions with the tool. Conversely, another participant suggested positioning them next to the corresponding questions and answer options to facilitate the interaction with them.

While these functionalities may prove beneficial to some users, they can represent challenges for others.

One of the participants even suggested creating different views of the survey for users with different needs, with the preferred view being indicated before completing the survey.

Considering these feedback, the tool has been modified to allow users to select which of the two functionalities remain enabled during survey completion.

To implement this, a new section has been added to the survey selection page (Figure 8.4). In this section, users can select the checkboxes corresponding to the functionalities they want to be present when filling in the survey. For example, selecting the checkbox labeled "Section for selecting the color of the text and background" allows users to access the text and background color customization throughout the survey. Similarly, selecting the checkbox labeled "Videos with translations in Portuguese Sign Language" enables translations in Portuguese Sign Language.

Users can activate both functionalities, with neither selected by default.

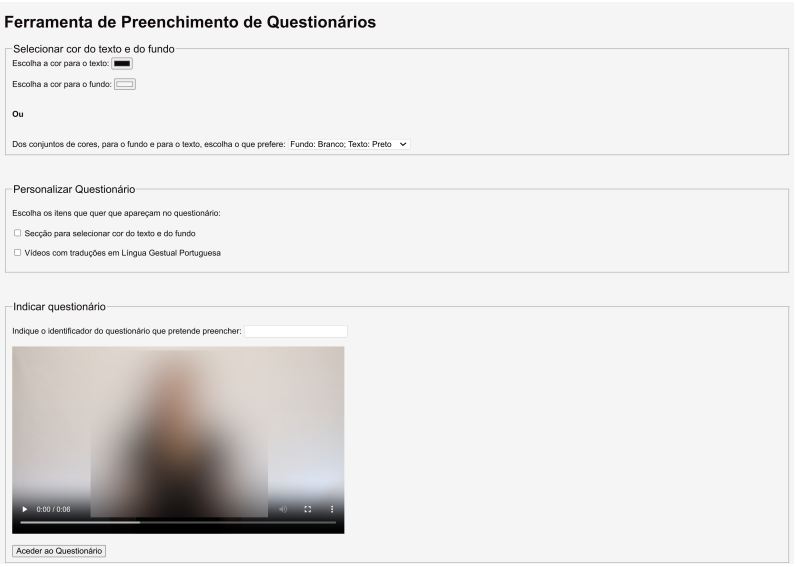


Figure 8.4: New section for survey personalization.

To accommodate respondents who may wish to modify their selections during survey completion, the customization section remains available throughout the survey. To this end, a "Customize Survey" option was added at the top of each page (Figure 8.5), opening a pop-up where users can update their choices. However, when pressing the "Update" button in this pop-up, one of two situations can happen:

1. If they are on the first page of the survey and have already uploaded a file with their answers to the tool (Figure 8.6), this file will be discarded.

2. If they are in one of the remaining pages of the survey and have made updates to the answer given to the question (Figure 8.7), these updates will be discarded.

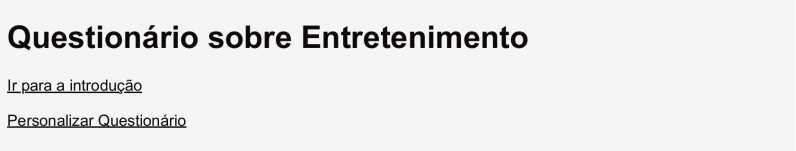


Figure 8.5: The "Customize Survey" ("Personalizar Questionário", in Portuguese) option brings up a pop-up window in which the user can update the checkbox selection previously made.

Additionally, in response to the comment made by one of the participants, the videos corresponding to answer options have been placed adjacent to them. However, this approach was not extended to the position of the remaining videos, as it was concluded that doing so would have a negative impact on the interaction experience with the tool. For example, given that questions can be accompanied by tips, it was concluded that placing the video adjacent to the question and the

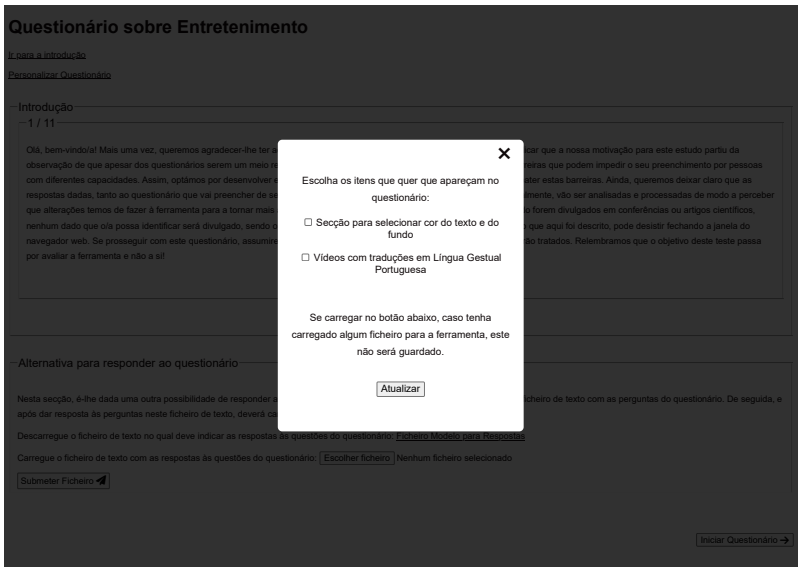


Figure 8.6: Personalization pop-up for the first page of the survey.

tip would be more confusing for the user understanding what the video is translating than placing it below these two elements.

When JavaScript is disabled, the section for selecting background and text colors is not available, and consequently, the corresponding checkbox is also absent.

8.3 Grouping of radio buttons and checkboxes

One of the participants noticed that in the questions to answer through radio buttons, these were not grouped together (i.e. role=“group”). Consequently, for each type of question whose answer is selected through radio buttons, the radio buttons are now grouped together inside an HTML div element containing the attribute “role” with the value “radiogroup”. Additionally, in the personalization section and for each question type whose answers are given via checkboxes, the checkboxes have been grouped inside an HTML div element containing the attribute “role” with the value “group”.

8.4 Fixing of buttons “broken” by the screen reader

One of the participants noted that the “Start Survey” and “Next” buttons were being “broken” when read by the screen reader. This situation resulted in the screen reader, for each button, transmitting the existence of two buttons instead of just one. Subsequent analysis of the HTML code of the tool revealed that this occurred due to improper placement of blank spaces in these buttons. This situation was fixed by removing these spaces.

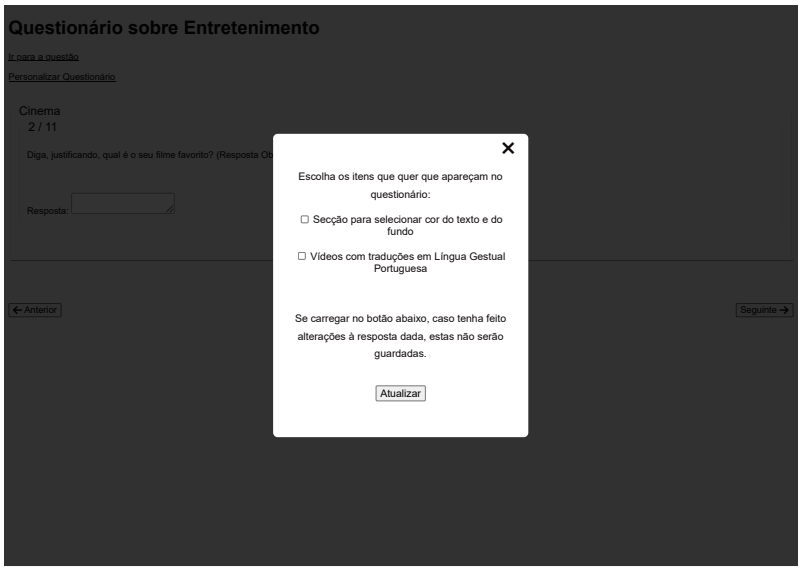


Figure 8.7: Personalization pop-up for the remaining pages of the survey.

8.5 Additional modifications

This section presents additional changes made to the processes of survey creation and completion.

8.5.1 Additional changes in the survey completion process

When implementing the above modifications, other problems were detected, requiring further adjustments to the tool.

Refinement of the validation performed in the alternative survey completion method

In its previous version, the validation process for survey responses, in particular when users are completing the survey via the alternative text file, was letting respondents submit the answers to the survey even if there were mandatory questions left unanswered. Considering this, the validation process was refined, and now if a user submits the file without answering the required questions, an error page is displayed, notifying them of the missing answers and prompting them to complete and resubmit the file (Figure 8.8).

Name change of the button to submit the survey identifier

The text of the submit button that is in the page where the survey identifier is indicated was “Submit Choice”. However, given that this designation can create confusion among users regarding where the button takes them, it was modified from “Submit Choice” to “Access the Survey”.

8.5.2 Additional changes in the survey creation process

Despite the fact that survey creators were not involved in the testing of the tool, discussions about the tool led to the conclusion that some aspects of the survey creation process could be improved.

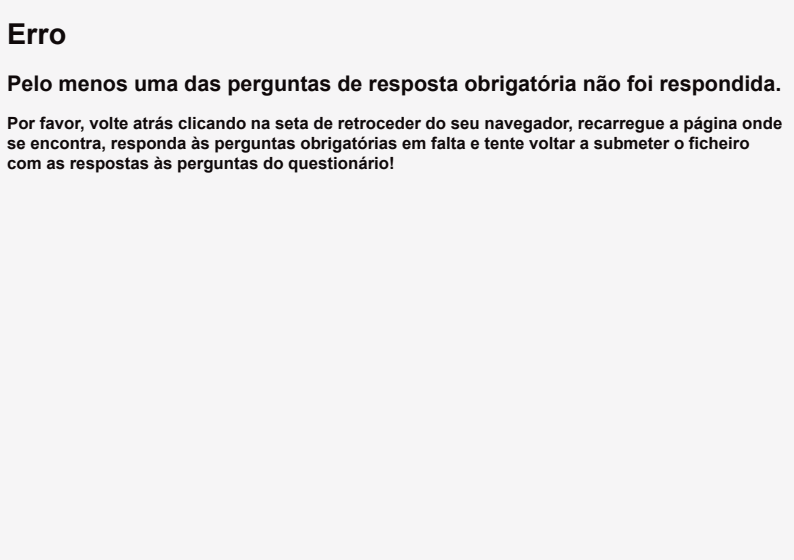


Figure 8.8: Error page returned when mandatory questions are left unanswered in the response file.

Change to the templates to indicate the survey questions

In the templates in which the survey creator indicates the survey questions, it was observed that the field "hotlink_", through which the creators enter a tip with additional information about a question, was not self-explanatory. As such, this field was renamed to "tip_". This change was performed in both txt and JSON templates.

Resolution of problems in completing surveys created through the template in JSON format

When performing final revisions to the survey creators and respondents workflows, it was discovered that there were problems accessing and completing surveys created through the JSON template. It was concluded that these were due to the improper use of a Python function in survey creation, which was substituted with the correct one. As such, now the tool enables, with no problems, survey creators to utilize the JSON template for survey creation, and respondents to answer these surveys.

8.6 Recommendations to create accessible surveys

In the previous chapter, it was decided that, based on the survey content findings, a set of recommendations for the construction of accessible surveys was going to be presented. It should be noted that these recommendations are directed to the survey creators so that they implement them during the survey content creation process, which is not within the control of the tool. The recommendations for creating accessible surveys are the following:

1. Avoid using ambiguous expressions in survey questions. For example, when asking the respondent to write their name, avoid using expressions such as "Say your name", but rather

use “Indicate your name”, to more inclusively express the action that the respondent has to perform;

2. Avoid collecting sensitive information from respondents unless it is strictly necessary for the study;

3. Avoid using expressions where special characters separate words, such as “Which one/ones” or “Mr./Mrs.”, as these may not be correctly interpreted by people with cognitive and learning disabilities (due to the potential complexity of these expressions), people with hearing disabilities (who have difficulty comprehending written language), and screen readers;

4. Avoid using complex terms or terms in other languages. If their use is unavoidable, provide explanations about them;

5. Do not use offensive or ableist terms;

6. The introductory text to the survey should contain all the necessary information for the respondent, namely: motivation and objectives of the study, how the respondent’s data will be processed and their confidentiality ensured, and also what the respondent’s rights are;

7. When using scale (e.g., Not Fond, Moderately Fond, Very Fond) for responses, prioritize common and easy-to-understand terminology.

These recommendations can be accessed through the link “Recommendations for constructing accessible surveys” (“Recomendações para a construção de questionários acessíveis”, in Portuguese) present in the page to upload the template filled with the survey questions (Figure 8.9) .

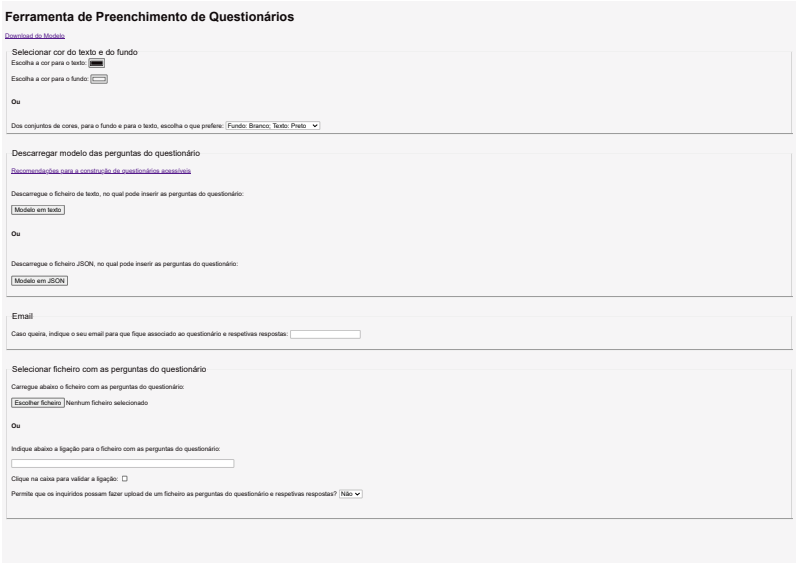


Figure 8.9: Page with the link to the “Recommendations for constructing accessible surveys” (“Recomendações para a construção de questionários acessíveis”, in Portuguese)

8.7 Discussion

Considering the information presented in the preceding sections, it is possible to state the following:

Survey submission: The modifications to the submission process included: relocation of one of the submission buttons to a position where users most probably expect to find it, which results in reinforcement of compliance with the WCAG 2.2 SC 3.2.3 Consistent Navigation; incorporation of a pop-up confirmation of the action to be performed when these buttons are pressed, to avoid unintentional submissions, which results in reinforcement of compliance with the WCAG 2.2 SC 3.3.6 Error Prevention (All); and placement of an icon representing a send arrow in these buttons to better describe their function, which results in reinforcement of compliance with the WCAG 2.2 SC 3.2.4 Consistent Identification.

Survey personalization: The personalization section allows users to select only the features, section for selecting the text and background colors or the videos in Portuguese sign language, that are relevant for them to have during survey completion, with the possibility of changing features' selection at any time during completion.

Grouping of radio buttons and checkboxes: The placement of related radio buttons in a HTML div element with role="radiogroup", helps screen reader users better understand that they can only select one of the radio buttons. Similarly, checkboxes were also grouped in HTML div elements, but was used the role="group" to better indicate that the checkboxes are related. These groupings contribute to reinforce the compliance with the WCAG 2.2 SC 1.3.1 Info and Relationships.

Fixing of buttons "broken" by the screen reader: The removal of improperly placed blank spaces that were causing the "Start Survey" and "Next" buttons being "broken" when read by the screen reader, contribute to the tool compliance with the requirement 3.1 (i.e., Ensure compatibility with assistive technologies) and with the WCAG 2.2 SC 4.1.2 Name, Role, Value.

Additional changes in the survey completion process:

- The refinement of the validation performed in the alternative survey completion method, hinders users from submitting the answers to the survey without answering all mandatory questions. This modification contributes to reinforce the tool compliance with the requirements 9.1 and 9.2, as in this validation it is employed a joint effort from client-side and server-side to return, if necessary, an error page informing the user about the existence of mandatory questions not answered in the file uploaded with the survey answers and explaining how to correct this situation. Since these two requirements are based in the WCAG 2.2 SC 3.3.1 Error Identification, 3.3.2 Labels or Instructions and 3.3.6 Error Prevention (All), compliance with these success criteria is also reinforced.

- The name change of the button to submit the survey identifier from "Submit Choice" to "Access the Survey", makes it easier for respondents to know where the button takes them. This change is compliant with the WCAG 2.2 SC 2.4.4 Link Purpose (In Context). Also,

compliance is reinforced with the requirement 6.1, as it is now employed a non-confusing term, and, consequently, with the WCAG 2.2 SC 3.1.5 Reading Level.

Additional changes in the survey creation process:

- The name change of the field "hotlink_" to "tip_" contributes to better explain what information should be provided in that field. This change reinforces the compliance of the tool with the WCAG 2.2 SC 3.3.2 Labels or Instructions. Additionally, there is also reinforcement of compliance with the requirement 6.1, as it is now employed a non-confusing term, and, consequently, with the WCAG 2.2 SC 3.1.5 Reading Level.
- The problems in completing surveys created through the template in JSON format were solved. After replacing a Python function, incorrectly being used, with the correct one, creators now can create surveys through the JSON template and respondents can answer them.

Recommendations to create accessible surveys: These recommendations are available to the survey creators so that they implement them during the survey content creation process. These recommendations promote compliance of the survey content with the requirements 6.1 (Recommendations 3.,4.,7.), 6.5 (Recommendation 1.), 8.2 (Recommendation 5.), 11.4 (Recommendation 6.). Consequently, compliance with the WCAG 2.2 SC 3.1.5 Reading Level is also promoted.

8.7.1 Refinements not performed to the tool

In the refinements made to the tool, the features whose problems detected or changes suggested had greater impact on the tool's accessibility and were related to more than one participant, were prioritized in relation to those that did not met both criteria. As a consequence, some of the problems detected or changes suggested were not properly or at all addressed in the refinement.

Missing HTML headings: One of the participants suggested that H1 heading should be for the survey title, H2 heading for the group each question belongs to, the introduction section title and the title of the section with an alternative method for responding, and H3 heading for the question itself. In the tool, only the H1 heading was assigned to the survey title, so there is no full compliance with WCAG 2.2 SC 2.4.6 Headings and Labels. However, if the respondent wishes to go more quickly to the section where the survey introduction is (if they are on the first page of the survey) or to the section where the question is (if they are in one of the remaining pages of the survey), they can use the quick access link at the top of the page.

Associate the question with the field for giving the response: One of the participants mentioned that this should be done so that the question can be heard by the respondents when they go to the field (or group of fields) to give their answer. However, this was not implemented in the refinement of the tool. Since the questions can be accompanied by tips, there was uncertainty regarding whether it would be beneficial for the respondent to also hear the tip in this scenario. If they could also hear the tip, this could potentially result in the respondents being exposed to more

information than they wanted, as they would be required to listen both the question and the tip again. Conversely, the exclusion of the tip could potentially result in the loss of this information by repeating the question and not the tip. Therefore, it will not be considered non-compliance with WCAG 2.2 SC 3.3.2 Labels or Instructions.

Answer options and answer fields need to be highlighted in the alternative method for responding to the survey: When observing the interaction of one of the participants with the alternative method of answering the survey, it became clear that the answer options and the fields to answer the questions needed to be highlighted in the text file. However, due to the prioritization of other problems detected and changes suggested, this was not addressed in the refinement of the tool. Future work should therefore focus on highlighting these elements.

Unexpected navigation when the "enter" key is pressed: In the tool, pressing the "enter" key within the field to give the answer takes the user to the previous page of the survey, instead of the next page. In the development of the tool, to ensure compliance with requirement 2.1, focus was given to the navigation throughout the survey with the "Back" and "Next" buttons (except on the error pages, where the instructions described should be followed). Thus, there is no full compliance with WCAG 2.2 SC 3.2.3 Consistent Navigation. Therefore, recognizing the usefulness of moving between questions by pressing the "enter" key, future work should focus on this aspect.

Alternative mode for interacting with the survey when it is completed within the tool itself not implemented: This alternative mode, suggested by one participant, consists in the respondent listening to the question and the answer options, with each option corresponding to a letter. Then, presses a letter corresponding to the intended answer and, finally, the "enter" or the "space bar" keys to move forward. In consequence of the prioritizations made, this alternative mode was not implemented in the tool refinement. As such, future work should focus on evaluating the accessibility and usability of this approach and, based on the results, decide whether to implement it or not.

Screen reader reading the question from the middle: One of the participants mentioned that, for some questions, when going from one question to the other, the screen reader started reading from the middle of the question. Despite the prioritizations performed, efforts were made to understand the cause of this situation and how to resolve it. However, none of the attempts made was effective. Consequently, it is not possible to state that the tool is fully compliant with the requirement 3.1 and with the WCAG 2.2 SC 4.1.2 Name, Role, Value.

It should be acknowledged that, since there is no full compliance with all WCAG 2.2 success criteria, the same applies for the requirement 11.2 (i.e., The tool built must comply with the accessibility guidelines and legislation considered).

8.7.2 Final considerations

Finally, it should be noted that the refinement of the tool was not straightforward, as it was challenging to take into account the different, sometimes conflicting, needs of users. To overcome

this, it was observed that a suitable approach is to empower users with the means to adapt the tool to their specific requirements. An example of the application of this approach is the personalization section that has been incorporated into the tool, which enables users to select the elements needed when completing the survey. In the next chapter, a more comprehensive discussion of this approach will be done.

Chapter 9

Discussion

This chapter presents a discussion of the work conducted, from requirements gathering to tool refinement, elucidating the outcomes of each phase and their impact on subsequent ones. Furthermore, the chapter explores how allowing survey interfaces to be personalized can enhance accessibility. To support this discussion, examples from existing literature on personalization are presented. Finally, there is a discussion regarding limitations of the work conducted and potential directions for future work.

9.1 Discussion of the work conducted

The contributions of this dissertation consist of the following: (1) Developing a comprehensive list of requirements for creating accessible surveys; (2) Building a survey completion tool that meets these accessibility requirements; (3) Identification of functionalities that promote accessibility in surveys and those that hinder it; and, (4) A set of recommendations to promote the accessibility of survey content.

To this end, a literature review was first conducted, in which 12 articles were analyzed based on the types of disability addressed, materials covered, testing methodologies employed, and reported outcomes. Based on this analysis, 47 accessibility requirements were gathered, which are presented in the Appendix. These requirements were categorized into 12 themes: Prefaces and context; Navigability; Assistance tools; Audio; Graphics; Clarity and visual adjustments of text; Types of questions; Minimize external influences; Error handling; Internationalization; Data protection, privacy and conformance with accessibility guidelines and legislation; Accessible informed consent.

These requirements informed the development of a survey completion tool designed to support two user roles: survey creators and respondents. Survey creators can design surveys with various question types, which can be accompanied by videos, audio, or images. Additionally, creators can also access the responses collected after prior authentication. Respondents can complete surveys directly within the tool or by uploading a text file with the answers. An analysis to the tool developed revealed that the requirement 10.1 (Implement mechanisms to promote the internationalization of tools developed) was not implemented because, in anticipation of the execution

of tests with Portuguese participants, the tool development ended up focusing on two languages: Portuguese and Portuguese sign language.

Following the development of the survey completion tool, tests were conducted with people with different abilities. During these tests, participants' demographic data was collected, as well as observational notes on their interaction with the tool and the comments they made during this process. Additionally, post-test interviews provided further insights into participants' perspectives on the accessibility of the tool.

The analysis of the data collected during the tests revealed both issues and suggested improvements, as well as positive aspects. These were divided according to whether they concerned tool findings or survey content findings.

Tool findings

Problems detected and WCAG 2.2 SC compliance

The tool findings revealed that the main problems identified were related to difficulties in locating the button to submit survey responses and lack of intuitiveness and impractical positioning of videos with Portuguese Sign Language translations. Such problems implied the tool's non-compliance with the success criteria 3.2.3 Consistent Navigation and 3.3.6 Error Prevention (All) of WCAG 2.2. However, subsequent refinements to these features culminated in the tool reinforcing compliance these success criteria.

In addition, other problems were detected such as: (1) missing HTML headings, (2) buttons being "broken" by the screen reader, (3) associate the question with the field for giving the response, (4) answer options and answer fields need to be highlighted in the alternative method for responding to the survey, (5) radio buttons not grouped, (6) screen reader reading the question from the middle and (7) unexpected navigation when the "enter" key is pressed.

Such problems point to the tool's non-compliance with the WCAG 2.2 SC 2.4.6 Headings and Labels (Problem (1)); 4.1.2 Name, Role, Value (Problems (2) and (6)); 3.3.2 Labels or Instructions (Problem (3)); 1.3.1 Info and Relationships (Problem (5)); 3.2.3 Consistent Navigation (Problem (7)).

In the refinements performed to the tool, the problems (2) and (5) were addressed, making the tool now comply with the success criteria 1.3.1 Info and Relationships and 4.1.2 Name, Role, Value. However, the problem (6), despite being considered in the refinement, it was not possible to discover the cause of its existence and how to solve it, making the tool not fully compliant with the success criteria 4.1.2 Name, Role, Value and with the requirement 3.1. For each of the remaining problems, it was performed a reflection on their impact on the tool, concluding that the tool is not fully compliant with the success criteria 2.4.6 Headings and Labels and 3.2.3 Consistent Navigation.

Additionally, it should be noted that, in the refinement of the tool, other problems were detected in the survey creation and completion processes, resulting in further refinements to the tool, such as: Refinement of the validation performed in the alternative survey completion method; Name change of the button to submit the survey identifier; Change to the templates to indicate

the survey questions. These changes reinforce compliance with the requirements 6.1, 9.1 and 9.2 and with the WCAG 2.2 SC 2.4.4 Link Purpose (In Context), 3.1.5 Reading Level, 3.3.1 Error Identification, 3.3.2 Labels or Instructions, 3.3.6 Error Prevention (All).

Finally, as previously stated, since there is no full compliance with all WCAG 2.2 success criteria, this also applies to requirement 11.2 (i.e., the tool built must comply with the accessibility guidelines and legislation considered).

Changes suggested

In terms of suggestions for changes, the tool findings revealed that more than one participant made suggestions on how the text and background color selection section should appear in the tool. In addition, there were also other suggestions for changes such as: alert the respondent about the presence of checkboxes or radio buttons, allow different survey views, and implementation of an alternative mode for interacting with the survey when it is completed within the tool itself. From these, only the latter was not implemented in the tool, and as such future work should focus in evaluating the accessibility and usability of this alternative method, to decide if it should be implemented or not.

Positive aspects denoted

Additionally, several positive aspects of the tool were noted, such as the one-question-per-page format, the presence of videos in Portuguese Sign Language, as well as the clearness of its content, and the alternative survey completion method.

Survey content findings

The survey content findings revealed that three participants found the questions clear, objective, and correctly worded. However, during the tests, it was observed that three participants misunderstood some survey questions. Moreover, the other four participants, despite some difficulties and doubts exposed about some questions, revealed an overall good understanding of the questions.

It should be acknowledged that the difficulties found stemmed from survey design choices made by the creator rather than accessibility limitations within the tool itself.

Finally, considering these findings, and to better inform the construction of surveys whose content is accessible to people with different abilities, a list of recommendations for the construction of accessible surveys was built. These recommendations promote compliance of the survey content with the requirements 6.1, 6.5, 8.2 and 11.4, and with the WCAG 2.2 SC 3.1.5 Reading Level.

Discussion of the findings

Considering the findings above described, the following can be concluded.

As previously mentioned, the tool does not fully comply with the requirements 3.1 and 11.2, due to lapses made during its construction, and does not comply with the requirement 10.1, in anticipation of the execution of tests with Portuguese participants. However, this does not invalidate the fact that the list of requirements, informed by previous research, serves as a comprehensive guide for promoting enhanced inclusion and accessibility for people with diverse abilities in sur-

veys completion. This allows as many individuals as possible to have the equal opportunity to express their perspectives on subjects that align with their interests. It should be noted, however, that the list of requirements presented is intended to be incremental and non-exhaustive, deliberately leaving room for future enhancements and refinements, aligning it with evolving accessibility standards and emerging technologies.

Additionally, the tests revealed various problems and change suggestions to the survey completion tool, from which the majority were addressed in the tool refinement. Despite this, the tool proved to be, in a general way, an accessible means for users with diverse abilities to complete surveys. This is evidenced by the observation of the participants which indicated that the majority of them demonstrated a correct comprehension of the questions and answer options. Also, three participants reported having no difficulty completing the survey using the tool.

This work presents a survey completion tool in which most of the requirements gathered were implemented, these being reflective of the accessibility needs of users with diverse types of disabilities. This constitutes an advancement in relation to the studies presented in the related work, as only four of them [16, 20, 34, 75] focus on people with disabilities in general, and of these, none of them encompasses the construction of a survey completion tool.

However, this work is analogous to previous ones as the tool built incorporates accessibility requirements and guidelines from the literature, WCAG, and feedback given by people from the target audience. Similarly, it was performed the evaluation of the accessibility of the tool built with people with disabilities.

Finally, it is believed that the work presented provides a solid foundation for future development, particularly in creating more inclusive survey platforms.

9.2 Personalization in surveys

During the execution of the aforementioned work, it became evident that addressing the diverse and sometimes conflicting accessibility needs of users with different abilities poses a significant challenge.

For instance, this study identified two main situations: the section for choosing the color of the text and background, and the videos in Portuguese sign language. While these functionalities may prove beneficial to some users, they may also present barriers to others, depending on their specific needs and preferences.

To address these conflicts, the chosen solution involved providing users with the autonomy to select which functionalities, either the section for choosing the color of the text and background or the videos in Portuguese Sign Language, they preferred to have enabled while completing the survey.

During implementation, it became clear that this approach could be extended to better accommodate the diverse accessibility needs of users with different abilities. By providing users control over the interface, that is, allowing them to enable or disable specific functionalities based on their preferences, the tool becomes more streamlined, accessible, and user-friendly.

It is also believed that this finding has the potential to promote the development of survey tools that support a broader range of disabilities, since only two studies reviewed in the related work, namely [34, 75] focused on survey creation tools directed to people with disabilities in general. A personalization-based approach offers the flexibility to support multiple user needs within a single tool.

To better support this approach, a review of the literature on personalization was performed. In this review, it was observed that the concept of personalization has been explored, reinforcing its relevance and potential as a strategy for improving accessibility.

For instance, [45] identified four design objectives to enable visually disabled users to customize visualizations accessible through screen readers. These objectives are: "presence, what content is included; verbosity, how concisely content is presented; ordering, how content is sequenced; and, duration, how long customizations remains active" [45]. The authors then developed a conceptual model of customization based on individual adjustable tokens (e.g., tokens could be activated or deactivated, or reordered), which they instantiate by extending an open-source accessible visualization toolkit. The tool was tested with people with visual disabilities, and the results showed that it improved access to the information users wanted to consult. However, [45] also observed that the tool posed greater challenge for participants with no prior experience using navigable hierarchies or customizable accessibility tools.

In a separate study, [69] proposed guidelines for designing digital teaching tools accessible to students with cortical/cerebral visual disabilities. To this end, the authors conducted 20 interviews with teachers working with students with this type of disability. Based on the insights gathered, they developed design guidelines that advocate for personalization options such as adjusting color, spacing, size, movement, and style of all text, objects, and animations. They also recommend the ability to (1) turn off audio for individual parts of an activity that may be distracting or overwhelming; (2) adjust tone for students sensitive to certain sounds; and (3) control the speed and timing of audio to assist students with slower visual latency [69]. One limitation of this study is its geographical scope, as the findings are based solely on interviews with teachers in the United States.

Additionally, [82] developed an adaptive UI/UX framework for mobile applications, composed of five key components: a user profile module, a context-aware adaptation design, a personalized interface generator, a user engagement metrics tracker, and a data management system. The user profile module creates and maintains user profiles while the context-aware adaptation component determines suitable strategies based on contextual inputs. The personalized interface generator uses these inputs to create personalized layouts and content. The user engagement metrics tracker collects feedback on interactions with these personalized interfaces. The data management system connects to all the other components and maintains data such as user data, interaction logs, and system settings. According to the authors, this framework benefits users by offering personalized interfaces that "improve usability, reduce cognitive load, and enhance overall satisfaction with mobile applications", while also supporting developers by providing insights that inform more ef-

fective design strategies and optimization techniques [82]. The findings of the study, based on user tests, demonstrated that the framework enhanced user task completion rates and user engagement. However, this study did not completely address the challenges of designing for users with specific accessibility needs.

In light of this, the concept of interface personalization emerges as a strategy for addressing diverse user needs, with the potential to be extended to users with disabilities. This reinforces the earlier argument in favor of enabling users with disabilities to personalize their survey interface. Nonetheless, when implementing personalization features it is important to consider that they introduce additional complexity and tend to offer more benefits to users who are already familiar with the type of application they are interacting with [45]. Moreover, users may encounter challenges in making the optimal choices when confronted with too many personalization options [69].

9.3 Final considerations

Based on the information described above, the following conclusions can be drawn regarding limitations and potential future developments.

9.3.1 Addressing the remaining problems detected and suggested changes

As noted above, in the refinement of the tool, the problems detected and changes suggested in the tests were not all addressed. This results in the tool not being fully compliant with all WCAG 2.2 SC and requirements gathered. Therefore, future work should focus on addressing the remaining points before retesting the tool with people with disabilities.

9.3.2 Internationalization of the tool developed

Anticipating the execution of tests with Portuguese participants, the tool development ended up focusing on two languages: Portuguese and Portuguese sign language. As such there is no compliance with the requirement 10.1.

That said, future work should focus on internationalizing the tool developed, i.e., enabling the tool to be and support content in various languages.

9.3.3 Evaluation of the tool's accessibility with a larger sample of participants

The evaluation of the tool was conducted with a small sample of participants, given that this prototype is at an initial stage of development of exploratory nature. Such situation makes it difficult to generalize of the results obtained.

Therefore, in future tests conducted following additional refinement of this tool, it is recommended to perform them with a larger sample of people with disabilities. These tests may reveal problems and suggestions for improvements that were not identified in the previous tests, or, having been identified, were not addressed in the refinements performed.

9.3.4 Further evaluation of the accessibility and usability of personalization features

Although the concept of allowing users with disabilities to personalize the survey interface was considered promising - both through the analyses carried out and the literature reviewed - this feature was not fully tested with people with disabilities. Consequently, the effectiveness of this approach cannot be assured.

As such, the concept of personalization should be included in the interview guides of future tests, inviting participants to share their perspectives on the usefulness and accessibility of customizing features. Other personalization features should also be explored, such as hiding and showing images. In addition, future testing should serve as basis for further discussion on the use personalization features for supporting users with contrasting accessibility needs.

9.3.5 Updating the list of requirements

The list of requirements was created based on articles published up to 2023. Consequently, it does not encompass potential requirements from studies published after that period.

As such, future work should also focus in updating the list of requirements for building accessible surveys. As previously stated, this list is designed to be incremental and non-exhaustive, aligning it to evolving accessibility standards and emerging technologies.

For instance, recent studies have suggested two new additional requirements concerning other types of questions. One of the requirements consists of allowing respondents to answer open-ended questions by uploading a text, audio, or video file [20]. The other one consists of enabling respondents to add their own answer option in closed-ended questions, offering more flexibility in their response [16].

9.3.6 Test survey authoring by creators with disabilities

Another potential direction for future work is testing the creation of surveys in the tool by people with disabilities.

If this creation process reveals accessibility issues, a possible alternative would be to allow the creation of the surveys exclusively within the tool itself. More specifically, in the page for survey creation, the creator would press a button which would generate a section containing the fields “question”, “introduction”, “type”, “option”, “mandatory”, “multimedia”, “group”, and “tip” (as in the templates now in use), in which:

- The “question”, “introduction”, “group” and “tip” fields would be each accompanied by text box in which the respective value would have to be entered.
- For the “type” and “mandatory” fields, radio buttons or drop-down lists could be employed, given that the values of these fields can only be selected from predetermined sets.
- In the case of the “option” field, the indication of answer options would depend on the type of question. For example, for the question type “choose one of the digital images”, it

could appear a button which would have to be pressed to generate as many text boxes as the number of answer options to the question.

- For the "multimedia" field, the interface would place three text boxes adjacent to the question and for each of the answer options to indicate the links to the videos, audios or images, respectively. However, the presence of these text boxes would be dependent on the type of question.

It should be noted that the button for generating the section would have to be pressed as many times as the number of questions in the survey.

Then, as already occurs, the creator would submit the survey and, finally, obtain a text file containing a password that allows access to the answers given to the survey and the survey identifier to be distributed to respondents.

9.3.7 Lessons that can be generalized to other types of interfaces

While the primary focus of this study is the accessibility of surveys for people with disabilities, some of the insights gained can be applied to the design of other types of interfaces as well:

- The process of requirements gathering should be informed by prior work within the context in which the interface will be developed, as well as by the target users to whom the interface is intended.

- In the interface development, the use of tools to assess adherence to accessibility guidelines and legislation is an helpful strategy to ensure compliance with them. In addition, a non-JavaScript version of the interface should be available for users of assistive technologies that do not support JavaScript.

- Conducting user testing is imperative for evaluating the interface's accessibility and identifying requirements that have been correctly implemented, or that the way they were implemented in the tool results in interaction problems with it, or that were not previously considered.

Additionally, it should be noted that the requirements identified in this study can be applied in other interfaces, including those where survey completion is not the primary focus, promoting their accessibility. Also, the problems identified, changes proposed, and positive aspects noted in this tool, through the tests, can also serve as requirements for the construction of other interfaces.

Chapter 10

Conclusion

Nowadays, surveys have become an essential means for gathering information. These are used by organizations such as companies, researchers, and governments to better understand the impact of different scenarios (e.g., pandemics) on the services they provide. However, despite their notable importance, surveys still present barriers that can prevent people with disabilities from completing them.

Considering this, throughout this dissertation, we aimed to answer the following research questions:

- RQ1: What are the key requirements identified in the literature for designing a survey completion tool accessible to people with disabilities?
- RQ2: Which features of a survey tool support or make difficult the interaction of people with disabilities with online surveys?

To answer these questions, the first step was to identify requirements in the literature for designing accessible digital surveys for people with disabilities, employing a snowballing research methodology. This process resulted in a list of 47 requirements, presented in Appendix.

These requirements were then implemented in a prototype of a survey completion tool. The prototype is a web application, developed with a Python back-end using the Django framework, and a front-end using HTML, JavaScript, and CSS. It includes a section, available when JavaScript is enabled, that allows users to customize the color of the text and background. Additionally, the tool includes Portuguese Sign Language videos translating its native content and supports for creators to add videos with translations of questions and answer options in this language. The tool supports two types of users: survey creators and respondents.

Following the development of the tool, tests were conducted with people with disabilities. These tests began with demographic questions regarding participants' age, type of disability, technology use, assistive tools, and prior experience with online surveys. Afterward, participants were asked to complete a survey and, then, were interviewed to collect feedback on the tool's accessibility.

The analysis of the tests' data revealed both issues and suggested improvements, as well as

positive aspects. These were divided according to whether they concerned survey content findings or tool findings.

The survey content findings revealed that three of the participants found the questions to be clear, objective, and correctly worded. Also, these findings revealed some interpretation problems and doubts related to some of the questions. Based on this data, a set of recommendations for the construction of accessible surveys was built.

The tool findings revealed a set of problems (e.g., difficulty locating the submission button), which implied non-compliance with some of the WCAG 2.2 SC (i.e., 3.2.3 Consistent Navigation, 3.3.6 Error Prevention (All), 2.4.6 Headings and Labels, 4.1.2 Name, Role, Value, 3.3.2 Labels or Instructions, 1.3.1 Info and Relationships) and requirements gathered (i.e., 3.1 and 11.2). Also, these results revealed suggested improvements (e.g., limiting color customization section to the first page), and positive aspects (e.g., use of the one-question-per-page format) pointed out to the tool.

Considering these findings, the tool was then refined to enhance its accessibility. These refinements included addressing issues in locating the submission buttons and preventing accidental submissions, introducing customization options for accessibility features, grouping of radio buttons and of checkboxes, fixing of buttons "broken" by the screen reader and additional refinements performed in the survey completion and creation processes. The refinements contributed to the tool now being compliant with most of the WCAG 2.2 SC, but not fully compliant with the success criteria 4.1.2 Name, Role, Value, 2.4.6 Headings and Labels and 3.2.3 Consistent Navigation and with the requirements 3.1 and 11.2.

Following this, a discussion was presented, reviewing the process from requirements gathering to tool refinement, and highlighting how earlier phases informed subsequent ones. Key takeaways include:

- Despite the fact that the tool does not fully comply with the requirements 3.1 and 11.2 and does not comply with the requirement 10.1, the list of requirements serves as a guide to promote inclusion and accessibility in survey design. This list is intended to be incremental and non-exhaustive, encouraging ongoing refinement and expansion as technologies and accessibility standards evolve.

- Despite the various problems and change suggestions to the survey completion tool, it proved to be, in a general way, accessible to people with diverse abilities. This finding is corroborated by the observation of the participants and by their statements. This tool also constitutes an advancement in relation to other tools presented in the related work, as it is a survey completion tool in which requirements were implemented that reflect the accessibility needs of users with different types of disabilities.

- Allowing users to personalize the survey interface, by choosing which functionalities are available during survey completion, can lead to more streamlined, accessible, and user-friendly interfaces. This aligns with existing research from which interface personalization

comes up as a strategy to meet users' diverse needs.

10.1 Limitations

As previously noted there are some limitations associated with the work performed.

Primarily, not all the problems detected and changes suggested in the tests were addressed in the tool refinement, which makes it not possible to claim full compliance with all WCAG 2.2 SC and requirements gathered.

Secondly, the tool was evaluated with a small sample of participants, due to the fact that the present prototype is at an initial stage of development of exploratory nature. However, this fact detracts from the generalization of the results obtained.

Additionally, the list of requirements was created based on articles published up to 2023. Consequently, it does not encompass potential requirements from subsequent studies.

Moreover, the tool development focused on two languages: Portuguese and Portuguese sign language. As such, since the tool does not support other languages, there is no compliance with the requirement 10.1.

Also, although the concept of enabling people with disabilities to personalize the survey interface was considered promising based on the analyses performed, such was not fully evaluated with people with disabilities. Therefore, the effectiveness of this approach cannot be guaranteed.

Finally, the process for creating surveys in the tool was not tested by people with disabilities.

10.2 Future work

Given the information above described, several directions for future work emerged.

Future work should begin by addressing the remaining problems detected and changes suggested in the tests performed. After this, the refined survey completion tool must be tested with a larger sample of participants. These tests may reveal or highlight issues and suggestions for improvements to the tool.

In addition, the personalization concept should be included in the interview guides of future tests, so that participants can share their perspectives on the usefulness and accessibility of personalization features. New personalization features should be explored as well, such as hiding and showing images. Also, the future tests should serve as a basis to discuss the use personalization features for handling contrasting accessibility needs.

Moreover, future work should also focus on refining the tool to support more languages, and thus ensure compliance with requirement 10.1.

Another important step is updating the list of requirements for building accessible surveys. As previously stated, this list is based on articles published until 2023. Also, it is designed to be incremental and non-exhaustive. As already discussed, recent studies have suggested two new additional requirements, namely, allowing respondents to answer open-ended questions by uploading a text, audio, or video file [20] and enabling respondents to add their own answer option

in closed-ended questions [16].

Additionally, a potential direction for future work is testing the creation of surveys in the tool by creators with disabilities. If this creation process reveals accessibility issues, a possible alternative would be to allow the creation of the surveys exclusively within the tool itself.

Furthermore, lessons learned throughout this study can be extended for other types of interfaces (e.g., use of tools to assess adherence to accessibility guidelines and legislation is an helpful strategy to ensure compliance with them). Also, the requirements gathered and the problems detected, changes suggested and positive aspects denoted during the tests can serve as requirements for the construction of other interfaces, promoting their accessibility.

Ensuring the inclusion and accessibility of people with disabilities in survey participation is a continuous effort that must not be overlooked. It is essential to ensure that all individuals have equal opportunities to express their opinions on subjects that matter to them.

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Appendix A

Requirements table

Requirements	Target Audience[1]	Feedback	Associated WCAG SC
1. Prefaces and context			
1.1. Legends should be located above the fields [36].	Visual disabilities [36]	Positive direct [36]	2.4.6 Headings and Labels
1.2. Use `<fieldset>` to group related fields and `<legend>` to identify the group of fields [36].	Visual disabilities [36]	Positive direct [36]	1.3.1 Info and Relationships; 3.3.2 Labels or Instructions
1.3. Invalid data should be visible on the error page, and valid data should be summarized with the possibility to edit it if necessary [24, 36, 67].	Visual disabilities [36, 67] and Cognitive and learning disabilities [24].	Positive direct [24, 36, 67]	3.3.6 Error Prevention (All)
1.4. General instructions should be placed at the top of the forms and instructions for each field should be placed throughout [36, 56, 59, 68, 75].	Visual disabilities [36]; Disabilities in general [75] and Cognitive and learning disabilities [56, 59, 68]	Positive direct [36, 56, 59]; Potential [75]; Positive indirect [68]	3.3.2 Labels or Instructions
1.5. Implement a progress indicator so that the participants can know where they are in the survey [75].	Disabilities in general [75]	Positive direct [75]	2.2.2 Pause, Stop, Hide; 2.4.8 Location
1.6. Use answer options consistently between similar questions [51, 55].	Hearing disabilities [51] and Cognitive and learning disabilities [55]	Potential [51]; Positive direct [55]	1.3.2 Meaningful Sequence; 3.2.4 Consistent Identification
2. Navigability			

[1]Target audience, in this article, refers to the people with a certain type of disability that tested these materials.

2.1. Include buttons to move between questions (“Back” and “Next”) [24, 68, 70].	Cognitive and learning disabilities [24, 68, 70]	Potential [68]; Positive direct [24, 70]	3.2.3 Consistent Navigation
2.2. Implement a mechanism so that, in mandatory questions, the button to move to the next question only appears once the current question has been answered[24, 70].	Cognitive and learning disabilities [24, 70]	Positive direct [24, 70]	3.3.6 Error Prevention (All)
2.3. Implement the “Toggle Switch” mechanism so that: A user can deselect an answer by clicking a second time on the box referring to it (“check” disappears from that box); A user can change the answer by clicking on the box referring to the desired answer (“check” would appear in that box), this for questions with only one answer option [24, 68, 70].	Cognitive and learning disabilities [24, 68, 70]	Positive direct [24, 70]; Positive indirect [68]	Not applicable
2.4. Align fields of a form in a single column to ensure that users do not misinterpret fields because of the linear nature of the screen reader [36].	Visual disabilities [36]	Positive direct [36]	1.4.8 Visual Presentation
3. Assistance tools			
3.1. Ensure compatibility with assistive technologies (e.g. screen readers or screen magnifiers) [67].	Visual disabilities [67]	Positive indirect [67]	4.1.2 Name, Role, Value
3.2. Allow the survey to be completed by uploading an external file with the necessary information [36].	Visual disabilities [36]	Potential [36]	2.5.6 Concurrent Input Mechanisms
3.3. Place buttons below questions that present them in other words, via audio [55, 56, 59, 68].	Cognitive and learning disabilities [55, 56, 59, 68]	Positive indirect [68]; Positive direct [55, 56, 59]	3.1.3 Unusual Words
3.4 Implement read-aloud functionalities in surveys [24, 38, 55, 56, 68, 70, 75].	Cognitive and learning disabilities [24, 38, 55, 56, 68, 70] and Disabilities in general [75]	Positive direct [24, 38, 55, 56, 70, 75]; Positive indirect [68]	Not applicable
4. Audios			
4.1. Use recorded voice instead of synthesized voice so that audio can be more understandable [24].	Cognitive and learning disabilities [24]	Positive direct [24]	Not applicable
5. Graphics			
5.1. Include alternative text on images [67].	Visual disabilities [67]	Positive direct [67]	1.1.1 Non-text Content
6. Clarity and visual adjustments of text			

6.1. Avoid using complex language, confusing terms or figures of speech and employ more direct terms [38, 51, 55, 56, 59, 68, 75].	Cognitive and learning disabilities [38, 55, 56, 59, 68]; Disabilities in general [75] and Hearing disabilities [51]	Positive direct [38, 55, 56, 59, 75]; Positive indirect [51, 68]	3.1.5 Reading Level
6.2. Explicit content direction and language in the <HTML> element [36].	Visual disabilities [36]	Positive direct [36]	3.1.1 Language of Page
6.3. Use a Sans Serif font family, with a size of 12 points for texts in alphabetic writing systems (e.g. English) and a size of 14 points for texts in complex writing systems (e.g. Arabic) [36].	Visual disabilities [36]	Potential [36]	Not applicable
6.4. Use a contrast ratio of 7:1 for normal-sized text, and a contrast ratio of 4.5:1 for larger text, both in relation to the background [36, 67].	Visual disabilities [36, 67]	Potential [36]; Positive direct [67]	1.4.6 Contrast (Enhanced)
6.5. Make questions more specific, avoiding ambiguity [51, 75].	Disabilities in general [75] and Hearing Disabilities [51]	Positive direct [75]; Positive indirect [51]	Not applicable
7. Types of questions			
7.1. Use questions such as "Choose between digital images (single choice questions)" [59, 70].	Cognitive and learning disabilities [59, 70]	Positive indirect [70]; Positive direct [59]	Not applicable
7.2. Enable the provision of a written version of each question and answer options translated into sign language [51].	Hearing disabilities [51]	Potential [51]	Not applicable
7.3. Use numerical scales on questions where the user must answer according to scale [51].	Hearing disabilities [51]	Positive indirect [51]	Not applicable
7.4. Use questions that incorporate images paired with numerical scales as visual aids [24, 51].	Hearing disabilities [51] and Cognitive and learning disabilities [24].	Positive indirect [51]; Positive direct [24]	Not applicable
7.5 Add graphics for response options using Likert type scales [55, 56, 59].	Cognitive and learning disabilities [55, 56, 59]	Positive direct [55, 56, 59]	Not applicable
7.6 Implementation of mechanisms to facilitate the process of entering data in specific formats, for example, multiple choice boxes for entering dates [36].	Visual disabilities [36]	Positive direct [36]	Not applicable
8. Minimize external influences			

8.1. Specify the context (temporal or spatial) in which the question is asked, when this conditions the answer to be given [38, 55, 56, 59].	Cognitive and learning disabilities [38, 55, 56, 59]	Positive direct [38, 55, 56, 59]	3.3.5 Help
8.2. Do not use ableist concepts (e.g., offensive conceptualizations of autism) [55, 59].	Cognitive and learning disabilities [55, 59]	Positive direct [55, 59]	Not applicable
8.3. Confirm that participants declare themselves capable of completing the survey, for example by asking questions to check their decision-making capacity throughout the survey [24, 38, 51, 55, 68].	Cognitive and learning disabilities [24, 38, 55, 68] and Hearing disabilities [51]	Positive direct [38, 55]; Potential [24, 51, 68]	Not applicable
8.4. Distinguish the responses of proxies, for example by creating a separate survey to be completed by proxies [55, 59].	Cognitive and learning disabilities [55, 59]	Positive direct [55, 59]	Not applicable
8.5. Distinguish a "supported participant" (i.e. who answers with the help of a supporter) from a "proxy" (i.e. who answers on behalf of someone else with minimal information from them) [55, 59].	Cognitive and learning disabilities [55, 59]	Positive direct [55, 59]	Not applicable
8.6. Save answers given by participants until timeout [36, 75].	Disabilities in general [75] and Visual Disabilities [36]	Positive direct [36, 75]	2.2.1 Timing Adjustable; 2.2.4 Interruptions; 2.2.6 Timeouts
9. Error handling			
9.1. Ensure clarity and sensitivity in reporting errors (where and why they occurred) and how to correct them [36, 67].	Visual disabilities [36, 67]	Positive direct [36, 67]	3.3.1 Error Identification; 3.3.3 Error Suggestion; 3.3.6 Error Prevention (All)
9.2. Error messages should be available through a combination of client-side and server-side validation [36].	Visual disabilities [36]	Positive direct [36]	3.3.1 Error Identification
9.3. Error messages should be made available in red [36, 67].	Visual disabilities [36, 67]	Positive direct [36, 67]	Not applicable
10. Internationalization			
10.1. Enable the tool to support translations into multiple languages, including Sign Language [55].	Disabilities in general	Positive direct [55]	Not applicable
11. Data protection, privacy and conformance with accessibility guidelines and legislation			

11.1. Promote the collection of data from participants avoiding using proxies, as this can make them more reliable [24, 38, 55, 59, 68, 75].	Cognitive and learning disabilities [24, 38, 55, 59, 68] and Disabilities in general [75]	Potential [68, 75]; Positive direct [38, 55, 59]; Positive indirect [24]	Not applicable
11.2. The tool must comply with accessibility guidelines (e.g., WCAG) and legislation (e.g., Decree-Law no. 83/2018) [34, 36, 67, 75].	Disabilities in general [34, 75] , Visual disabilities [36, 67]	Positive direct [36, 67, 75]; Positive indirect [34]	Not applicable
11.3 When CAPTCHA is to be used, the system must provide audio CAPTCHA [36].	Visual disabilities [36]	Positive direct [36]	1.1.1 Non-text Content
11.4 Guarantee the confidentiality of the answers given by the participants [24, 51, 55, 68, 75].	Cognitive and learning disabilities [24, 55, 68]; Disabilities in general [75]; Hearing disabilities [51]	Positive indirect[68]; Positive direct [55, 75]; Potential [24, 51]	Not applicable
12. Accessible informed consent [2]			
12.1 A sign language version of the consent form should be available to participants [51, 55].	Hearing disabilities [51] and Cognitive and learning disabilities [55].	Positive indirect [51]; Positive direct [55]	Not applicable
12.2 A text version of the consent form should be provided to participants [51, 56].	Hearing disabilities [51] and Cognitive and learning disabilities [56].	Positive indirect [51]; Positive direct [56]	Not applicable
12.3 Promote obtaining consent online, so that signing a paper consent document can be dispensed when this is inconvenient for participants [55].	Disabilities in general	Positive direct [55]	Not applicable
12.4 Adapt consent form templates by eliminating sections that may unnecessarily hinder participants' understanding [55].	Cognitive and learning disabilities [55]	Positive direct [55]	Not applicable
12.5 Supplement consent forms by adding images to increase accessibility for people with cognitive and learning disabilities [55].	Cognitive and learning disabilities [55]	Positive direct [55]	Not applicable

[2] Despite the importance of obtaining informed consent, WCAG does not mention or provide specific instructions for this context.

12.6 Adapt online consent forms by providing audio versions of them [55].	Cognitive and learning disabilities [55]	Positive direct [55]	Not applicable

Table A.1: List of requirements for building an accessible survey completion tool