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Browser Extension to Address Cognitive Disabilities, Neurodivergences and Other Related Conditions

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Abstract

Many users with cognitive or neurodivergent conditions encounter significant barriers when interacting with standard web interfaces, often leading to stress, confusion, and premature task abandonment. This thesis presents the design, development, and evaluation of a browser extension aimed at reducing cognitive load and enhancing web accessibility for these user populations.

The tool was conceived as an all-in-one, lightweight solution, integrating several accessibility-focused features including content simplification, key concept highlighting, text summarization, and adaptive navigation aids. The design process followed a modified User-Centered Design (UCD) methodology, adapted to accommodate the needs and participation constraints of users with cognitive impairments. User insights were collected through a qualitative questionnaire, which suggested the selection of core functionalities.

The extension was developed using Manifest V3 compatible technologies, incorporating JavaScript, DOM APIs, and local NLP libraries to ensure relatively fast functionality and privacy preservation. Usability testing was conducted with a group of volunteers, simulating real-world browsing scenarios. Quantitative metrics and qualitative feedback were collected through task-based evaluations, think-aloud protocols, and a System Usability Scale (SUS) questionnaire.

The results indicate a high level of user satisfaction (SUS average score: 88.125), strong task success rates, and widespread appreciation for the tool's integrated features and minimalist design. These findings support the thesis that even lightweight browser-based interventions can significantly improve web accessibility for neurodivergent individuals. The project provides a replicable framework for inclusive browser extension development and contributes to bridging the accessibility gap in everyday digital experiences.

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1 Introduction

Individuals may face difficulties when interacting with technology, including websites, due to various cognitive differences or disabilities [1]. Among these, the following categories can be distinguished:

Autism Spectrum Disorder (ASD) is a category of neurodevelopmental disorders. It is considered a spectrum disorder, meaning it affects individuals in different ways and to varying degrees [1] [2] [3] [4] [5]. ASD is generally characterized by impairments in three core areas: socialisation, communication, and restricted and repetitive behaviours and interests, often referred to as the 'triad of impairment' [1] [2] [4] [5]. ASD can be accompanied by cognitive and language difficulties [1]. The intellectual impact of ASD varies widely, with some individuals having a severe intellectual disability and others having normal or very high levels of intelligence [1] [2] [3]. Autistic people may be prone to sensory overload and can demonstrate atypical attention patterns [1]. They may suffer from Stimulus Over selectivity, responding only to a subset of stimuli, which can result in limited cognitive function [1]. This can align with a tendency to process local sensory information preferentially over global, contextual, and semantic information, potentially leading to a focus on details rather than the bigger picture [1] [3]. Individuals with ASD may also have problems with sensory integration to varying degrees [1], difficulties with fine and gross motor control [2], and an expressed need for predictability [2].

Attention Deficit Hyperactivity Disorder (ADHD) is characterized by severe deficits in attention, hyperactivity, and impulsivity [6]. While a distinct condition from ASD, the two can co-exist [6], with some overlap in their characteristics [6].

Cognitive Disabilities is a broader term that can encompass conditions affecting cognitive abilities such as language, reasoning, memory and learning, visual perception, and attention [7]. Intellectual and developmental disabilities (IDD) fall under this umbrella [7]. People with cognitive disabilities often face significant barriers when using technology [7]. These barriers can stem from physical features of devices, as well as the cognitive complexity or confusing design of interfaces [7]. A lack of universal design features and cognitive access can severely limit the functional use of a wide array of technologies for individuals with cognitive

disabilities [7]. The Web Content Accessibility Guidelines (WCAG), while aiming to accommodate disabled users' needs, have historically concentrated less on the difficulties faced by cognitively disabled users [1]. There is a recognized need for more research and guidelines specifically addressing the usability and accessibility challenges faced by this population, including autistic people [1] [4].

It is evident that many common web design practices may be incompatible with the needs of users with cognitive or neurodiverse conditions. Elements such as intrusive pop-ups, persistent banners, excessive textual content, non-essential interface components, complex navigation menus, and an overabundance of buttons or links can contribute to cognitive overload. For individuals affected by these conditions, such design choices may lead to confusion, increased stress, and, in more severe cases, complete disengagement from the website.

The central objective of this thesis is to design and develop a tool that supports users during everyday web navigation by minimizing the stress and cognitive burden induced by certain user interface (UI) elements. The tool aims to identify and mitigate potentially overwhelming or distracting components, thereby promoting a more accessible and user-friendly browsing experience, particularly for individuals with cognitive or neurodiverse conditions. The tool needs to be designed as an all-in-one solution, incorporating multiple features to address a range of cognitive and accessibility-related challenges.

User-Centred Design (UCD) provides a valuable framework for achieving the goals of this project, as it emphasizes the creation of technology interfaces that are both usable and accessible to a broad range of users, including individuals with specific needs [1] [2] [3]. Consequently, UCD will serve as the foundational methodology for the development of the proposed tool. However, the process will be adapted to address the unique requirements of the target user population and tailored to the practical constraints and resources available within the scope of this project.

The findings from the user research indicate the need to develop a Google Chrome extension equipped with specific features designed to reduce user stress during web navigation. This work aims to provide a proof of concept demonstrating the feasibility of supporting users through targeted interventions in web navigation environments.

This document uses left-aligned text, increased line spacing, extra spaces between paragraphs to enhance readability and accessibility, particularly for individuals with dyslexia, ADHD, and other cognitive or learning disabilities. Left alignment avoids uneven spacing between words, helping readers track lines more easily, while increased line spacing and extra space between paragraphs reduce visual crowding and supports better comprehension. These formatting choices reflect the inclusive goals of the project and align with accessibility guidelines recommended by organizations such as the W3C [8] and British Dyslexia Association [9].

2 Background and State of the Art

This chapter provides an overview of the key concepts, existing research, and current technological solutions relevant to this work. It aims to position the proposed tool within the broader context of accessibility, cognitive disabilities, and user-centred design.

2.1 Theoretical Background

2.1.1 Cognitive and Learning Disabilities

Cognitive and learning disabilities encompass a wide range of conditions that affect processes such as memory, attention, reasoning, and problem-solving. Various organizations and initiatives have addressed these disabilities from both practical and theoretical perspectives.

From a technological standpoint, the Cognitive and Learning Disabilities Accessibility (COGA) Task Force [10], part of the Web Accessibility Initiative (WAI) under the World Wide Web Consortium (W3C), is a leading authority in web accessibility for users with cognitive and learning disabilities. COGA provides research-informed guidance and design patterns to help developers build more accessible content and user agents. This work supports broader efforts within the Accessibility Guidelines (AG) and Accessible Platform Architectures (APA) Working Groups, producing deliverables such as user needs summaries and cognitive accessibility design patterns [10].

A more theoretical perspective is provided by Sweller's (1988) study on Cognitive Load Theory [11], which explores how working memory constraints impact learning. The paper argues that conventional problem-solving strategies, such as means-ends analysis, place a high cognitive demand on learners, leaving little room for schema acquisition. This concept is especially relevant for understanding the barriers experienced by individuals with cognitive disabilities when interacting with complex user interfaces or learning environments.

2.1.2 Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by persistent challenges in social interaction, verbal and non-verbal communication, and restricted or repetitive behaviours. While the manifestation of symptoms varies widely, individuals with ASD often demonstrate unique cognitive, sensory, and attentional profiles [1] [2] [3] [4] [5] [12].

The Centres for Disease Control and Prevention (CDC) [12] define ASD as a condition that emerges in early childhood, often before the age of three, and continues throughout life. Symptom onset can occur as early as 12 months but may be delayed until 24 months or later. Some children may regress, losing previously acquired skills.

Common indicators include difficulties in initiating and sustaining social interactions, atypical language development, sensory sensitivities, and a strong preference for routines or predictability.

The diagnosis of ASD relies on behavioural assessment rather than medical tests [12]. Professionals such as developmental paediatricians or child neurologists perform evaluations based on standardized criteria and parental observations. Early diagnosis is crucial, as timely intervention can significantly improve developmental outcomes.

Emerging technologies, such as Computer-Assisted Technologies (CATs), have shown potential in supporting social communication and learning for individuals with ASD. Applications include emotion recognition, language development, and social skills training. Challenges include programs not being specifically developed for the ASD population, potential for distraction [13].

Research also highlights the frequent co-occurrence of ASD with other conditions such as ADHD, anxiety, or depression, which can complicate diagnosis and intervention strategies [12].

2.1.3 Attention-Deficit/Hyperactivity Disorder (ADHD)

ADHD is one of the most prevalent neurodevelopmental disorders, typically diagnosed in childhood and often persisting into adulthood. It is marked by

symptoms of inattention, hyperactivity, and impulsivity that can significantly impair academic, social, and occupational functioning [14].

According to the CDC, ADHD can be classified into three presentations: predominantly inattentive, predominantly hyperactive-impulsive, and combined. While physical hyperactivity may decline with age, difficulties with focus, organization, and impulse control often persist into adolescence and adulthood [14].

Diagnosis involves a multi-step process that includes behavioural checklists, developmental histories, and medical assessments to rule out other conditions such as learning disabilities or emotional disorders. There is no single diagnostic test for ADHD [14].

Although the exact aetiology of ADHD is not fully understood, contributing factors may include genetics, prenatal exposure to toxins, low birth weight, and family mental health history [14].

As with ASD, ADHD is frequently associated with co-occurring disorders, especially within the neurodivergent population, and this overlap is an important consideration in research and intervention [12].

2.1.4 Cognitive Load Theory

Cognitive load refers to the mental effort required to process information during problem-solving and learning activities. According to Sweller's Cognitive Load Theory (1988), the effectiveness of problem-solving strategies is closely tied to the cognitive processing resources they consume [11]. The theory emphasizes that domain-specific knowledge, encapsulated in schemas, is the key factor distinguishing expert from novice performance. However, conventional problem-solving strategies, particularly means-ends analysis, are argued to hinder schema acquisition due to the high cognitive load they impose.

Two mechanisms are proposed to explain this interference: selective attention and the limited capacity of working memory [11]. When using means-ends analysis, learners must simultaneously track the current problem state, the goal state, their relationship, relevant operators, and maintain a goal stack. This multitasking demand leaves little room for constructing or internalizing schemas. By contrast, a

nonspecific goal strategy (e.g., "calculate as many unknowns as possible") reduces cognitive burden by removing the need for constant comparison between the current and goal states.

Empirical evidence supports this theoretical distinction [11]. Experiments in trigonometry tasks have shown that learners using a nonspecific goal strategy had better recall of structural problem elements and solution procedures, which are essential for schema formation. Moreover, higher cognitive load associated with means-ends analysis has been linked to increased mathematical errors, presumably due to the reduced capacity available for correct equation application.

2.1.5 Stimulus Over Selectivity in Autism Spectrum Disorder

Stimulus over selectivity, a concept frequently discussed in the context of Autism Spectrum Disorder (ASD), refers to the tendency to focus on a limited subset of environmental cues while ignoring others. This atypical attentional pattern can hinder the processing of complex or multimodal information and impair adaptive functioning.

Studies utilizing computer-assisted technologies (CAT) [13] have provided empirical insights into over selectivity. For example, one study using a computer game found that children with ASD prioritized prosodic features over semantic content in spoken language, in contrast to typically developing peers. Another investigation involving virtual reality environments revealed that complex multimedia displays caused confusion for children with ASD, suggesting difficulties in integrating multiple sensory and informational cues.

Although not a universal solution, CAT platforms that synchronize visual and auditory stimuli may help address this challenge. Such tools can train attention to multiple cues by reducing the complexity of the environment and providing structured feedback. Nevertheless, the abnormal attention patterns associated with stimulus over selectivity may continue to limit the effectiveness of many educational and therapeutic applications, especially if those systems do not explicitly account for these cognitive profiles.

2.1.6 Sensory Overload and Neurodiversity

Sensory overload, another phenomenon commonly reported in autistic individuals, occurs when a person is overwhelmed by excessive sensory input. This condition arises from sensory processing differences, where any sensory modality (e.g., sight, sound, touch, proprioception) may be over- or under-sensitive, and these sensitivities can fluctuate over time [15].

Experiencing too much sensory stimulation can result in anxiety, physical pain, or emotional distress, potentially triggering meltdowns or withdrawal behaviours. A vivid description offered by an autistic individual likens the experience to being "tuned into 40 TV channels at once." [15] These episodes significantly impact the ability to engage with learning materials, social situations, or structured environments.

Support strategies focus on environmental adaptation and anticipatory guidance. These include identifying and mitigating sensory triggers, creating sensory-friendly spaces, and informing individuals in advance about upcoming sensory stimuli. Tools such as personalized sensory profiles can help caregivers and educators implement effective accommodations tailored to individual needs.

2.2 State of the Art

Ongoing technological innovation has significantly influenced the development and accessibility of assistive technologies (AT) for individuals with cognitive disabilities. These advancements have not only expanded the range of tools available but also transformed the ways in which users navigate daily life, education, and employment [16].

2.2.1 Expansion of Assistive Technology Options and Support

The continuous evolution of digital technologies has led to what several sources describe as an "explosion of options" in assistive tools. As innovation progresses, the emergence and widespread adoption of novel solutions are expected to continue, further broadening the support available to individuals with cognitive challenges. The increasing availability of these technologies is enabling broader access, reaching more users and enhancing quality of life in impactful ways [16].

Moreover, in the context of application and website development, organizations such as the Cognitive and Learning Disabilities Accessibility Task Force (COGA) offer valuable guidance to developers through use cases and practical scenarios. These resources emphasize key design principles that are especially important for users with cognitive and learning disabilities. Among these principles are simplicity, consistency, clear communication, predictable interfaces, error prevention and recovery, and the provision of support and alternative content formats [17].

Equally important is the active involvement of users with diverse cognitive and learning disabilities throughout the design and testing phases. By including individuals with lived experience, developers can better identify barriers and create digital content that is truly accessible and usable. This user-centred approach ensures that accessibility is not only theoretical but effectively implemented in real-world contexts [17].

2.2.2 Diversification of Tools and Use Cases

Technological developments have paved the way for a diverse set of tools tailored to specific needs across multiple domains:

Daily Life Support: Devices such as smartwatches, voice assistants (e.g., Amazon Alexa), and smartphone applications provide reminders for tasks, appointments, and deadlines through visual, auditory, and tactile cues. These tools help individuals maintain routines and reduce reliance on memory for task management [16].

Educational Support: Students with cognitive or learning disabilities now benefit from a variety of educational technologies. Examples include:

- *Text-to-speech software*, supporting individuals with dyslexia or writing difficulties [18].
- *Graphic organizers* and *mind mapping tools*, aiding focus and information structuring [18].
- *Talking calculators*, particularly useful for users with dyscalculia.
- *Multisensory educational platforms*, offering content through audio, visuals, and interactive feedback [18].

- *Browser extensions*, such as those available on Google Chrome, which enhance reading comprehension, simplify content, or support homework organization [19].

Workplace Accessibility: Many operating systems and productivity tools include built-in assistive features. Examples include [16]:

- *Focus modes* to minimize distractions.
- *Word prediction tools* that support written communication.
- *Screen magnifiers* and other visual adjustment tools to support users with attention or perceptual difficulties.

Web Interaction Enhancements: Users increasingly rely on browser extensions and add-ons to navigate the web effectively. These tools offer features such as [17]:

- *Text-to-speech* with visual highlighting.
- Acronym expansion.
- Simplification of complex content.
- Password and form management.
- Alternative input (e.g., *speech recognition*).
- *Visual customization*, such as adjusting whitespace or changing interface symbols.

These technologies are only effective, however, when web content is compatible with relevant APIs and accessibility standards. Lack of support for assistive extensions can become a significant barrier.

The field of assistive technology is dynamic. As noted by accessibility task forces and advocacy groups, improvements are continuously being made, whether through refinements to existing tools or the development of entirely new ones [16]. This rapid pace of innovation has implications not only for end users but also for policy and guideline development. For instance, updates to standards such as the W3C's guidance on accessible web content often reflect the need to accommodate emerging technologies and new user expectations [17].

2.2.3 Personalization as a Key Component of Assistive Technology

Personalization plays a central role in making digital tools and content usable for people with cognitive and learning disabilities. It allows individuals to adapt interfaces, content, and functionalities to better fit their personal needs and preferences [17].

One of the most important benefits of personalization is that it enables the use of assistive technologies, such as browser extensions and add-ons. These tools, like spell checkers, text-to-speech readers, visual simplifiers, and page formatter, are often essential for users with cognitive challenges. Ensuring that these technologies remain supported and functional is critical; sources explicitly recommend that they should not be disabled or restricted [17].

Personalization also helps create familiar and consistent interfaces, which is particularly valuable for users who may struggle with learning new designs or remembering unfamiliar layouts. This includes allowing users to choose known terms, symbols, or layouts that align with their previous experience or learned communication systems, such as those used in Augmentative and Alternative Communication (AAC) [17].

In practical terms, personalization allows users to [17]:

- Adjust the appearance of content (e.g., font size, contrast, spacing).
- Simplify interfaces to reduce distraction and confusion.
- Use preferred methods for reminders and notifications.
- Choose familiar units for navigation or directions.
- Maintain access to known layouts and versions of applications.

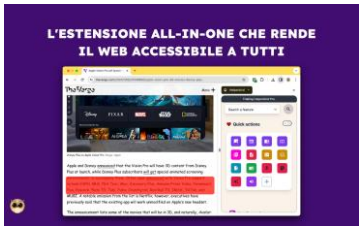
Importantly, personalization supports a wide range of diverse needs. What works for one individual may not work for another, so offering flexible options empowers users to shape their digital experience. This not only helps overcome cognitive barriers but also promotes greater independence and autonomy in navigating websites, forms, applications, and other online tools [17].

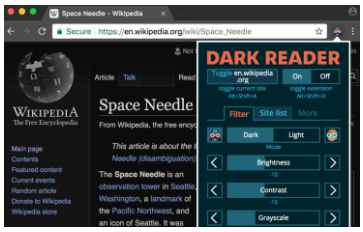
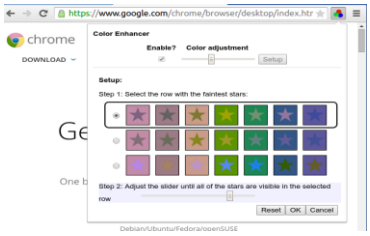
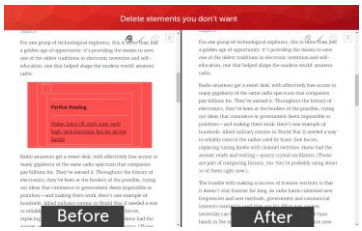
Technological innovation, especially in the area of web standards and extension support, should continue to prioritize features that allow users to customize their digital environment in ways that make it accessible, familiar, and supportive.

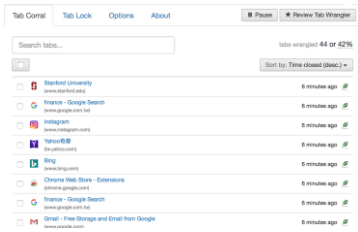
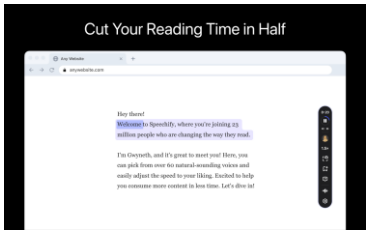
2.2.4 Browser Extensions Availability on the Market

One prominent domain in which accessibility advancements have been realized is that of browser extensions. These lightweight applications extend the native capabilities of web browsers, enabling enhanced user experiences through the addition of tailored functionalities that address diverse user needs, including those related to cognitive, sensory, or motor impairments. Extensions serve as modular augmentations to the browsing environment, offering support for tasks such as content simplification, screen reading, input adaptation, and personalized interface modifications.

The following is a curated list of notable Chrome extensions currently available on the Chrome Web Store, selected based on their ongoing compatibility with the latest platform requirements. Notably, the transition from Manifest V2 to Manifest V3 introduced significant architectural and security-related changes that rendered many legacy extensions obsolete. As a result, Google enforced the deprecation of non-compliant extensions, and only those successfully migrated to the Manifest V3 framework remain listed in the official repository.

Extension Name	What It Helps With	Browser	Pricing	Key Features	Example screenshot
Helperbird	Dyslexia, ADHD, autism, general reading help	Chrome, Edge, Firefox	Paid premium ($30-$1500/yearly)	- Font customization (OpenDyslexic, Lexend, etc.) - Text-to-speech - Screen masking - Colour overlays - Dyslexia rulers - Translation - Ad removal	

BeeLine Reader	Dyslexia, ADHD, reading speed and focus	Chrome, Firefox	Paid premium ($2/month one browser)	- Eye-guiding colour gradients - PDF support - Customizable colour schemes - Export to Kindle - Improved focus reading mode	
Dark Reader	Autism, sensory processing sensitivity, migraine	Chrome, Firefox, Edge, Safari	€9.99 one time	- Dark mode for all websites - Customizable brightness, contrast, sepia, grayscale - Site-specific settings - Keyboard shortcuts	
Color Enhancer (Google)	Colour blindness, sensory processing	Chrome	Free	- Colour adjustment wizard - Simulate and adjust colours for better visibility - No signup required	
Just Read	ADHD, sensory overload, dyslexia	Chrome, Firefox	Free basic / Paid premium ($2/month)	- Remove page clutter - Custom reading themes - Save and annotate articles - Print-friendly versions	

Tab Wrangler	ADHD, executive function support	Chrome	Free	- Auto-closes inactive tabs - Saves closed tabs - Lock important tabs - Customizable timeouts	
Speechify	Dyslexia, ADHD, low vision, auditory preference	Chrome, Safari	Free basic / Paid premium ($29/month)	- Text-to-speech (natural AI voices) - Adjustable reading speed - Scan and read PDFs - Sync across devices - Highlight text as it reads	

2.3 Summary and Research Gap

2.3.1 Challenges and Considerations

While technological innovation has substantially expanded the possibilities for accessible digital experiences, it has also introduced new layers of complexity, particularly for individuals with cognitive impairments. Despite increased awareness and the proliferation of assistive tools, many digital interfaces remain cognitively taxing. Users often encounter difficulty navigating systems with non-intuitive layouts, dense information structures, or time-sensitive interactions, such as auto-advancing content, expiring form sessions, or rapid modal changes. These challenges are compounded when design choices fail to consider neurodivergent cognitive processing styles.

Another critical limitation lies in the inconsistent compatibility with assistive technologies, including screen readers, voice input systems, and alternative navigation mechanisms. Variability in implementation between browsers and web

applications often leads to unpredictable behaviour, limiting the reliability of assistive tools across platforms and usage contexts.

Nevertheless, the trajectory remains broadly positive. The increasing availability and technical maturity of browser APIs and platform-level accessibility frameworks have catalysed the development of more refined, usable tools. As accessibility becomes embedded within mainstream UX and frontend development practices, the ecosystem of supportive technologies continues to expand in both reach and functionality.

2.3.2 Unaddressed Needs and Design Gaps

Despite substantial progress, several critical gaps persist in the landscape of accessibility extensions, particularly with regard to supporting neurodivergent users. These unmet needs point toward promising directions for future research and tool development:

Lack of Unified, Multi-Modal Support Systems: A prevailing limitation is the fragmentation of functionality across individual extensions. Most current solutions are highly specialized, focusing exclusively on a single domain of support such as text simplification, dark mode interfaces, or text-to-speech conversion. While these tools are valuable in isolation, users with intersecting or evolving cognitive needs must frequently install and configure multiple extensions, each with its own learning curve, UI, and resource consumption footprint.
The absence of integrated, all-in-one accessibility suites that support a broad spectrum of neurodivergent traits represents a significant oversight. A next-generation tool should aim to consolidate multiple accessibility features into a single, modular architecture with adaptive personalization capabilities.

Static and Manual Adaptation Models: Contemporary accessibility tools typically operate in a static configuration mode, where users must manually define preferences, which then remain fixed regardless of context. However, neurodivergent cognitive states are often dynamic and situation-dependent, influenced by factors such as fatigue, task difficulty, and emotional regulation. To date, there is minimal exploration of context-aware or responsive accessibility

interfaces that can adapt in real time based on inferred user state. For example, a browser extension might monitor interaction patterns such as:

- Typing speed decrease (indicating cognitive fatigue),
- Rapid tab switching (signalling task overwhelm or attention drift),
- Periods of inactivity following failed inputs (suggesting confusion or disengagement).
- These behavioural signals could inform a system capable of modifying the interface dynamically (e.g., simplifying layout, activating focus mode, offering guided prompts), or issuing alerts to recommend cognitive rest or task reprioritization.

Insufficient Support for Visual and Auditory Learners: The vast majority of accessibility-focused extensions continue to assume textual engagement as the default modality, thereby under-serving users who benefit from visual or auditory information processing, such as individuals with dyslexia, ADHD, or autism spectrum conditions. Emerging user models suggest a strong need for tools that emphasize:

- Multimodal representations of content (e.g., converting complex text into narrated summaries or infographics),
- Automated visual aids such as intelligent text highlighters that track reading focus,
- Interactive audio-visual scaffolds for forms, navigation, and comprehension tasks.
- Such capabilities could significantly broaden the accessibility of web content for non-text-centric learners by aligning with their cognitive strengths rather than imposing traditional reading-heavy paradigms.

3 Methods and Techniques

3.1 User-Centred Design (UCD)

The following diagram contains the main steps of the UCD process:

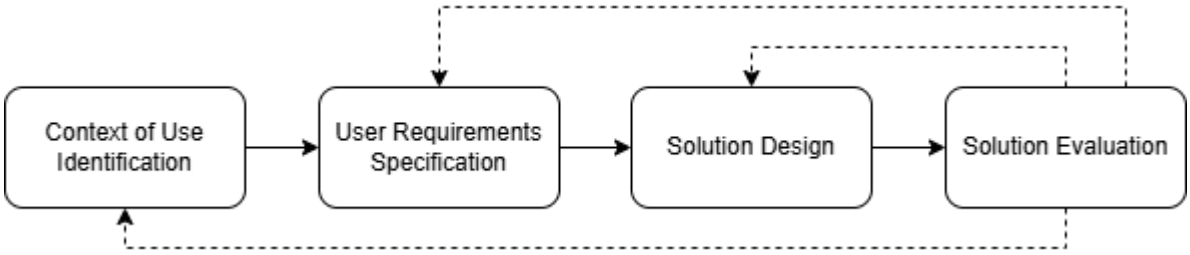


Figure 1 - UCD diagram.

3.1.1 Definition and Overview

User-Centred Design (UCD) is a design methodology that places the needs, preferences, abilities, and limitations of end users at the centre of the design and development process for interactive systems [20] [21] [22]. Its objective is to create products, systems, or services that are highly usable and tailored to their intended audience [22]. UCD is inherently iterative, involving continuous interaction between designers and users to gather feedback, refine prototypes, and ensure alignment with real-world requirements [20] [22].

The UCD process includes several stages: research, ideation, prototyping, testing, and evaluation. This cyclical structure enables designers to test and validate assumptions about user behaviour and progressively improve the product [22]. UCD draws on knowledge from ergonomics and usability to better identify user needs [20].

Key elements include user research, persona creation, prototyping, user testing, and iterative improvement. Central to the methodology is the cultivation of empathy, encouraging designers to understand the user's perspective and the context in which the system will be used [22].

3.1.2 Core Principles of UCD

Foundational principles for a successful UCD approach include:

Early and Continuous User Involvement: Users should be engaged throughout the entire design process, allowing products to evolve in alignment with their feedback [22] [23].

Focus on Needs, Goals, and Context: A deep understanding of the users' environment, challenges, and preferences guides the design [22].

Iterative Process: The system is refined continually based on user evaluation [20] [22] [23].

User-Centred Evaluation: Systems are tested with real users to identify pain points and optimize user experience [23] [22].

Multidisciplinary Teams: Teams with diverse skills contribute a variety of perspectives and expertise [20].

Comprehensive User Experience: Attention is given to all aspects of interaction, including usability, emotions, accessibility, and past experiences [20] [23].

Accessibility by Design: Systems must accommodate various impairments, including cognitive disabilities, aligning with standards such as the WCAG and ADA [22].

The ISO 9241-210 standard formalizes UCD practices, emphasizing ergonomics and usability to increase user satisfaction and productivity while minimizing errors and support needs [20] [23].

3.1.3 Benefits of UCD

Adopting UCD yields numerous advantages:

- Enhanced usability and user satisfaction [20]
- Increased productivity and reduced training/support costs [20]
- Greater inclusivity and accessibility [20] [22]
- Improved brand reputation and competitive advantage [20]
- Reduction in user stress and frustration [20]

- Contribution to sustainability and ethical design [20]

3.1.4 Challenges in UCD Implementation

Despite its benefits, UCD is not without difficulties:

- Higher time and resource investment due to iterative cycles [20].
- Tension between user needs and business constraints, which can be restrictive or impede adoption if market limitations and the business environment are not explicitly considered [20] [22].
- Difficulty involving users consistently: user participation should fit the context and may vary, citing examples where direct user involvement can be difficult or undesirable, such as with users with different levels of mental ability [20].
- Risk of bias when designers rely on personal assumptions, research and interaction with actual users are considered essential, as professionals may not be able to discover all relevant facts about complex human beliefs and behaviours [20].
- Complexity in accommodating diverse user groups and platforms [20] [22].

3.1.5 UCD for Users with Cognitive Disabilities

Cognitive disabilities can impact memory, attention, problem-solving, reading, writing, and understanding complex information [17]. Designing for this user group requires special attention to variability, communication needs, and inclusive involvement.

Variability and Personalization: No single solution suits all users. Designs must support personalization and adaptation to accommodate different impairments [17] [21].

Communication Barriers: Users may rely on symbols or simplified language, requiring adjustments in communication and interface design [17].

Involvement Challenges: While inclusion can be difficult, evidence supports that individuals with cognitive disabilities can significantly contribute when supported appropriately [20].

Team-Centered Design: Collaboration with caregivers and professionals can enrich the design process, although it must not replace direct user involvement [20] [21].

3.1.6 Design Patterns for Cognitive Accessibility

The W3C document [17] identifies key objectives and actionable design patterns that can guide the development of cognitively accessible systems:

Use familiar and consistent design elements: Employ universally recognized icons (e.g., magnifying glass for search), common layouts (e.g., top navigation bar, left-hand sidebar), and repeated interface structures to reduce the cognitive effort needed to learn the system.

Create a clear visual hierarchy: Use larger fonts and bold headings for titles, group related content using whitespace or borders, and emphasize primary actions with distinctive button styles (e.g., colour, size). Ensure a clear contrast between text and background to enhance readability. Break media into understandable chunks. Make important actions and information easy to find.

Simplify navigation and layout: Design navigation that is shallow (few levels deep), consistent across pages, and enriched with breadcrumbs or progress indicators. Highlight the most important tasks using icons or labels and provide a “home” button or persistent menu.

Present content in a clear and simple format: Use plain language, short sentences, and bulleted or numbered lists to enhance comprehension. Support content with relevant images, diagrams, and video. Provide summaries or alternative formats (e.g., easy-to-read versions).

Prevent user errors and provide recovery mechanisms: Use input constraints (e.g., date pickers), clear error messages in plain language, undo options for critical actions, and step-by-step guidance (e.g., wizard-style forms).

Reduce cognitive load and distractions: Eliminate unnecessary animations or pop-ups, chunk information into manageable sections, and provide cues to maintain context (e.g., headings that indicate the task step).

Avoid memory-heavy interactions: Offer autofill suggestions, save user preferences, and provide prompts or reminders where appropriate (e.g., “You last visited this page on…” or “Don't forget to submit your form”).

Provide accessible help and support: Make support options visible and easy to access. Offer multiple formats for help content (e.g., text, video, icon-based tutorials). Simplify access to human assistance (e.g., chat, phone number).

Support user personalization: Enable interface customization options, such as adjusting text size, changing colour schemes, simplifying layouts, or switching to symbol-based navigation. Ensure compatibility with browser extensions or assistive technologies (e.g., screen readers or text simplifiers).

3.1.7 User Involvement and Testing

Involving users with cognitive disabilities in the design process is essential. Methods include:

- Focus groups, interviews, and observations [17].
- Usability tests with simplified protocols [22] [17].
- Contextual inquiry and task analysis [22] [21].
- Inclusion of users or peer-researchers in design teams [17].

Special considerations include ensuring accessible participation materials, allowing breaks, involving support persons, and emphasizing that testing evaluates the system, not the user. [17]

Automated accessibility tools are not sufficient; usability testing with real users is crucial to understanding effectiveness, clarity, and user satisfaction. [17]

3.2 Technical Framework for Google Chrome Extension Development

3.2.1 Introduction

Google Chrome extensions constitute modular software artifacts designed to enhance and customize the functionality of the Chrome browser. Their development requires a rigorous command of the underlying technical infrastructure provided by the Chrome Extension API ecosystem. This chapter

presents a comprehensive technical analysis of Chrome extension development, with a specific emphasis on the architectural constructs, platform APIs, and constraints introduced under Manifest V3, as articulated in the documentation [24].

3.2.2 Core Architecture and Design Paradigms

At the core of every extension lies a structured architecture, whose configuration and capabilities are governed by the manifest file (manifest.json). Under Manifest V3, this file enforces the encapsulation of all executable code, explicitly prohibiting the use of externally hosted scripts, and mandates the use of service workers as background execution contexts. These constraints significantly influence how extensions are engineered.

Principal architectural elements include:

Manifest File: Specifies required permissions, host access patterns, background logic, UI assets, and content script configurations.

Service Worker: An event-driven JavaScript module that mediates interaction between browser events and the extension logic. It operates without persistent DOM access and replaces the persistent background pages of Manifest V2.

Content Scripts: Executed within the context of specified web pages, content scripts have direct access to the DOM and act as the primary bridge between web content and the extension's internal logic.

Offscreen Documents: HTML-based, non-visible documents used to execute DOM operations indirectly from service workers.

Permissions Model: Explicit declaration of API access and domain reach through permissions and host_permissions keys, with security- and privacy-preserving constraints.

3.2.3 User Interface Construction and Integration

Extensions provide a range of UI affordances for user interaction:

Popup Interfaces: Triggered by clicking the extension icon, these interfaces are implemented as lightweight HTML documents.

Side Panel Interfaces: Persistent, docked interfaces leveraging the chrome.sidePanel API, suitable for augmenting user workflows.

Options Pages: Settings and configuration interfaces registered within the extension.

Contextual Menus: Dynamically generated right-click menu entries via chrome.contextMenus or chrome.menus.

Action API Integration: Enables dynamic control over the extension icon's visibility, state, and badge attributes through chrome.action.

3.2.4 Browser Control and Modification Capabilities

Extensions are empowered to programmatically control and monitor the browser environment through a comprehensive suite of APIs:

Tab and Window Manipulation: APIs such as chrome.tabs, chrome.windows, and chrome.tabGroups allow for the creation, rearrangement, and state tracking of browser windows and tabs.

History and Navigation Control: The chrome.history and chrome.webNavigation APIs facilitate querying historical data and intercepting navigation events.

Settings Overrides: Extensions may redefine Chrome’s default new tab, bookmarks, and history pages via chrome_url_overrides.

Notification Mechanisms: System-level user alerts can be issued through the chrome.notifications API.

Download Management: Initiation and control of file downloads are supported via chrome.downloads.

Privacy Configuration and Proxy Settings: Browser-level privacy options and proxy routing can be controlled using chrome.privacy and chrome.proxy.

DevTools Extensions: Developers can extend the Chrome DevTools interface using APIs under chrome.devtools.*, enabling custom panels or sidebars.

Authentication Support: OAuth2 authorization workflows and identity management are handled via the chrome.identity API.

3.2.5 Web Content Interaction and DOM Manipulation

To influence or augment web content, extensions utilize multiple strategies:

Content Scripts: Declared in the manifest and injected into specified domains, these scripts directly modify DOM structures and register event handlers.

Runtime Injection: JavaScript and CSS files may be dynamically injected using the chrome.scripting API.

Network Interception: HTTP request and response flows can be monitored or modified using chrome.webRequest, chrome.declarativeNetRequest, and chrome.webNavigation.

Media Capture: Browser tab audio and video can be captured via chrome.tabCapture or standard media APIs like getDisplayMedia().

Content Setting Modifications: Site-specific behaviours (e.g., enabling JavaScript, managing cookies) can be reconfigured using chrome.contentSettings.

Bookmark and Top Site Management: The chrome.bookmarks and chrome.topSites APIs allow structured access to user-defined navigation resources.

3.2.6 Messaging and Persistent State Management

Efficient inter-component communication and data persistence are vital for robust extension functionality:

Short-lived Messaging: Components communicate asynchronously using chrome.runtime.sendMessage and associated listeners.

Long-lived Ports: Persistent connections are established via chrome.runtime.connect, facilitating sustained messaging flows.

Storage API: Structured data persistence is supported through the chrome.storage API, which provides sync, local, and session storage partitions along with real-time change listeners.

Native Messaging Protocol: Allows secure message exchange between the extension and host-native applications.

3.2.7 Security Enhancements and Process Isolation

To ensure user safety and enable advanced capabilities:

Cross-Origin Isolation: Extensions may enable this mode via manifest directives (cross_origin_embedder_policy, cross_origin_opener_policy) to leverage features such as SharedArrayBuffer.

Content Security Policy (CSP): Enforced by default under Manifest V3, CSP restricts inline script execution and controls permissible resource origins, thereby mitigating injection attacks.

3.2.8 Development Lifecycle and Deployment Workflow

A typical extension development pipeline involves:

1. **Requirements Analysis**: Determining scope of functionality and associated permissions.
2. **Design and Implementation**: Architecting the extension structure, developing service workers, UI components, and scripting logic.
3. **Testing and Debugging**: Using chrome://extensions to load unpacked versions, leverage browser consoles, and inspect runtime behaviours.
4. **Packaging and Publication**: Preparing a zipped package for submission to the Chrome Web Store, including documentation, metadata, and compliance justifications.

3.3 Technical Overview of JavaScript

3.3.1 Introduction

JavaScript is a ubiquitous, lightweight, interpreted scripting language that forms the backbone of modern web development. While initially designed to enable dynamic behaviour within web pages, its scope has expanded far beyond browsers to include server-side environments such as Node.js, document processing in Apache CouchDB, and scripting within Adobe Acrobat. This chapter provides a comprehensive technical overview of JavaScript, elucidating its language characteristics, specification standards, core concepts, and available documentation resources [25].

3.3.2 Language Characteristics and Paradigms

JavaScript is best understood as a prototype-based, multi-paradigm, single-threaded, dynamic programming language. This description captures the essence of its architecture and operational model:

Prototype-based: Unlike classical object-oriented languages that rely on classes and inheritance hierarchies, JavaScript employs prototypes , objects that serve as templates for other objects, enabling dynamic inheritance and property delegation.

Multi-paradigm: JavaScript supports diverse programming paradigms, including:

- Object-oriented programming through prototypes and ES6 classes.
- Imperative programming, with control flow structures such as loops and conditional statements.
- Declarative programming, notably functional programming styles, supported via first-class functions, closures, and higher-order functions.

Single-threaded: JavaScript operates on a single execution thread, relying heavily on asynchronous programming models and event loops to handle concurrent operations without blocking.

Dynamic typing: Variable types are determined at runtime, allowing flexible and rapid development but requiring careful management to avoid type-related errors.

3.3.3 JavaScript Specifications and Standards

The authoritative definitions and standards governing JavaScript are formalized by the ECMAScript Language Specification (ECMA-262) and its supplement, the ECMAScript Internationalization API specification (ECMA-402).

ECMAScript (ECMA-262): This document specifies the core syntax, semantics, and API of the language. It is the basis upon which all compliant JavaScript engines implement language features, including new additions such as classes, modules, and promises.

ECMAScript Internationalization API (ECMA-402): Defines interfaces for language-sensitive operations such as string comparison, number formatting, and date/time formatting, providing standardized support for globalized applications.

Implementation of ECMAScript features by browser vendors often precedes formal standardization. For this reason, MDN Web Docs serve as an essential resource, documenting both finalized features and proposals under consideration, thereby helping developers stay abreast of evolving capabilities.

3.3.4 Error Handling and Diagnostics

Understanding JavaScript's error model is crucial for developing resilient applications. The language specifies several native error types, each with specific use cases:

SyntaxError: Indicates a parsing failure due to incorrect code syntax.

ReferenceError: Triggered when attempting to access undefined variables.

TypeError: Occurs when operations are performed on incompatible types.

RangeError: Raised when numeric values fall outside acceptable ranges.

URIError: Raised during malformed URI handling.

AggregateError: Represents multiple errors combined in a single object.

These error types enable developers to implement fine-grained exception handling, essential for debugging and fault tolerance.

3.3.5 Resources and Documentation Ecosystem

Developers rely on authoritative resources for mastering JavaScript, most notably:

MDN Web Docs: A comprehensive, community-maintained resource detailing language syntax, APIs, and browser compatibility.

ECMAScript Specifications: The official documents detailing language evolution and technical requirements.

Browser and Runtime Documentation: Detailed notes from environments like V8 (Chrome), SpiderMonkey (Firefox), and Node.js.

These resources provide layered knowledge from introductory tutorials to exhaustive references, supporting continuous learning and adaptation to language changes.

3.3.6 Distinction from Java

It is imperative to clarify that JavaScript is fundamentally distinct from the Java programming language, despite the similarity in their names and shared Oracle ownership. Differences manifest in syntax, semantics, runtime environments, and typical use cases. Java is a statically typed, compiled language primarily used for enterprise applications, whereas JavaScript is a dynamically typed, interpreted language primarily geared towards web environments.

3.4 Project Plan

3.4.1 Introduction

The aim of this project is to design, develop, and evaluate a browser extension intended to enhance web accessibility for individuals with cognitive and learning disabilities and neurodivergent users. The extension is envisioned as a tool capable of mitigating common usability barriers by implementing personalized, distraction-reducing, and content-simplifying features directly within the browser environment. To ensure that the final product is not only technically robust but also user-centred and functionally relevant, the project will be structured into three

sequential phases: User Research, Feature Development, and Utility Testing. The UCD process will be changed a bit to adapt to the context of the users and the resources available for the project itself (in term of money and time). The personalization of the UCD process is possible in these cases as specified in the chapter related to challenges of UCD with the participation of cognitive disabled or neurodivergent users.

3.4.2 Phase I: User Research

The first phase of the project is focused on understanding the real-world needs, frustrations, and expectations of users with respect to navigating web content. In order to gather authentic, unfiltered insights, a qualitative online questionnaire designed and distributed. The questionnaire will be composed of open-ended questions covering topics such as general web usage, design elements that cause stress, desired accessibility features, and past experiences with browser extensions.

The rationale for using open-ended questions is to capture rich, descriptive responses that could reflect the cognitive and emotional dimensions of web interaction. The questionnaire will be available in multiple languages (including English, Italian, and Spanish) to broaden the diversity of responses and ensure inclusivity.

After data collection, the responses will be imported into *NotebookLM* [26], a tool used to structure, summarize, and analyse qualitative content. This analysis will facilitate the identification of recurring themes, stress-inducing patterns, and the most frequently requested accessibility features. The output of this phase will be a ranked list of user-desired functionalities, which will serve as the foundation for the second phase of the project.

3.4.3 Phase II: Design and Development

Based on the results of the questionnaire analysis, the project will move into the design and implementation of the Chrome extension. In this phase, the top five most requested features by users will be prioritised and developed.

Each of these features will be implemented using the Chrome Extension API under Manifest V3, ensuring compatibility with current platform standards. The development process will adhere to best practices for accessibility and performance, using modular JavaScript, structured HTML, and accessible CSS practices.

3.4.4 Phase III: Usability Testing

The objective of Phase III is to conduct a comprehensive usability evaluation of the browser extension through structured testing with end users. This phase is designed to assess the tool's practical effectiveness, efficiency, and user satisfaction, especially in relation to its accessibility features for individuals with cognitive and neurodivergent conditions.

A group of volunteer participants will be asked to perform a series of real-world tasks that represent core functionalities of the extension. These tasks will include using highlight and summarization modes, hiding or removing visual elements, and navigating complex web content with the support of tooltips and interface simplification.

The usability test will be conducted in a controlled environment with facilitator guidance, while participants will be encouraged to think aloud. Both quantitative and qualitative data will be collected:

- *Quantitative* metrics will include task success rates, time to completion, number of errors, number of clicks.
- *Qualitative* insights will be gathered through observational notes and post-task interviews focused on perceived usefulness, clarity, and interface satisfaction.

Participants will also complete a System Usability Scale (SUS) questionnaire to provide a standardized measure of overall usability. In addition, they will respond to a brief open-ended interview designed to capture emotional responses, suggestions for improvement and perceived accessibility.

The collected data will be analysed to identify usability bottlenecks, accessibility barriers, and areas for refinement.

3.5 Conclusion

User-Centred Design (UCD) offers a robust and adaptable framework for developing inclusive digital systems. Its application to users with cognitive impairments necessitates not only direct user engagement but also the inclusion of flexible, adaptive design strategies, collaboration with caregivers or support professionals, and continuous usability validation. When implemented rigorously, UCD facilitates the creation of digital environments that are not only functional but empowering, responsive, and meaningful for a diverse spectrum of cognitive needs [17] [20] [21].

A technical foundation in JavaScript remains central to the development of modern, accessible web applications. It is important to emphasize the importance of understanding JavaScript's specification standards (ECMA-262, ECMA-402), core programming paradigms, and asynchronous execution model. Proficiency in these areas is essential for leveraging JavaScript effectively across dynamic, user-centric interfaces and for integrating robust error-handling and state management into assistive technologies.

Furthermore, the adoption of Manifest V3 has marked a significant evolution in Chrome extension development. By emphasizing modular architecture, enhanced security constraints, and asynchronous execution via service workers, Manifest V3 imposes both challenges and opportunities for developers. Mastery of this environment, including Chrome's declarative APIs, scripting models, and user interface frameworks, is critical for implementing browser-based assistive tools.

The usability testing phase plays a crucial role in validating the real-world applicability of the extension. It ensures that the tool not only functions as intended but also aligns with the actual needs, behaviours, and limitations of its target users.

Collectively, these insights underscore the importance of combining rigorous technical fluency with empathetic, participatory design practices in the development of digital accessibility solutions.

4 User research

4.1 Problem Definition, Research Goals, and User-Centred Inquiry

4.1.1 Purpose of the System

The primary objective of the proposed system is to improve web accessibility and usability for individuals with cognitive disabilities, neurodivergent traits, or related conditions. The system aims to address cognitive barriers that inhibit effective web navigation, comprehension, and task completion by implementing functionalities that reduce distractions, enhance readability, support memory, and simplify interaction pathways. The overarching goal is to foster autonomy, reduce cognitive load, and support equitable digital inclusion through adaptive browser-based technologies.

4.1.2 Research Goals

To guide the development of this system, the research component of the project focuses on achieving the following goals:

- Identify prevalent web accessibility challenges encountered by neurodivergent users, including stressors introduced by modern design patterns and interactive elements.
- Understand user preferences for customization, simplification, and content presentation features that facilitate cognitive accessibility.
- Gather user feedback on existing assistive tools and interface mechanisms that are perceived as beneficial or counterproductive in mitigating cognitive effort and promoting task success.

The *W3C's Cognitive and Learning Disabilities Accessibility Task Force (COGA)* [17] is utilized as a foundational reference for framing user scenarios, accessibility barriers, and functional needs relevant to this population and after formulating the open questions for the online questionnaire submitted as first step.

4.1.3 User Research Questions

A structured set of user research questions was designed to capture qualitative and quantitative data across several key domains, aligned with recognized cognitive accessibility priorities. From each category only one question was chosen to be asked to the users. The chosen one are going to be underlined.

4.1.3.1 General Web Usage & Challenges

- What are the most common frustrations you experience when browsing websites?
- Do you currently use any browser extensions or tools to improve your web experience? If so, which ones and why?
- How do you feel about navigating complex menus and multi-step processes online?
- What aspects of a website make it easier for you to use and understand?

4.1.3.2 Readability & Content Comprehension

- Do you find it difficult to read or process text-heavy content on websites? If so, what specific challenges do you face?
- Would you benefit from text customization options such as font adjustments, text simplification, text-to-speech, automatic keyword highlighting?
- How do you feel about websites that use metaphors or abstract language in their content?
- Would tooltips or hover-over explanations for complex terms or buttons improve your experience?

4.1.3.3 Navigation & Interaction

- Do you find yourself accidentally clicking the wrong buttons or struggling with website layouts?
- Would you prefer simplified website menus with fewer distractions? Would you like to hide elements that you consider useless?

- Do you find auto-scrolling banners, carousels, or pop-ups distracting or overwhelming? Would it be better for you to control the behaviour of those elements?
- How often do you get lost or disoriented when navigating a website? What would help with orientation?

4.1.3.4 Forms & Online Transactions

- Have you ever had difficulty filling out online forms due to timeouts, unclear instructions, or unexpected errors?
- Would you benefit from an external help that keeps form instructions visible while typing?
- Do you worry about making errors in online purchases, such as selecting the wrong item or entering incorrect payment details?
- Would features like auto-fill verification or spending limit notifications help with financial transactions?

4.1.3.5 Reducing Cognitive Load & Distractions

- Do you feel overwhelmed by large amounts of information on a single webpage?
- Would a “special mode” that hides unnecessary elements improve your browsing experience? Would you like to personalise what to hide?
- How do you feel about search engines providing fewer, more relevant results instead of long lists?
- Would features like highlighting key information or breaking content into digestible chunks be helpful?

4.1.3.6 Support for Memory & Organization

- Do you have difficulty remembering information between different steps in an online process?
- Would you find it useful if a website could remind you of past actions or selections?
- Would a visual indicator of where you are in a process help you navigate more confidently?

4.1.3.7 Accessibility Preferences

- Which of these features would be most useful for your browsing experience? (Multiple choice: text-to-speech, simplified layouts, distraction blocker, easy navigation buttons, font adjustments, colour contrast options, etc.)
- Are there specific design elements (e.g., icons, colour schemes, layout structures) that make websites easier or harder for you to use?
- Do you feel that current accessibility settings in browsers and operating systems meet your needs? If not, what's missing?

4.1.3.8 Additional Feedback

- What is one feature you wish websites had that would make your experience significantly better?
- Have you ever abandoned a website because it was too difficult to use? If so, what caused the frustration?
- Do you have any examples of websites that you find particularly easy to use? What makes them accessible for you?

4.2 Questionnaire results

4.2.1 Overview

This chapter presents the results of the "Web Interfaces Stress Questionnaire," which was designed to capture user experiences, frustrations, and preferences related to web navigation, with particular attention to cognitive accessibility. The questionnaire aimed to inform the development of a Chrome extension intended to support neurodivergent users or individuals with cognitive impairments by identifying common stressors and usability barriers on the web. Data was collected through a Microsoft Form and analysed using *NotebookLM* [26] to allow for open-ended, user-centred input in a remote, accessible format. Find more information about the use of NotebookLM and the questionnaire in the relative annex (9.1).

4.2.2 Participant Demographics

A total of 19 responses were analysed. The demographic composition of the sample is summarized as follows:

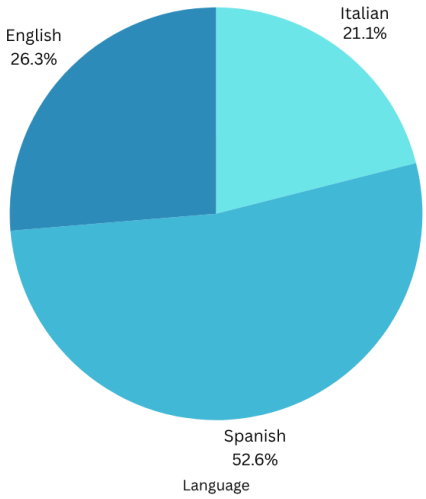


Figure 2 - Language distribution

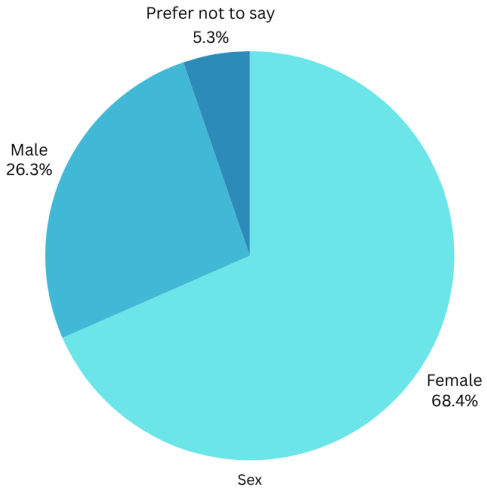


Figure 3 - Sex distribution

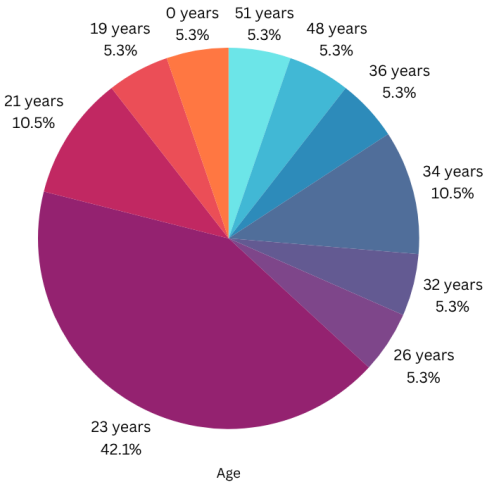


Figure 4 - Age distribution

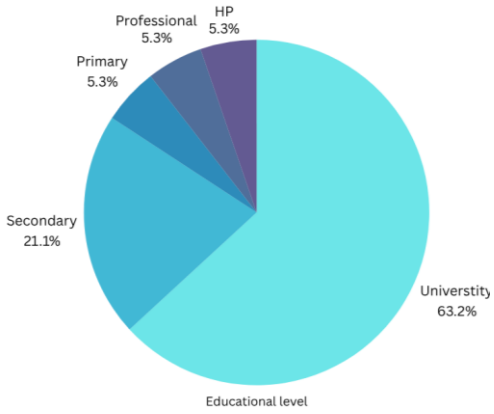


Figure 5 - Educational level distribution (HP means Higher Professional)

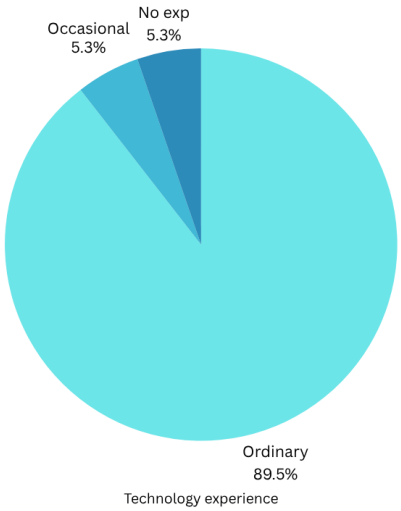


Figure 6 - Technology experience distribution (No exp stands for No experience)

4.2.3 Thematic Analysis of Key Issues and Needs

4.2.3.1 Complex Layouts and Visual Distractions

The majority of respondents reported significant cognitive stress due to complex layouts, pop-ups, auto-playing elements, or non-static content. These distractions often obscured the main information, triggered loss of focus, or led to misclicks.

Quotes:

- “If there are many pop-ups on the site it is difficult, since the text is often moved” (ID 2)
- “Any moving object that is next to a text for me is unnecessary and annoying” (ID 18)

Many participants reported the use of AdBlock or similar tools as a coping strategy to remove distractions, indicating a functional gap in native website usability.

4.2.3.2 Difficulties with Long or Dense Text

Many users expressed difficulty in processing long or unstructured text blocks. Problems cited included:

- Loss of attention
- The need to reread several times

- Inability to identify key information
- Tendency to abandon pages

Quotes:

- “If the texts are too long, I'm more likely to get distracted and therefore have to reread” (ID 3)
- “I waste a lot of time reading and trying to identify important information; I often leave the page” (ID 14)

These issues suggest a strong user demand for text summarization, key concept highlighting, and visual structure improvements such as increased spacing or section headers.

4.2.3.3 High Demand for Personalization and Special Modes

Participants showed significant enthusiasm for a “special mode” or personalized display features that would allow them to:

- Hide ads and non-essential elements
- Display only user-relevant sections
- Filter and collapse/expand page sections

Quotes:

- “I would like the page to always show an index with hyperlinks and filters to hide/display sections” (ID 13)
- “I want to see just the fields related to certain words … the rest should disappear to avoid distraction” (ID 8)

This personalization preference aligns with modern accessibility principles advocating for user agency and adaptability in interface interaction.

4.2.3.4 Desired Functional Features

Based on aggregated responses, the most requested features (in descending order of importance and novelty) were:

Rank	Feature	Votes
1	Key concept highlighting	14

2	Simplified layouts	14
3	Text summarizer	9
4	Distraction blocker	9
5	Easy navigation buttons	6
6	Reminder of past actions	4
7	Text-to-speech	4
8	Colour contrast options	4
9	Font adjustment	2
10	Icon personalization	1
11	Other	0

Table 1- Frequently requested features

These results confirm that content simplification and visual guidance are top priorities for users who experience cognitive overload or attentional fragmentation during browsing.

4.2.3.5 Browser Extensions as Coping Tools

Participants frequently cited the use of browser extensions, especially AdBlock, to reduce stress and enhance usability. The tools were used to:

- Block ads and pop-ups
- Minimize visual complexity
- Prevent misdirection

Quotes:

- "I use AdBlock to minimize the amount of information and see only what I am looking for" (ID 8)
- "Ad blocker prevents me from getting various pop-ups that could be potential viruses" (ID 4)

Interestingly, some participants used privacy-focused browsers (e.g., Brave) as substitutes for traditional extensions, suggesting a broader user need for integrated distraction-blocking.

4.2.3.6 Usability Barriers in Forms and Processes

A recurring complaint involved the difficulty of completing forms, citing issues like:

- Timeouts
- Confusing instructions
- Lack of visibility into previously entered or submitted information

Such problems contributed to abandonment or user frustration, underscoring the need for clearer feedback, better form guidance, and memory supports such as action reminders.

4.2.3.7 User-Identified Best Practices

Several users named websites they considered well-designed for cognitive accessibility:

- *Amazon*: for intuitive workflows
- *Wikipedia*: for clear structure and concept highlighting
- *WIPO, EMT, Canvas*: for large icons and organized content
- *Language platforms (WordReference, Linguee)*: for fast search and clear layout

Conversely, websites that deviated from common interaction patterns were described as confusing or cognitively demanding.

4.2.4 Findings

The questionnaire results highlight a range of accessibility concerns experienced by users when interacting with web content. Key insights include:

- Most respondents were women, consistent with research showing greater female participation in surveys on psychological or emotional topics [27] , which aligns with the stress-related nature of this questionnaire.
- The sample's high digital literacy and cultural diversity highlight that accessibility barriers persist even among tech-savvy users, indicating widespread design shortcomings across web platforms.
- Widespread difficulty processing dense text without clear formatting or summaries.
- A desire for adaptive features, such as special modes that filter content and simplify layouts.

- Heavy reliance on external extensions, such as ad blockers, indicating unmet internal browser or website capabilities.
- A preference for navigational scaffolds like indexes, collapsible content, and task reminders.
- Support for customizable display settings, including font, colour contrast, and layout simplification.

These results validate the core direction of the system under development: a Chrome extension focused on reducing cognitive load, enhancing readability, and increasing user autonomy via intelligent content control and personalization.

5 Design and development

5.1 Introduction

This chapter details the design and development process of the Chrome extension proposed to reduce cognitive stress and improve accessibility for users with neurodivergent traits or cognitive impairments. Informed by user research findings and aligned with accessibility best practices, the extension was designed with a strong emphasis on personalization, clarity, and minimal cognitive load. The following sections outline the system's requirements, design methodology, architectural components, and implementation strategies.

5.2 System Objectives and Requirements

5.2.1 Functional Requirements

FR#	Description
FR1	Highlight key concepts in webpage content.
FR2	Simplify complex layouts by hiding non-essential elements.
FR3	Provide a distraction blocker to remove ads.
FR4	Summarize long paragraphs or articles.
FR5	Add navigation tips and button highlighting.

Table 2 - Functional requirements

5.2.2 Non-Functional Requirements

NFR#	Description	Category
NFR1	Should run efficiently with low CPU and memory usage.	Performance
NFR2	Usage as much as possible of lightweight, offline and local libraries.	Portability
NFR3	Ensure compatibility with Chrome and Firefox on Windows.	Portability

Table 3 - Non-functional requirements

5.2.3 User Requirements

From user research:

NFR#	Description	Category
NFR4	Minimalistic and predictable interfaces.	Usability
NFR5	Must accommodate users with reduced attention spans.	Usability
NFR6	Allow real-time switching of accessibility modes (switch on/off modes).	Usability
NFR7	Prioritize features that reduce reading effort and visual distractions.	Usability

Table 4 - User Requirements

5.3 Design Process

5.3.1 Design Methodology

A User-Centred Design approach guided the development process, grounded in findings from the Web Interfaces Stress Questionnaire.

For the scope of the study just one iteration will be done, and the results of the usability test will be used to create open challenges and future works.

5.3.2 UI Sketches

5.3.2.1 Base

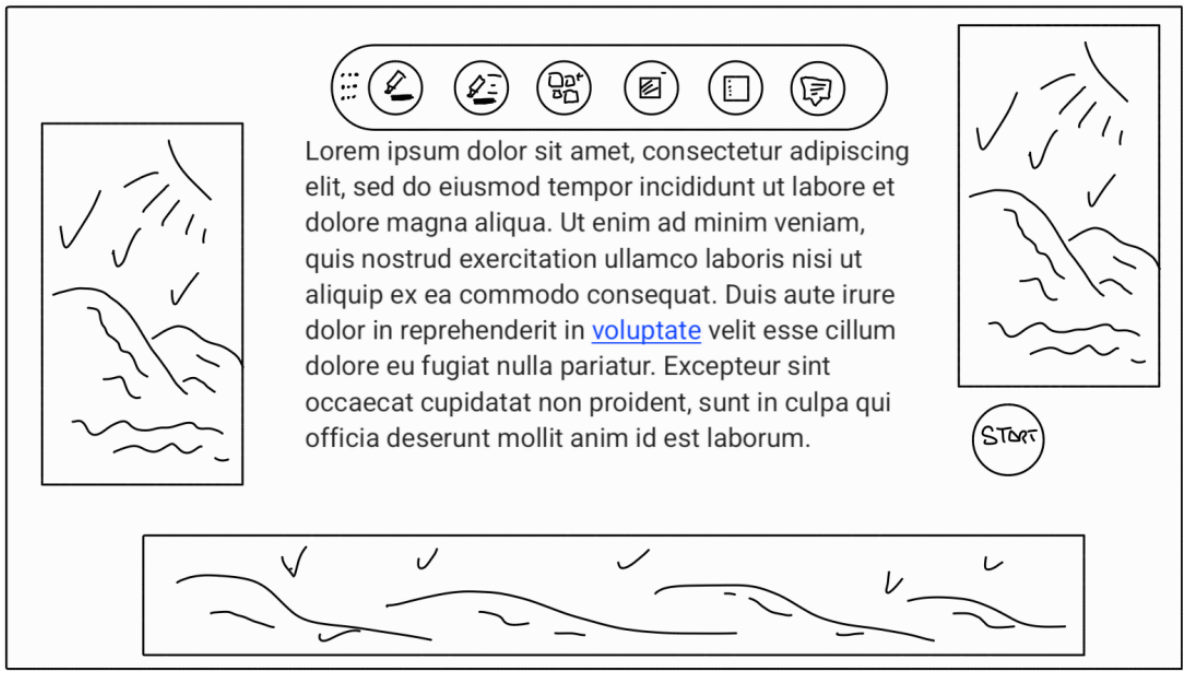


Figure 7 - The user interface of the extension is represented by the Floating Menu, positioned at the top of the sketch. This menu can be freely moved around the screen by dragging it from the grip handle located on its left side, indicated by a series of dots.

5.3.2.2 Highlight Paragraph and Highlight All Paragraphs

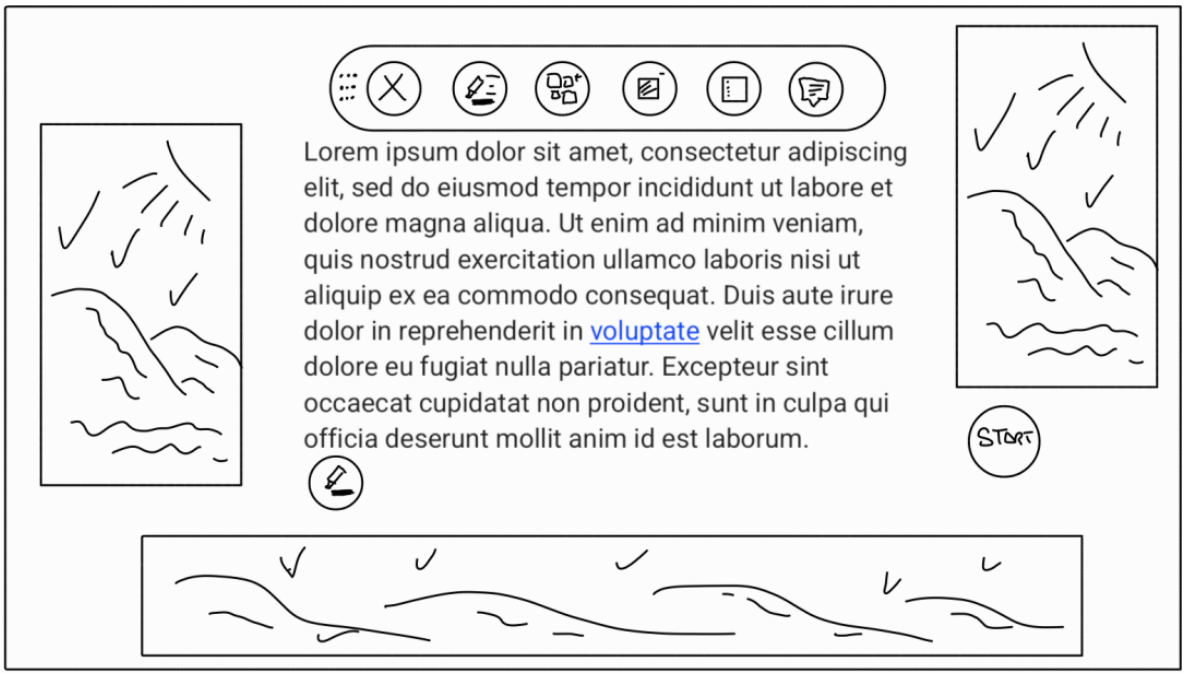


Figure 8 - When the button is clicked, the highlight mode is activated. As a result, a highlight button appears beneath each paragraph, allowing users to selectively highlight key content.

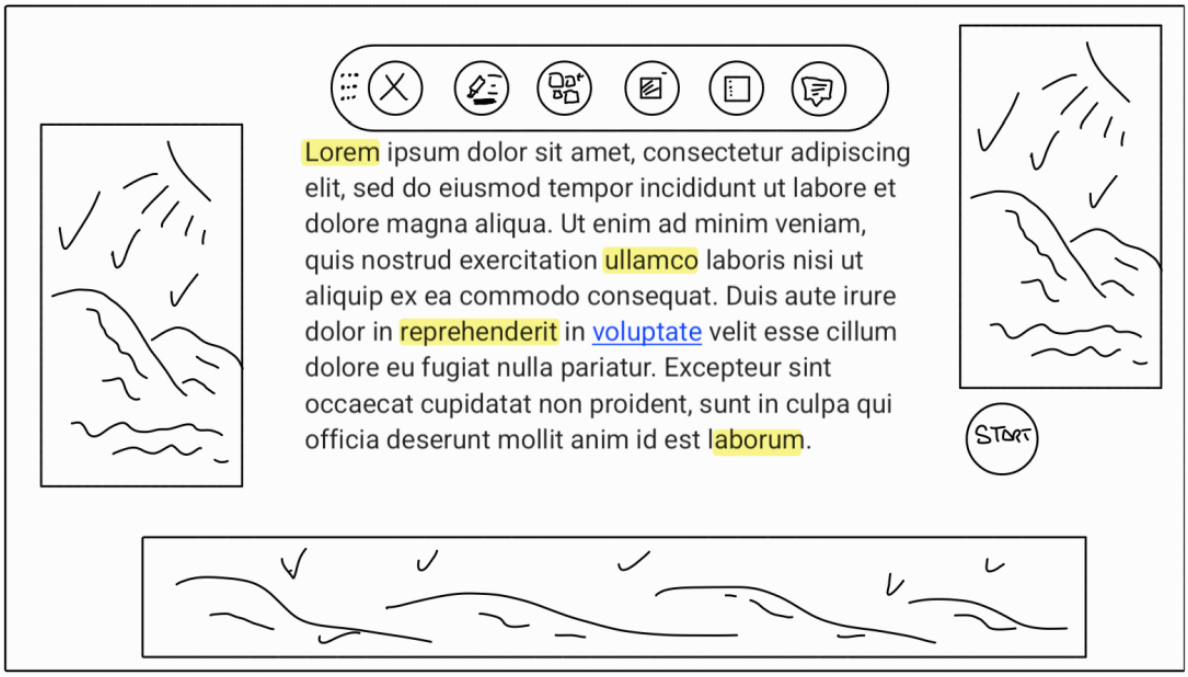


Figure 9 - This sketch represents the state after a user clicks the highlight button beneath a paragraph. To exit highlight mode, the user can click the "X" icon located in the Floating Menu.

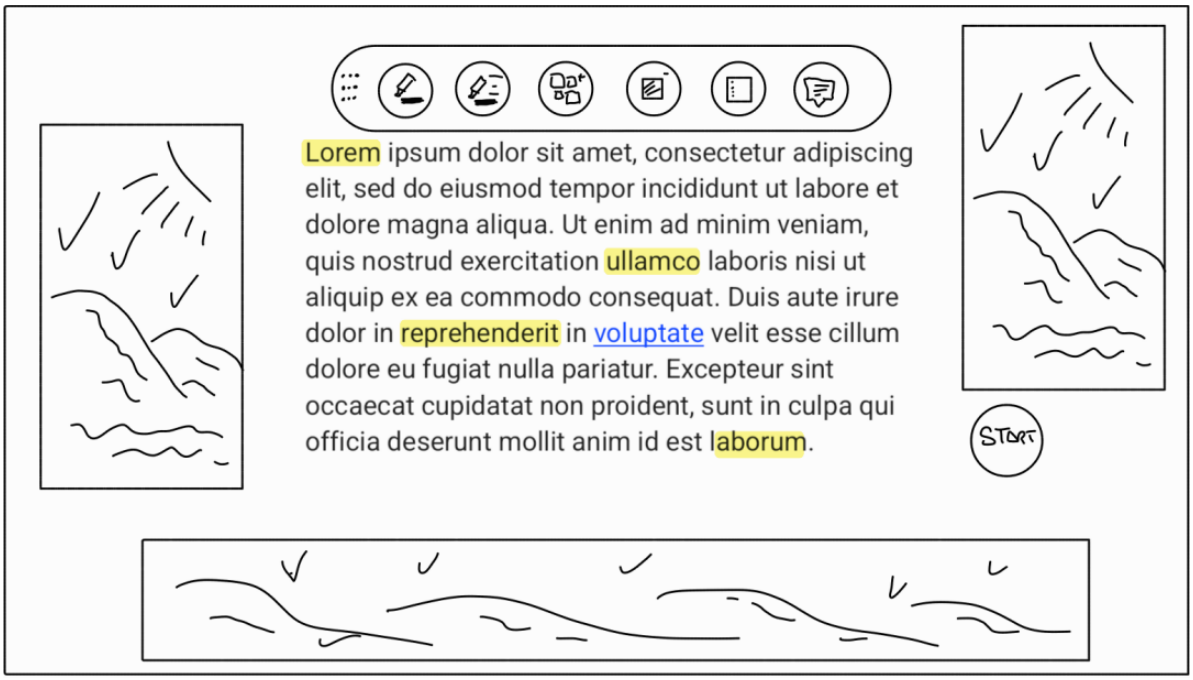


Figure 10 - This sketch illustrates the final state after exiting the Highlight Paragraph mode, or alternatively, after activating the Highlight All Paragraphs feature. In the latter case, all paragraphs are highlighted simultaneously.

5.3.2.3 Hide Elements

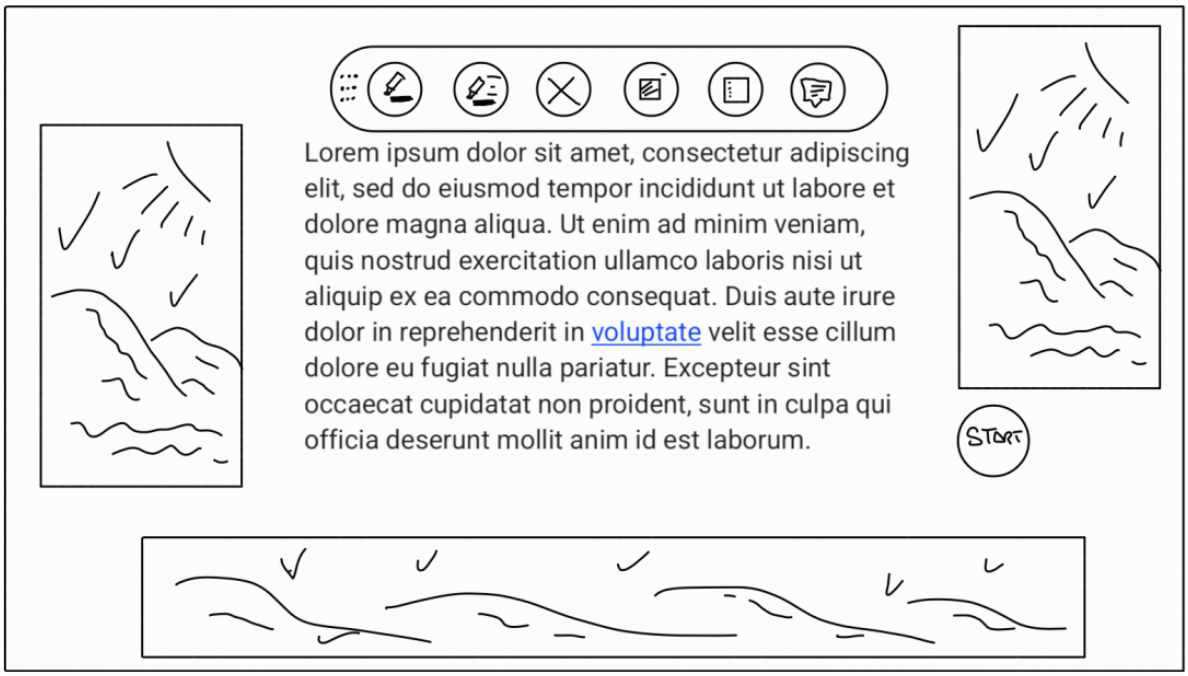


Figure 11 - When the button is clicked, the Hide Elements mode is activated.

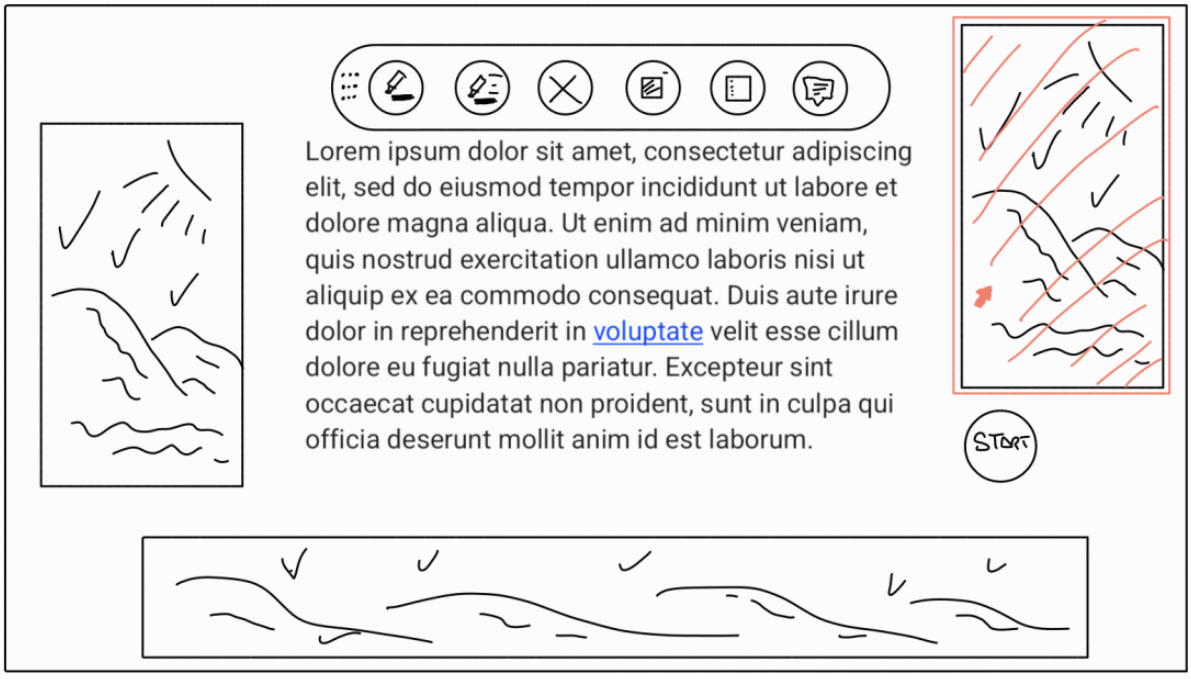


Figure 12 - When the user hovers the cursor over an element, it is visually highlighted to indicate that it is the target for "removal". This feedback communicates that the element will be "deleted" if the action is confirmed.

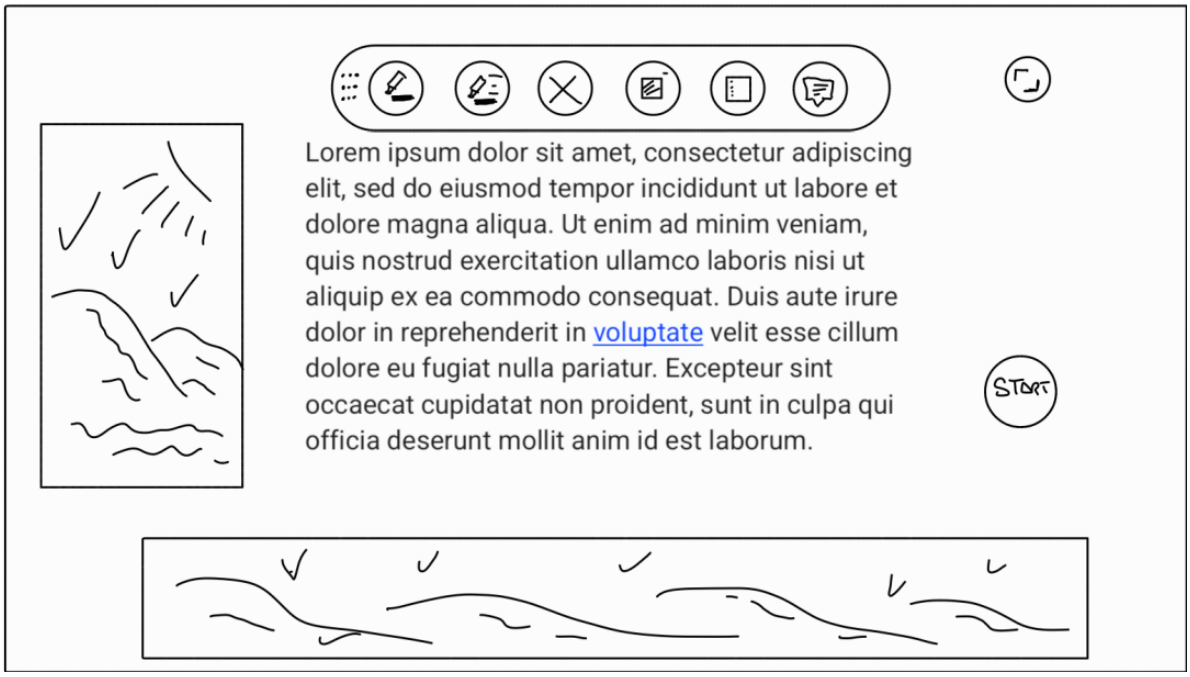


Figure 13 - The "deleted" element will be substituted with a button that can be clicked to restore it.

5.3.2.4 Remove Elements

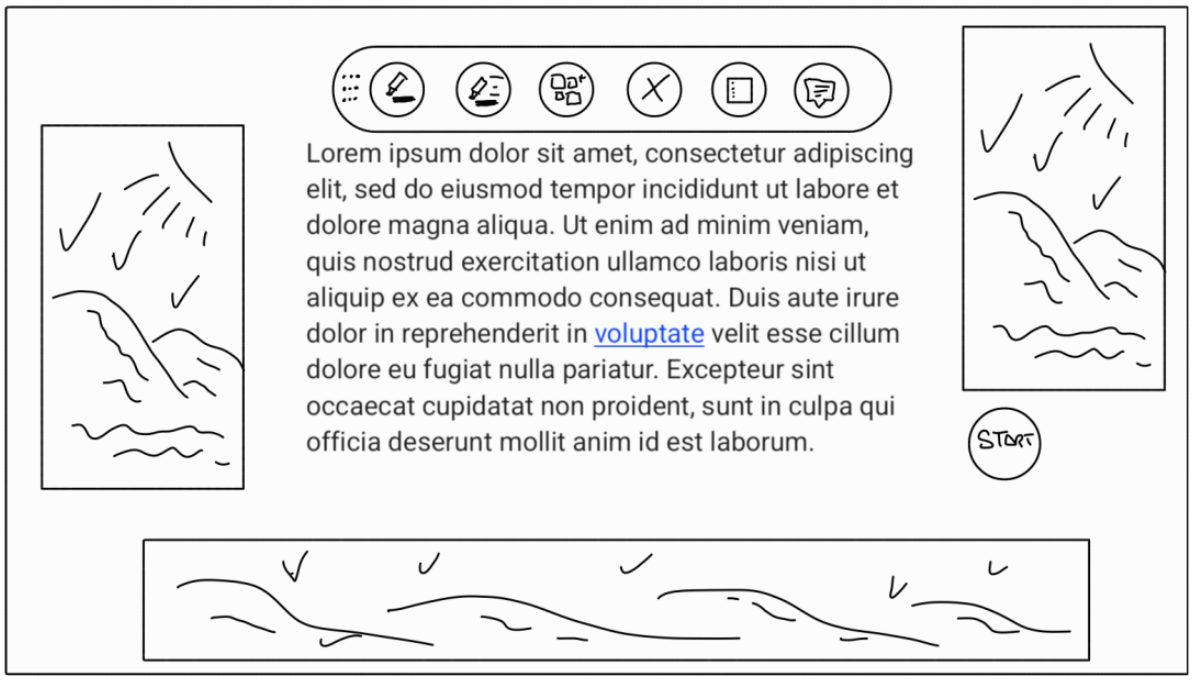


Figure 14 - When the button is clicked, the remove mode is activated.

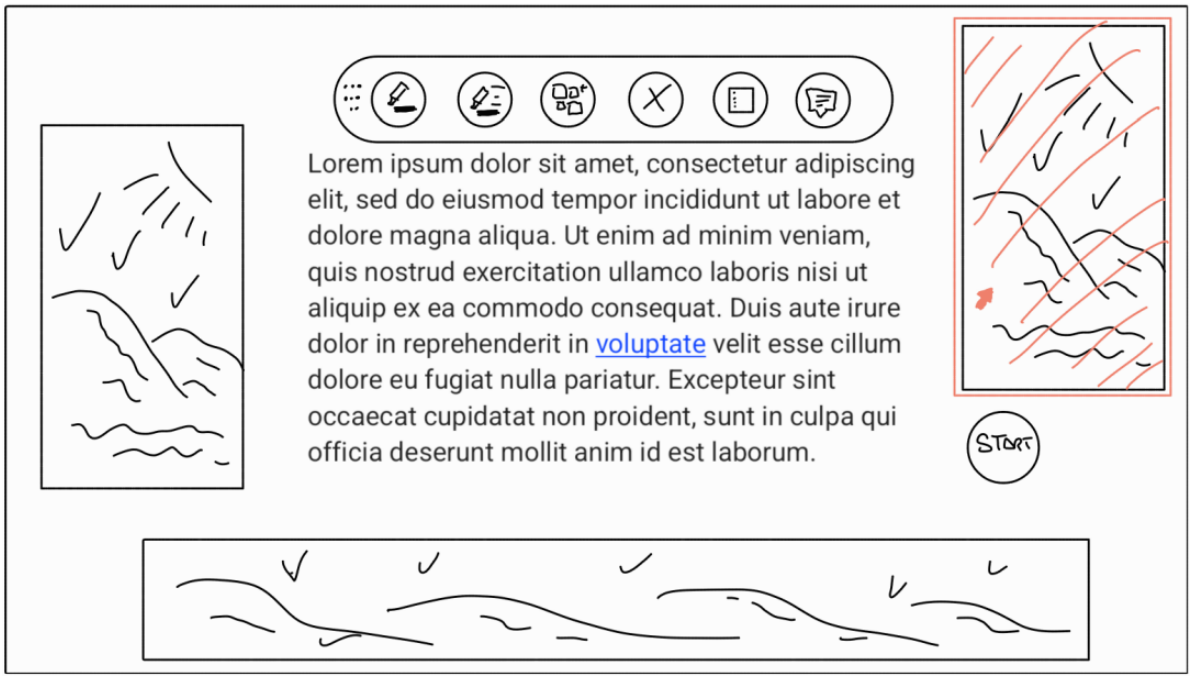


Figure 15 - When the user hovers the cursor over an element, it is visually highlighted to indicate that it is the target for "removal". This feedback communicates that the element will be "deleted" if the action is confirmed.

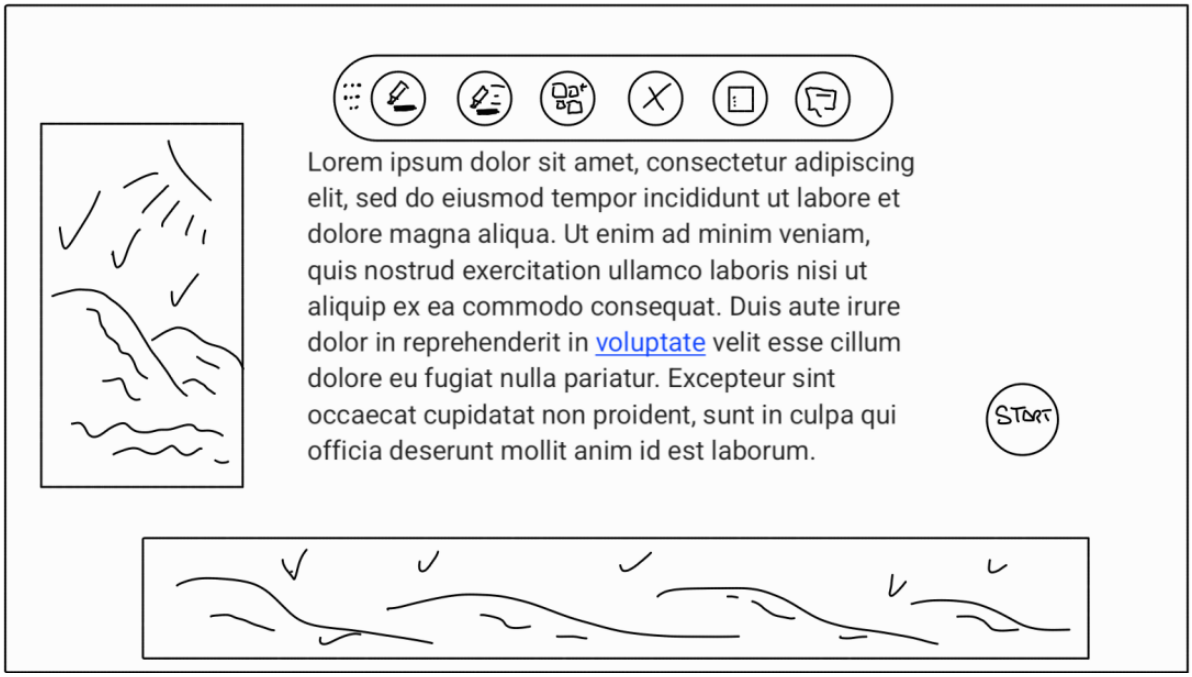


Figure 16 - It is evident that this mode closely resembles the Hide Elements feature; however, in this case, the removed elements are not replaced by placeholder buttons for restoration.

5.3.2.5 Summarize

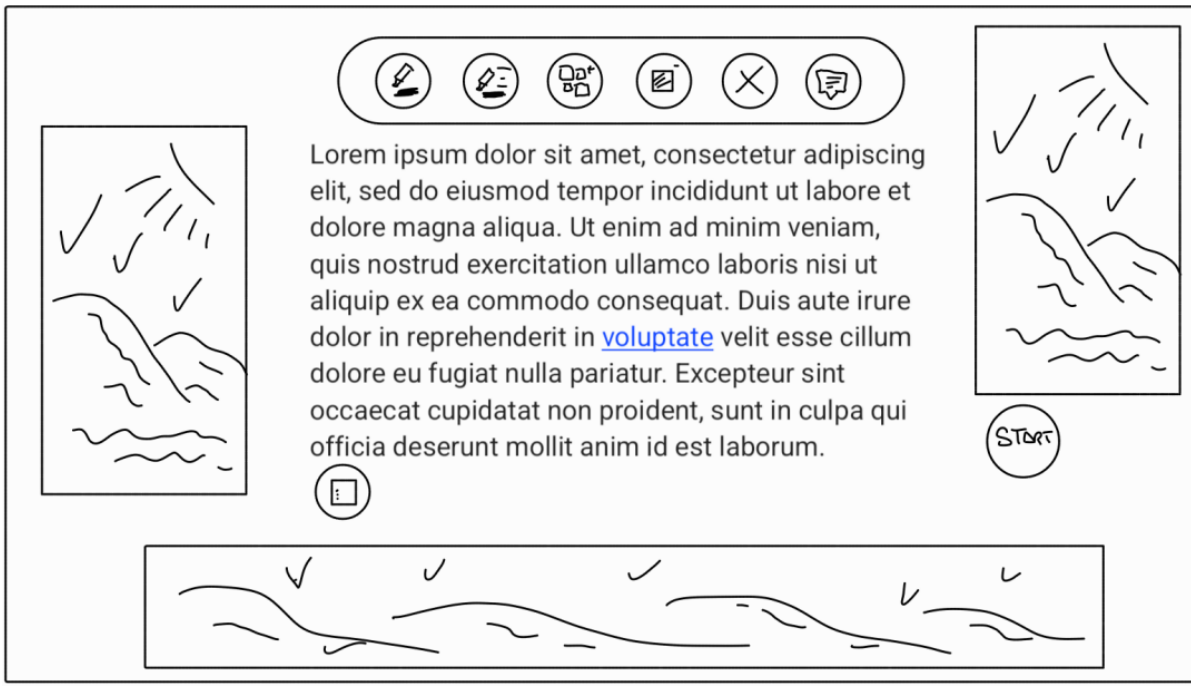


Figure 17 - When the button is clicked, the summarize mode is activated.

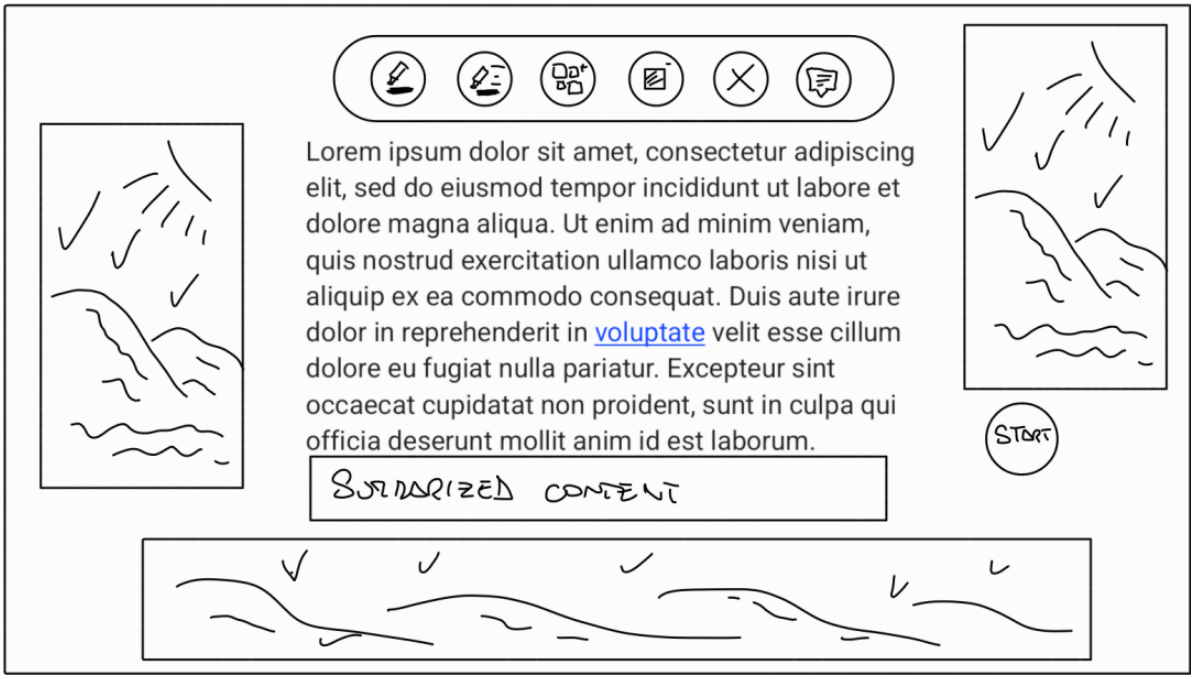


Figure 18 - The summarized content can be found inside this new section that can be open and closed as the user prefer.

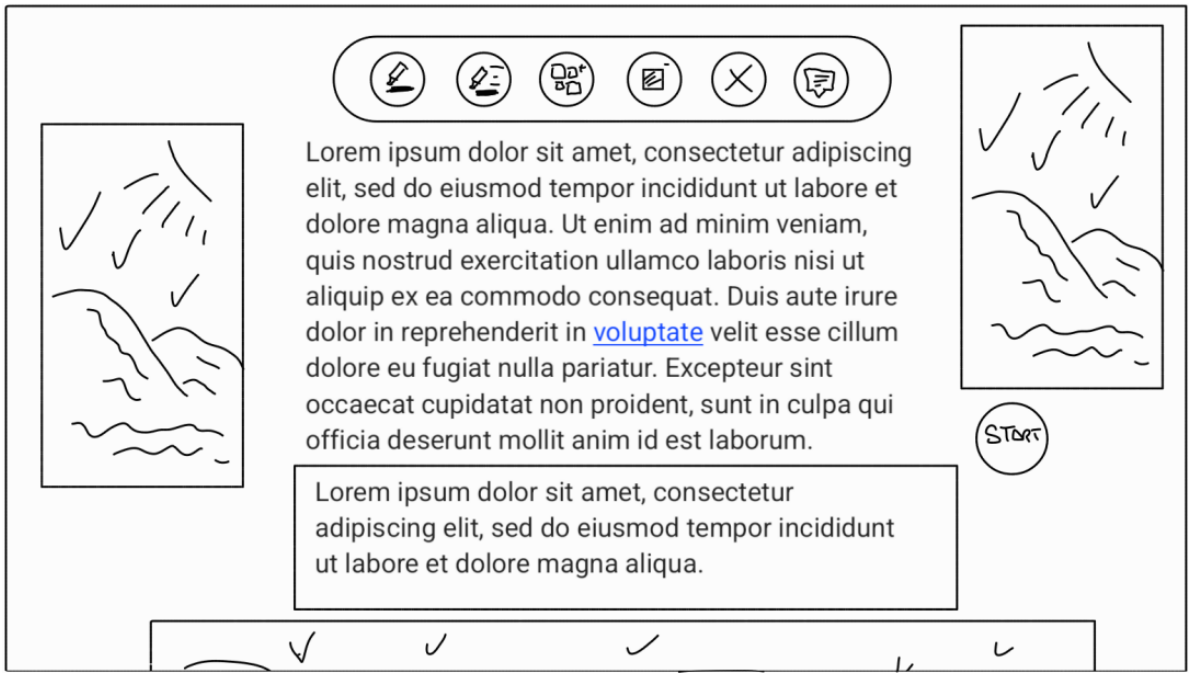


Figure 19 - The summarized content is visible after the click on the box.

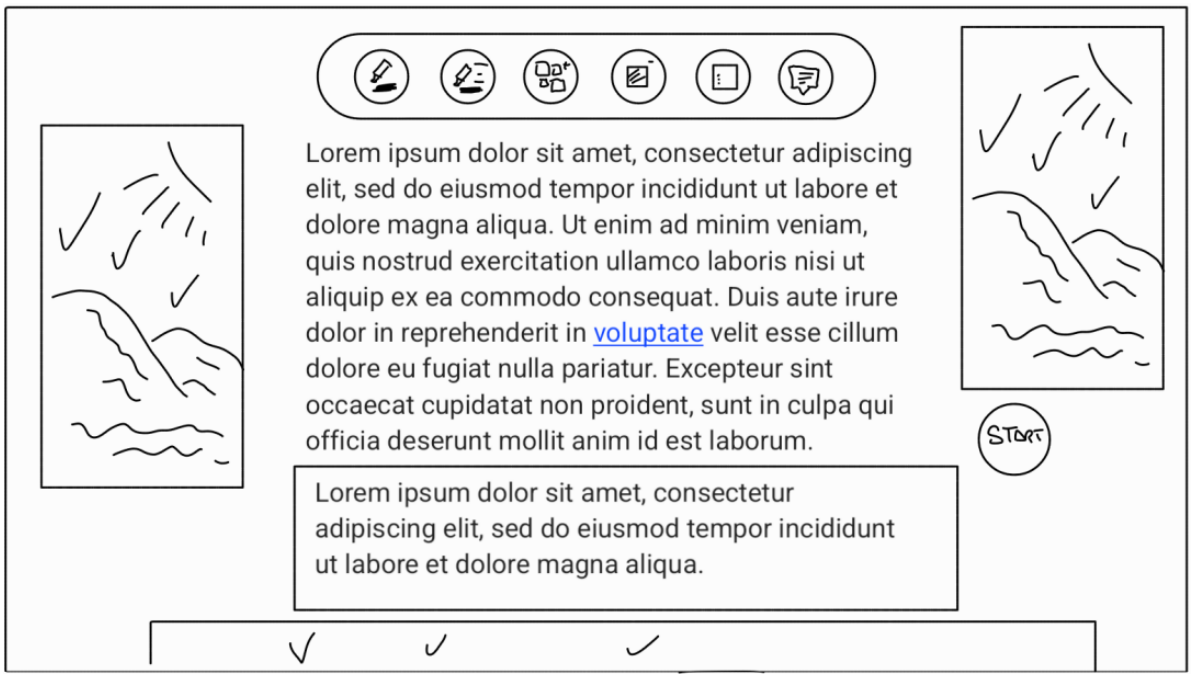


Figure 20 - The summarize mode has been deactivated.

5.3.2.6 Navigation Simplifier

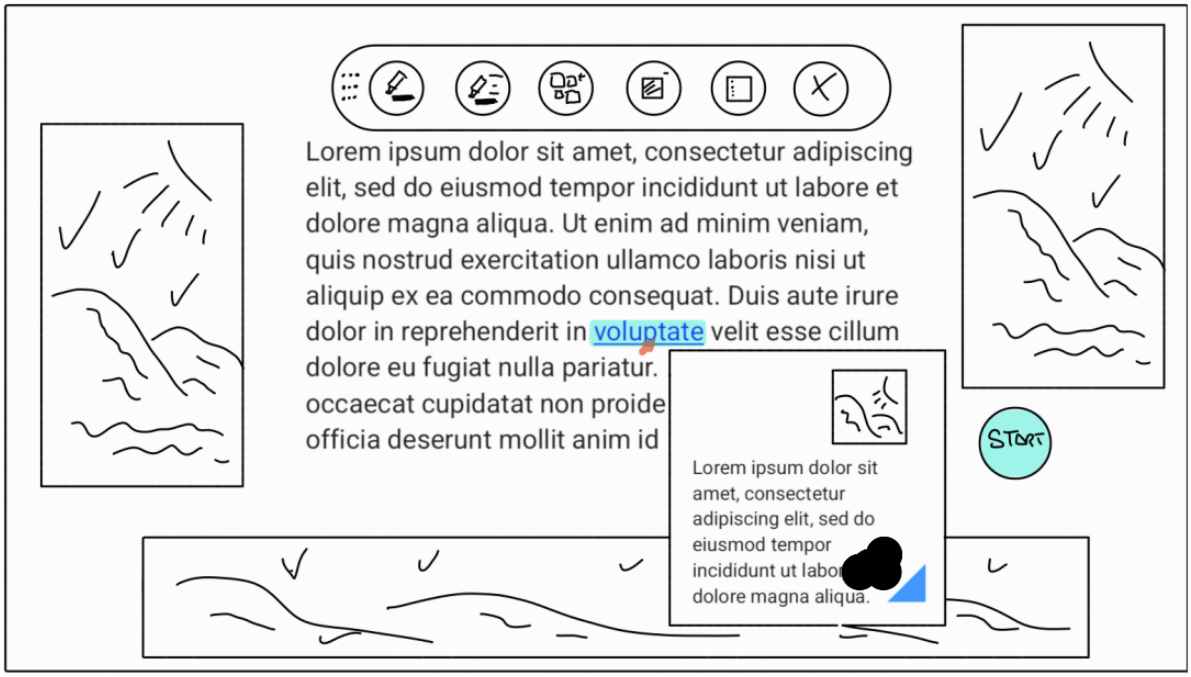


Figure 21 - When this mode is activated, all links and buttons on the page are visually highlighted. Additionally, hovering the cursor over a link triggers a preview of the linked page, providing the user with contextual information before clicking.

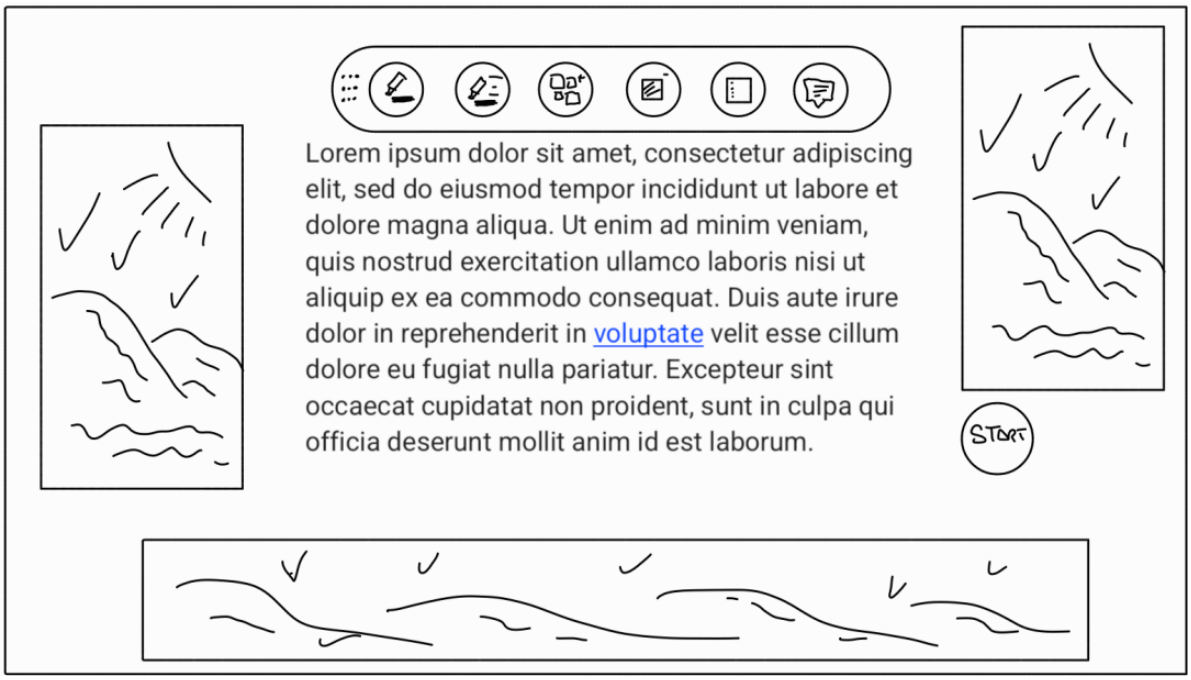


Figure 22 - Once out of the mode, the preview and highlights are deactivated.

5.3.3 Information Architecture

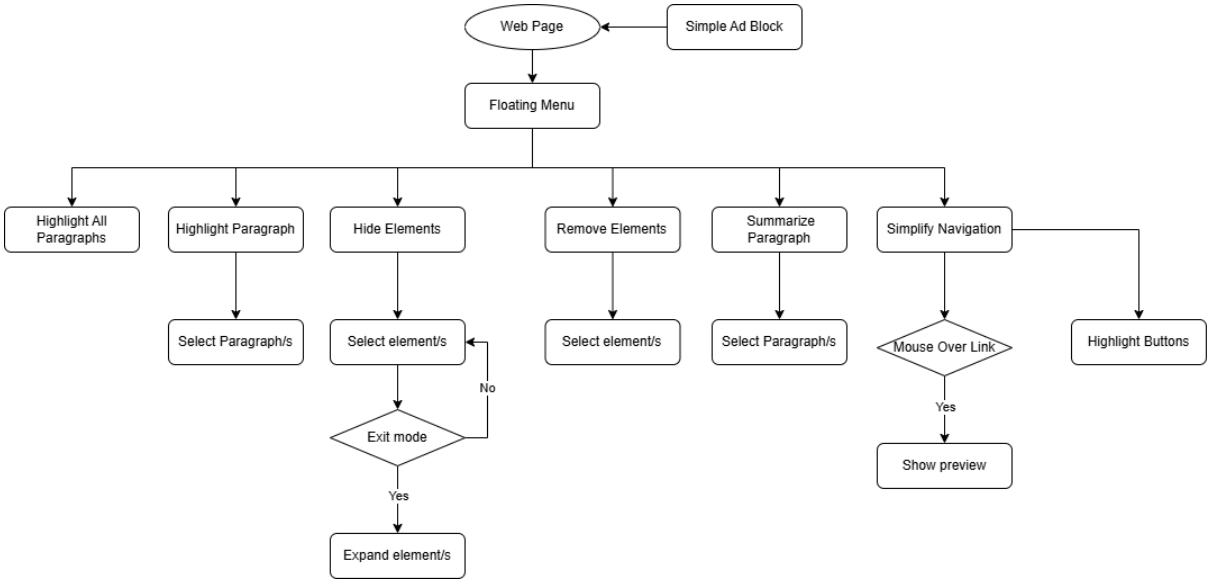


Figure 23 - Navigation map.

The web interface contains two core components of the application: the Floating Menu, which serves as the primary user interaction element, and the Simple Ad Block, which operates in the background without direct user involvement.

The Floating Menu provides access to all interactive features available to the user. Upon completing an interaction, users can exit or close the feature by clicking the "X" button displayed on the Floating Menu. For the sake of clarity and to avoid unnecessary complexity, this exit action has been omitted from the navigation diagram. Most features can be used simultaneously; however, Hide Elements and Remove Elements are mutually exclusive and cannot be used in conjunction with other tools. If either is active, it must be deactivated before enabling additional features. This constraint was implemented to prevent interface conflicts and ensure a smooth user experience.

5.4 Technical Architecture

5.4.1 Technology Stack

Languages: JavaScript, HTML, CSS
APIs: Chrome Extensions API (Manifest V3), DOM API

Libraries: Summary.js (text summarization) [28], compromise.js (NLP) [29]

5.4.2 System Components

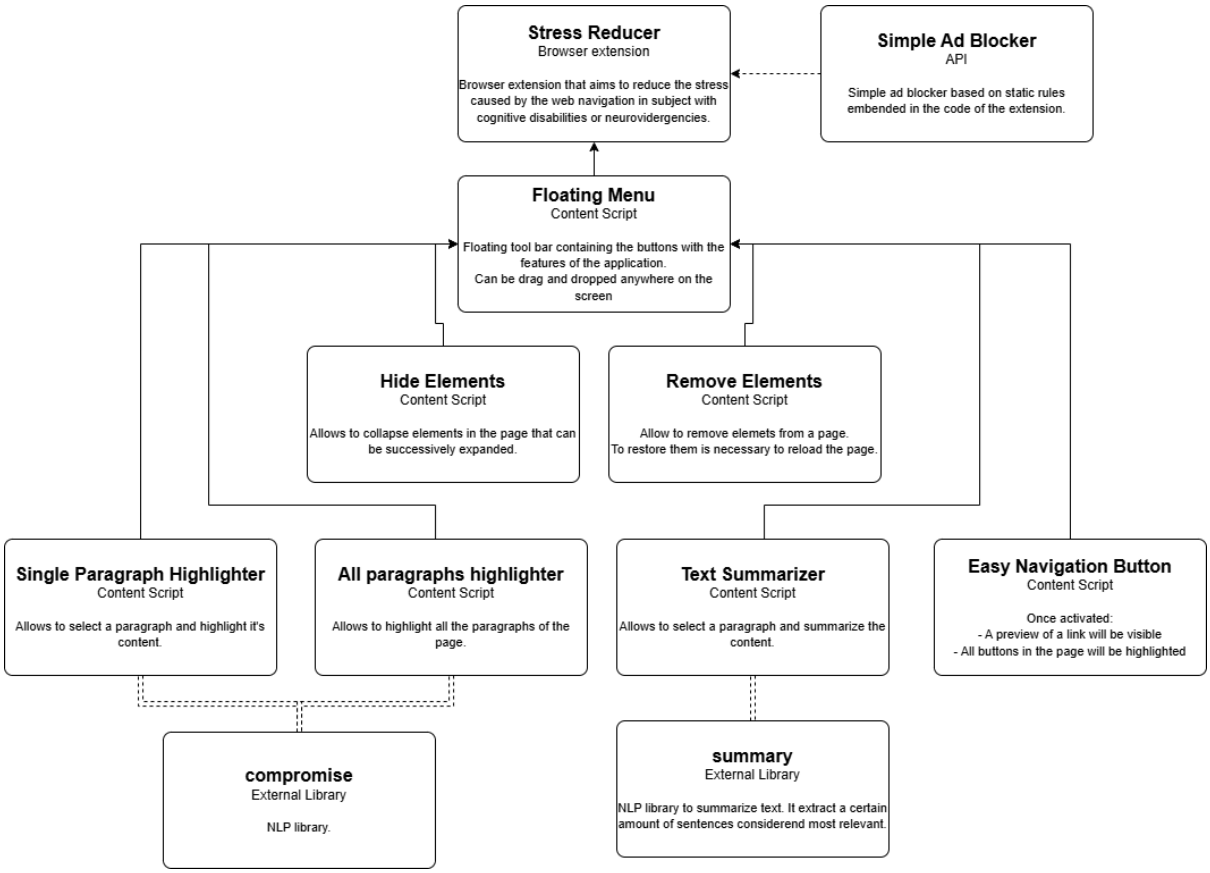


Figure 24 - System Components map.

Stress Reduced (Core Module): This module represents the core functionality of the extension. It encapsulates the overall purpose of the system: reducing cognitive stress during web interaction by offering adaptive tools and simplification features.

Simple Ad Blocker: This component filters webpage content by blocking known sources of advertisements. It uses a basic set of predefined rules to identify and suppress ad-related elements. The implementation is intentionally lightweight compared to commercial ad blockers, due to limited development resources.

Floating Menu: The extension includes a draggable floating menu that houses all available features. This toolbar provides users with quick access to interaction tools without disrupting the content of the webpage.

Hide Elements Mode: In this mode, users can selectively collapse visual components such as menus, images, or text blocks. Collapsed elements are

temporarily hidden and replaced by clickable placeholders that allow them to be restored as needed. This helps reduce sensory overload.

Remove Elements Mode: This mode enables users to permanently remove undesired elements from the interface during the current session. Unlike hiding, removed elements cannot be reinstated without reloading the page, offering a more aggressive way to minimize distractions.

Single Paragraph Highlighter: This feature allows the user to select an individual paragraph, which is then analysed to highlight key concepts such as people, organizations, acronyms, and other significant terms. This helps users quickly grasp the core message of the text.

All Paragraphs Highlighter: An extension of the single-paragraph tool, this function applies concept highlighting across all paragraphs on the page, offering a comprehensive overview of important content.

Text Summarizer: When activated, this tool processes a selected paragraph and identifies the most relevant sentence within it. This simplified version of summarization helps users with reduced attention capacity or time constraints focus on the most important information.

Easy Navigation Mode: In this mode, all interactive elements (e.g., buttons and links) are visually emphasized. Additionally, hovering over hyperlinks triggers a tooltip that provides a short preview or description of the target page. This improves orientation and reduces uncertainty during navigation.

Compromise: This natural language processing library is used to parse selected text and extract key terms, including named entities and numerical references, which are then highlighted to enhance comprehension.

Summary: This utility supports the summarization feature by identifying the sentence in a paragraph that most accurately represents its overall meaning, providing a minimalistic but effective text simplification method.

5.5 Implementation Details

5.5.1 Overview

The complete source code for the extension is available on GitHub [30].

The application was developed incrementally, with each feature implemented in a dedicated branch. Upon completion, each feature branch was merged into the main

branch through a pull request. As the project progressed, it became necessary to work on multiple features concurrently. To manage this complexity, an intermediate development branch (dev) was introduced between the feature branches and the main branch. New features were first integrated into the dev branch, tested for stability, and then merged into the main branch only after successful validation. This branching strategy ensured modular development while maintaining code integrity throughout the project lifecycle.

5.5.2 Feature Development

Feature	Description	Technologies/APIs Used
Text Simplification	Highlights or summarizes key ideas on a page	DOM APIs, NLP libraries
Ad Blocking	Hides distracting elements (e.g. advertisements)	Chrome APIs (declarativeNetRequest), static ruleset
Navigation Enhancements	Shows link previews and highlight buttons	Local storage, DOM APIs
Layout Simplification	Remove manually page elements	DOM APIs

Table 5 - Feature development summary

5.5.3 Code snippets

In this section some interesting parts of the code are shown.

5.5.3.1 floating-menu

```
...
// Create and append buttons
    const singleParagraphHighlighterButton =
createSingleParagraphHighlighterButton(document);
    floatingMenu.appendChild(singleParagraphHighlighterButton);

    const allParagraphHighlighterButton =
createAllParagraphHighlighterButton(document);
    floatingMenu.appendChild(allParagraphHighlighterButton)

    const hideElementButton = createHideElementsButton(document);
    floatingMenu.appendChild(hideElementButton);

    const removeElementButton = createRemoveElementsButton(document);
    floatingMenu.appendChild(removeElementButton);
```

```
    const summarizerButton = createTextSummarizerButton(document);
    floatingMenu.appendChild(summarizerButton);

    const easyNavButton = createActivateEasyNavigationButton(document);
    floatingMenu.appendChild(easyNavButton);
    /* More buttons here
    *
    */
...
```

This snippet demonstrates how buttons are dynamically added to the Floating Menu. It highlights the modular structure of the codebase, where each feature is encapsulated within its own function. To add a new button, it is sufficient to define a function that generates the corresponding DOM element and appends it to the Floating Menu at the desired position. This design promotes reusability, scalability, and ease of maintenance.

5.5.3.2 highlighter

```
function extractKeyWords(text){
    const doc = nlp(text);
    const topics = doc.topics().out('array');
    const numbers = doc.numbers().out('array')
    const acronyms = doc.acronyms().out('array');
    const hyphenated = doc.hyphenated().out('array');
    const emails = doc.emails().out('array');
    const phoneNumbers = doc.phoneNumbers().out('array');

    const out = [...topics, ...numbers, ...acronyms, ...hyphenated, ...emails,
...phoneNumbers]
    return out
}
```

This snippet illustrates how the Compromise.js library is used, invoked via the doc variable, to extract and highlight key concepts from a given text. Each function call targets specific types of content: named entities (such as people, places, and organizations), numerical values, acronyms, hyphenated terms (e.g., *like-this*), email addresses, and phone numbers. The identified terms are collected into an output array, which is then used to locate and highlight the corresponding words within the HTML content of the page.

5.5.3.3 Rest of the code

The remainder of the code primarily involves dynamic manipulation of the DOM, which, while essential to the extension's functionality, is relatively standard and not particularly relevant to highlight in this section.

6 Evaluation

6.1 Planning of the usability testing

6.1.1 Evaluation goals

The goal of this evaluation is to perform a usability test of the extension, including performance measuring. The results obtained for effectiveness, efficiency and satisfaction will be checked against optimal values that are defined in this document.

Further details on the questionnaires, dates, facilitators, modalities, consent form are available in the annex 9.2.

6.1.2 Process

1. Say the "welcome text" to the participant.
2. Explain the consent form and collect the participant signature.
3. Gather personal information.
4. Explain generally how the extension works (what button does what).
5. Do the usability testing of the prototype. Ask the participant to perform the tasks, gather data and observations.
6. After using the prototype, ask the participant to fulfil the user satisfaction questionnaire and ask for general impressions.

6.1.3 Tasks to be performed by participants

Task	**T1**
Title	Highlight a paragraph at a time
Starting situation	The feature is disabled
Task instructions	Please highlight a paragraph/s.

Table 6 - Task 1

Task	**T2**

Title	Highlight all paragraphs at once
Starting situation	The page is not ALL highlighted
Task instructions	Please highlight all paragraphs at once.

Table 7 - Task 2

Task	**T3**
Title	Hide elements from the page
Starting situation	The feature is disabled
Task instructions	Please hide an element/s from the page.

Table 8 - Task 3

Task	**T4**
Title	Remove elements from the page
Starting situation	The feature is disabled
Task instructions	Please remove an element/s from the page.

Table 9 - Task 4

Task	**T5**
Title	Summarize a paragraph
Starting situation	The feature is disabled
Task instructions	Please summarize a paragraph/s.

Table 10 - Task 5

Task	**T6**
Title	Use the easy navigation function
Starting situation	The feature is disabled

Task instructions	Please activate the easy navigation function.

Table 11 - Task 6

6.1.4 Measurements

6.1.4.1 Objective measurements

Measurement	Description
Time	Time required to complete one task
Actions	Number of elemental actions performed (click, tap, …) to complete one task.
Mistakes	Number of mistakes made during one task.
Success	Yes/no (whether the participant succeeds at completing the task).

Table 12 – Measurements description

6.1.4.2 Optimal values

Task	Time	Actions
T1	5s	3
T2	<1s	1
T3	7s	>4
T4	5s	3
T5	7s	>4
T6	5s	3

Table 13 - Task optima time and action values

6.2 Usability evaluation report

6.2.1 Goal of evaluation

Evaluate the performance (effectiveness and efficiency) of participants when using the browser extension. Evaluate the participants' satisfaction with the SUS questionnaire.

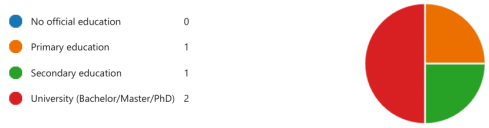
Further details on the dates and gathered data are available in the annex 9.3.

6.2.2 Participant demographics

2. Age

3. Gender

4. Educational level

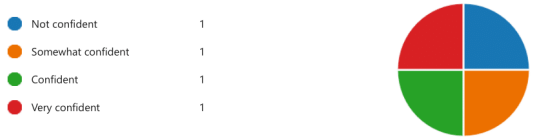


5. How much time do you spend using a personal computer (desktop or laptop) on an average day?

Figure 25 - Page one of demographic questionnaire

6. How often do you use browser extensions in your everyday browsing?

7. How confident do you feel using digital tools (e.g., apps, browser add-ons, accessibility features)?



8. Do you regularly use any accessibility tools (e.g., screen readers, text-to-speech, font changers, color filters)?

Figure 26 - Page two of demographic questionnaire

9. If the previous answer was yes, which ones?

   “text-to-speech"

10. Any additional information you'd like to share about your web browsing experience or needs?

    “text to speech saved me in university, when I had to read a lot.”

    “I struggle when the button is confusion, the contact information gets lost. I like minimalist websites.”

6.2.3 Effectiveness

6.2.3.1 Effectiveness results

	Mistakes (average)	Mistakes (std. dev.)	Success rate
T1	0	0	100%
T2	0	0	100%
T3	0.5	0.5	100%
T4	0.25	0.433	100%
T5	0	0	100%
T6	0	0	100%

Figure 27 - Example of table with effectiveness information

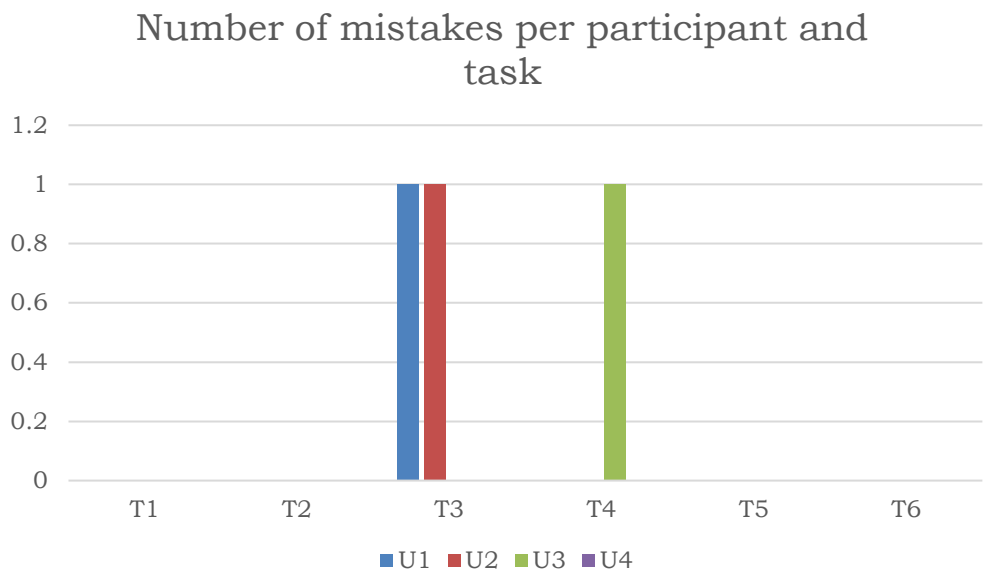


Figure 28 - Number of mistakes per participant.

Effectiveness findings:

- Finding 1: All the tasks have a success rate of 100%.
- Finding 2: T1, T2, T5, T6 have zero mistakes.
- Finding 3: two users have done one mistake in T3.
- Finding 4: one user has done one mistake in T4.

6.2.3.2 Effectiveness analysis

Effectiveness problems of the extension:

- Problem 1: While success was ultimately achieved in these tasks, most mistakes occurred during layout personalization tasks. Two users made mistakes in T3, and one in T4.
  Examples:
  - Participant 0001 believed only one element was hidden, when actually multiple were. Participant 0005 had a similar experience.
  - Participants expressed confusion over similar-looking icons or unclear interactions.
  - Participant 0007 tried to remove a link and was unexpectedly redirected, suggesting either a bug or usability flaw.
- Problem 2: Tasks T3 and T4 were frequently described as too similar or indistinguishable. This resulted in reduced clarity and confidence in use.
  Examples:
  - Participant 0005 and 0010 both noted the overlap in functionality and design between the features.
  - Participant 0010 explicitly mentioned preferring T3 but not noticing a meaningful difference in T4.
- Problem 3: Some users struggled with understanding visual indicators during interaction.
  Examples:
  - in T1, users did not initially recognize the highlighting due to the green dotted line being too subtle or unclear. This happened because there was nothing to highlight and only the green dotted line appeared.

- In T6, too many green-highlighted parts led to confusion.

- Problem 4: Participants sometimes misunderstood what icons meant or what actions they triggered.

  Examples:
  - Participant 0001 thought the “plus” icon implied adding something instead of hiding elements.
  - Participant 0010 had general difficulty understanding icon meanings.

6.2.4 Efficiency

6.2.4.1 Efficiency results

	Time (avg.)	Time (std. dev.)	Optimum time	Time ratio
T1	3.75s	1.48s	5s	0.75
T2	1.5s	0.5s	<1s	<1.5
T3	8.75s	3.77s	7s	1.25
T4	11.25s	2.99s	5s	2.25
T5	13.75s	2.5s	7s	1.96
T6	1.5s	0.5s	5s	0.3

Table 14 - Table containing information about time to perform tasks.

	Actions (avg.)	Actions (std. dev.)	Optimum number of actions	Actions ratio
T1	3	1.22	3	1
T2	1.25	0.43	1	1.25
T3	4.25	1.48	>4	1.125
T4	5	0	3	1.67
T5	3.75	1.3	>4	0.94
T6	2.25	0.43	3	0.75

Table 15 - Table containing information about number of elemental actions.

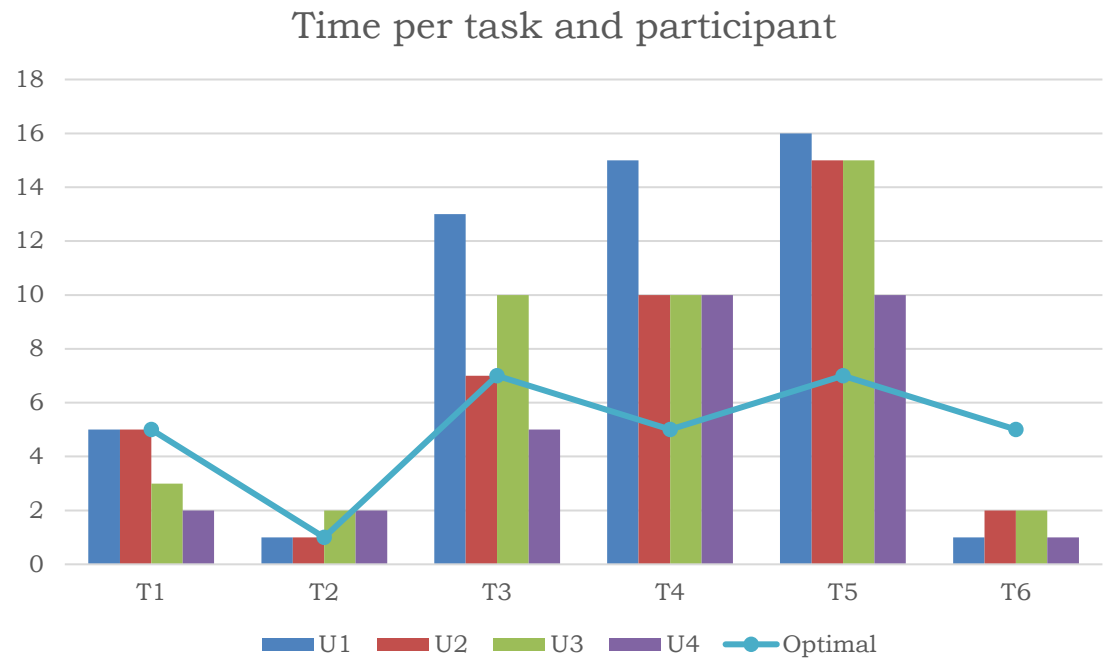


Figure 29 - Time to complete the task, compared to optimal value.

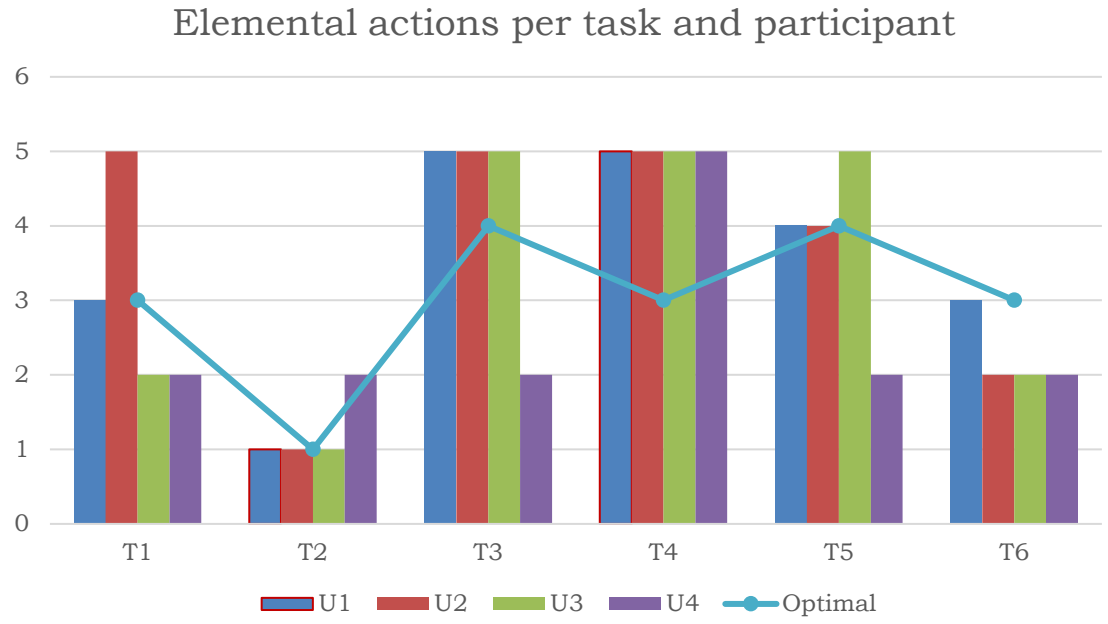


Figure 30 - Number of elemental actions to complete the task, compared to optimal value.

Efficiency findings for the extension:

- Finding 1: The time ratio is high only for tasks T4, T5

- Finding 2: The action ratio is high only for tasks T4
- Finding 3: From the graph is visible that the action and times are more or less following the distribution of the optimal case, except for the tasks T3, T4, T5.

6.2.4.2 Efficiency analysis

Efficiency problems of the extension:

- Problem 1: T4 and T5 had noticeably high time ratios. These results suggest that participants needed more time than expected to understand or execute these features.
  Examples:
  - Participant 0010 felt overwhelmed and confused by the English-only interface in T5.
  - Participant 0007 hesitated to trust the summarizer (T5), especially due to language barriers (Spanish).
  - Participant 0001 found the T4 layout visually confusing because of excessive blurring and colours.
- Problem 2: T4 required actions showed a higher than optimal number of elemental actions.
  Examples:
  - Participant 0007 tried to click many elements and wished for a multi-selection option.
  - Participant 0005 had to interact with multiple elements before understanding the result of their actions.
- Problem 3: Some participants expressed difficulty distinguishing between similar features (e.g., T3 vs. T4, T1 vs. T2), leading to inefficient interaction patterns. Users clicked through both to understand the difference, increasing time and actions unnecessarily.
- Problem 4: Visual cues (like highlighting or iconography) were not always interpreted as intended.
  Examples:
  - Participant 0001 initially failed to understand the highlight in T1.

- Participant 0010 tried to reverse an action in T3 but couldn't figure it out easily, leading to wasted time.

6.2.5 User satisfaction: SUS questionnaire

6.2.5.1 SUS results

SUS Score	Value
SUS Score 1	85
SUS Score 2	82.5
SUS Score 3	95
SUS Score 4	90
SUS Average	88.125
SUS Std. dev.	5.543389457

Table 16 - SUS scores

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	0	0	0	2	2
2	2	1	1	0	0
3	0	0	0	0	4
4	4	0	0	0	0
5	0	0	1	1	2
6	3	0	1	0	0
7	0	0	2	0	2
8	4	0	0	0	0
9	0	0	0	1	3
10	3	0	0	0	1

Table 17 - Example of results of the SUS questionnaire

SUS findings for the extension:

- Finding 1: 100% of the users would like to use the extension again.
- Finding 2: 100% of the users strongly agreed that the extension is easy to use.

- Finding 3: 100% of users strongly disagreed with the need of a technical support, 75% think they do not need a lot of time to learn how to use it.
- Finding 4: slightly more than 50% thinks the extension is well integrated and consistent.
- Finding 5: 100% of users think the extension is not over complicated to use.
- Finding 6: 100% of users felt confident using the system and 50% thinks most of the people would learn how to use it quickly.

6.2.5.2 Analysis of SUS

The average SUS score was 88.125, which is well above the industry average of 68, indicating very high user satisfaction.

The SUS questionnaire does not present huge problems.

6.2.6 General impressions of participants

6.2.6.1 What are the main problems you have found while using this extension?

Findings on main problems:

- Finding 1: 50% of users reported confusion related to blurring effects and hidden elements, in layout personalization tasks (T3/T4).
- Finding 2: 50% of users identified the lack of a Spanish version or poor language support as a problem.
- Finding 3: 25% of users stated that icons were unclear or misleading.
- Finding 4: 25% of users expressed no major problems using the extension.

6.2.6.2 What is the part of the extension that has been more difficult to understand? Why?

Findings on parts of the prototype more difficult to understand:

- Finding 1: 50% of users reported confusion between similar features (T1 and T2, T3 and T4).
- Finding 2: 25% of users said that the icons were unclear, making the interface harder to interpret.

- Finding 3: 25% of users indicated that the easy navigation mode (T6) was visually overwhelming due to excessive colour usage.
- Finding 4: 25% of users reported no specific difficulties in understanding any part of the extension.

6.2.6.3 What have you liked most of the extension? Why?

Findings on most liked features:

- Finding 1: 50% of users liked the T3 (hide elements).
- Finding 2: 50% of users liked the T5 (summarise).
- Finding 3: 50% of users liked the T2 (highlight all).
- Finding 3: 25% of users liked the T6 (easy navigation) especially for the previews.

6.2.6.4 Can you describe your overall experience with this extension?

Findings on the overall experience with design:

- Finding 1: 100% of users is positive towards the overall experience with the extensions.
- Finding 2: 50% of users would for sure use it often.
- Finding 3: 25% of users liked the possibility of hiding pictures and unliked the possibility of save the preferences.

6.2.7 Summary of usability problems

Extension	Problem	Severity
Problem 1	Difficulty distinguishing between similar features (e.g., T1 vs. T2 and T3 vs. T4)	Major
Problem 2	Blurring and visual effects in layout personalization caused confusion	Major
Problem 3	Unclear icon meanings (e.g., "+" symbol misinterpreted as adding)	Major
Problem 4	High time and action ratios in T4 and T5 tasks (inefficient interaction)	Major

Problem 5	Lack of Spanish language support, reducing usability for non-English users	Minor
Problem 6	Visual overload in easy navigation mode (too many colours on screen)	Minor
Problem 7	Difficulty understanding preview delays or feedback during T6 execution	Minor
Problem 8	Highlight feedback not immediately visible or intuitive in T1	Minor
Problem 9	Functional redundancy perceived by users reduced satisfaction	Major

Table 18 - Identified problems

6.2.8 Proposals to improve the prototype

Improvement	Problem(s) addressed	Description of improvement
Improvement 1	Problem 1, Problem 4, Problem 9	The features T1 and T4 can be removed, lowering the misunderstandings and increasing the learning curve.
Improvement 2	Problem 2, Problem 6, Problem 8	Personalising the blur (activate/deactivate) and the colour of the buttons in the easy navigation mode (different colours, maybe also with transparent). Personalise feedback for the highlighting or change it in something clearer, so that even though nothing is highlighted the user can understand.
Improvement 3	Problem 3	Change icon.
Improvement 4	Problem 5	Support different languages.

Improvement 5	Problem 7	Make the loading of the preview visually understandable with an animation maybe.

Table 19 - Proposal of improvements

6.2.9 General conclusions

The usability evaluation of the extension was conducted with four participants who completed a series of structured tasks. The primary objectives of this evaluation were to assess the effectiveness, efficiency, and user satisfaction of the prototype. All participants successfully completed the tasks, resulting in a 100% success rate across all interactions. Additionally, the System Usability Scale (SUS) revealed an average score of 88.125, which is significantly above the standard benchmark of 68, indicating that users found the prototype highly usable and satisfying.

Throughout the testing, several features were positively received, including the "highlight all" functionality, the summarizer, and the element-hiding tool. Users found these features intuitive and valuable, particularly for focused reading or academic tasks. The overall experience was described as enjoyable and effective, and several participants expressed interest in using the extension regularly, especially in educational contexts.

However, the testing also revealed areas for improvement. One of the most significant issues was the difficulty users had in distinguishing between similar features. This redundancy led to confusion and additional time spent trying to understand functional differences. Visual elements, such as the blurring effect and certain icons (e.g., the "plus" symbol), were also sources of misunderstanding and contributed to minor errors during task completion. Efficiency issues were evident in tasks that required layout personalization or navigation adjustments, where users took longer than the optimal time and performed more actions than necessary. Furthermore, the lack of Spanish language support impacted the usability experience for two participants and highlights a need for better inclusivity in future iterations.

Overall, the usability testing process offered valuable insights into both the strengths and limitations of the prototype. While the prototype is functionally complete and well-received, addressing the identified usability issues, particularly those related to clarity, interface design, and accessibility, will be crucial for improving the user experience.

6.3 Expert Cognitive Walkthrough

This chapter presents a selection of recommendations provided by an expert during a cognitive walkthrough. A complete summary of the expert feedback can be found in annex 9.4.

6.3.1 Highlight Single and All Paragraphs

Two modes are justified: fine-grained control (at the paragraph level) and automated summarization (at the page level). These options address different user needs by providing both detailed customization and broader automation, allowing users to choose based on their disability type or personal preference.

6.3.2 Removing/Hiding Elements

Currently, there is no meaningful distinction between the two modes, as neither offers true persistence; both reset upon page reload. To improve usability and consistency, it is recommended to merge them into a single “Hide” tool, accompanied by a small icon allowing users to undo the action. To ensure that user preferences are retained across sessions, user actions should be stored using cookies or local storage, so that hidden elements remain concealed upon revisiting the page.

6.3.3 Summarizing Paragraphs

Accessing the summary currently requires two interactions: one click to summarize and a second to expand the summary. This multi-step process hinders efficiency and user experience. Additionally, the summary remains visible even after the feature has been deactivated. To address these issues, the interaction should be streamlined by displaying the summary immediately upon icon click. Furthermore, summary boxes should automatically collapse or be removed when the feature is turned off, ensuring a more coherent and predictable user experience.

6.3.4 Easy Navigation (Link Highlighting)

Users should be allowed to customize highlight colours to accommodate individual contrast needs, particularly for accessibility purposes. This customization is essential for users with visual impairments or colour perception differences. Additionally, the system should ensure compatibility with grayscale and contrast-enhancing tools to support a broader range of assistive technologies and user preferences.

6.3.5 Interaction & Usability Issues

A noticeable delay in mouse cursor tracking was observed, which could potentially confuse users and hinder smooth interaction. While tooltip placement is generally effective and contextually appropriate, there is room for improvement in the positioning of controls, particularly on widescreen devices where interface elements may appear misaligned or distant from the user's focus area. To further enhance accessibility, the implementation of keyboard shortcuts is recommended, enabling more efficient navigation and interaction for users who rely on keyboard input or have motor impairments.

7 Conclusions, Impact and Challenges

7.1 Introduction

This final chapter presents the conclusion of the project, highlighting its key achievements, practical impact, current limitations and potential future challenges for further development and refinement.

7.2 Achievements, Impact and Contribution

The central goal of this study was to design and develop a tool that supports users in everyday web navigation by reducing the stress commonly induced by complex or distracting user interface elements. The focus was given to the needs of individuals with cognitive or neurodivergent conditions, whose interaction with digital environments can be significantly affected by such design barriers. The all-in-one solution was required to avoid users the installation of multiple tools to address their challenges.

The project successfully resulted in a functional browser extension that addresses the most frequently requested features identified through user research. Notably, the extension integrates these features into a single, cohesive, and highly usable tool, something rarely achieved by existing solutions, which typically focus on isolated functionalities.

The following features, derived from the most requested functionalities identified during the user research phase, were successfully developed:

Description
Highlight key concepts in webpage content.
Simplify complex layouts by hiding non-essential elements.
Provide a distraction blocker to remove ads.
Summarize long paragraphs or articles.
Add navigation tips and button highlighting.

Table 20 - Developed features/functionalities

As demonstrated by the usability evaluation results, the extension achieved a high level of user satisfaction, with an average SUS score of 88.125, accompanied by positive feedback. These findings demonstrated how a lightweight local tool could

also play a significant role in enhancing accessibility for neurodivergent and cognitive disabled user.

By offering an all-in-one solution, the extension effectively addresses a significant gap in the field: the lack of multiple features tools capable of supporting users with diverse cognitive and neurodivergent needs. The inclusion of multiple accessibility-oriented features within a single interface enables the extension to provide comprehensive support to the target population. Furthermore, the use of a slightly adapted User-Centred Design (UCD) process ensured a development approach that is replicable, scalable, and adaptable. This outcome reinforces the critical importance of involving users, particularly those with specific cognitive or neurological challenges, throughout the design process to create tools that are not only functional but genuinely inclusive.

7.3 Limitations

7.3.1 Technical and Functional

The current implementation of the highlighting feature is based on scanning and processing <p> (paragraph) elements within a webpage. This approach offers a straightforward method for extracting and visually emphasizing relevant textual content. However, it also introduces limitations: not all valuable content on a webpage is encapsulated within <p> elements, and conversely, some <p> elements may contain information that does not require highlighting. This mismatch can lead to either omission of important data or the highlighting of irrelevant text. An attempted enhancement involved extending the scope to include elements. However, this resulted in an overly dense and visually cluttered output, significantly impairing readability. Based on this observation, the decision was made to retain a more conservative highlighting approach, focusing on clarity rather than coverage.

As of 31 May 2025, Google has initiated the publishing process for a native text summarizer feature. While this development may eventually allow for integration of more advanced summarization capabilities, the current version of the tool utilizes a simple heuristic: extracting the most contextually relevant sentence from a

paragraph. Although basic, this method serves as a lightweight and functional solution in the absence of access to more robust summarization APIs.

Recent changes introduced by the browser extension platform's Manifest V3 specification have significantly altered the capabilities available for developing ad blockers [31]. Under Manifest V2, developers could implement request-blocking mechanisms using the webRequest API with background service workers. Manifest V3 has deprecated this capability in favour of the more restrictive declarativeNetRequest API, which introduces both static and dynamic rule limits (30,000 and 5,000 respectively). Static rules can only be updated through a full extension package update, while dynamic rules are constrained in volume and scope. As a result, the development of sophisticated and frequently updated ad-blocking logic has become considerably more complex. Leading ad blocker providers have implemented various workarounds, including hybrid filter engines and proprietary frameworks, to circumvent these constraints. However, replicating such complexity was beyond the scope of this project. Accordingly, the implemented ad blocker is intentionally simple, utilizing a static, non-updating set of filters. This approach serves as a foundational proof of concept and provides ample opportunity for future enhancement.

A central design decision in this project was to avoid reliance on external APIs. This choice brings several advantages: the extension is faster, functions offline (in case of loss of connection on a loaded page), and maintains user privacy by avoiding third-party data exchanges. However, it also introduces significant limitations. Advanced features such as keyword extraction and summarization are currently powered by lightweight JavaScript libraries, which offer only modest accuracy compared to cloud-based machine learning services. Nevertheless, this trade-off was deemed acceptable in the context of a performance-focused and privacy-aware browser extension.

The application is theoretically compatible with all Chromium-based browsers. However, practical testing was primarily conducted using Google Chrome (versions 137.0.7151.55 and 137.0.7151.56), with limited supplementary testing performed on Mozilla Firefox (version 139.0.1).

The current version of the extension represents an early prototype of what could eventually become a more complete and fully featured tool. From the outset, support for multiple languages was not included due to time constraints. However, even if more time had been available, several technical limitations would have posed challenges during development. Specifically, the compromise.js library used for natural language processing and highlighting does offer limited support for additional languages such as Italian, Spanish, and Portuguese. However, these implementations are still in early development and lack many of the features available in the English version. Moreover, the library does not include automatic language detection, meaning that a custom mechanism for identifying the language of the webpage content would need to be implemented before enabling multilingual support. This remains a clear area for future improvement.

Regarding multilingual support for the summarization feature, this limitation could potentially be addressed through the new summarization functionality recently introduced by Google, as described earlier in this chapter. This feature not only delivers more accurate and context-aware summaries compared to the currently implemented lightweight solution, but it also includes automatic language detection and supports a broader range of languages. Integrating this capability in future versions of the extension could significantly enhance both the quality and inclusivity of the summarization function.

7.3.2 User-related

Recruiting participants for user research proved particularly challenging due to the neurodiversity of the target population. Individuals with neurodivergent conditions are often less accessible through conventional recruitment channels, and even when available, the interview process can be more complex than with neurotypical users. Neurodivergent participants may be more susceptible to cognitive overload or emotional fatigue during interviews, which can result in early withdrawal from the study or lead to responses that are inconsistent or affected by stress. For example, some participants declined to have their sessions recorded, which limited the researchers' ability to review and capture subtle details that may have been missed in real time. This further illustrates the need for adaptive, low-intrusion

research methods when working with neurodivergent individuals, in order to respect their comfort levels while still gathering meaningful insights.

7.4 Challenges

Despite the overall success and positive reception of the browser extension prototype, the usability evaluation and expert cognitive walkthrough revealed a number of critical challenges that must be addressed to ensure broader accessibility, clarity, and long-term user engagement. These challenges span issues related to interface complexity, personalization, visual communication, inclusivity, and system feedback. This chapter synthesizes the most significant obstacles encountered during testing and review.

7.4.1 Interface Redundancy

One of the primary challenges identified was the redundancy and lack of clear distinction between certain interface features, specifically T1 and T4. Multiple participants expressed confusion when attempting to differentiate between similar functions, leading to longer task completion times and increased cognitive load. This lack of clarity not only impeded the learning curve for new users but also highlighted inefficiencies in interface design. Simplifying and, where necessary, removing redundant features is essential to improve user comprehension and streamline interactions.

7.4.2 Limitations in Personalization and Visual Feedback

Another significant challenge concerned the limited personalization options available for visual elements such as button colours, blur effects, and feedback highlighting. Users with visual impairments or individual contrast preferences were particularly affected by the lack of flexibility in the interface. The inability to adjust highlight colours or deactivate visual filters like blur reduced the accessibility of the easy navigation mode. Additionally, the current feedback mechanisms were sometimes unclear, for example, users could not always tell if an action had taken effect when nothing appeared highlighted. Ensuring a customizable and perceptually accessible interface is crucial for accommodating diverse user needs and preferences.

7.4.3 Inadequate Iconography and Visual Communication

Visual indicators, including icons and symbols (e.g., the “plus” icon), presented another challenge. Some icons lacked intuitive meaning and caused hesitation or incorrect assumptions about their functionality. This issue was particularly evident in tasks requiring element hiding or summarization, where unclear iconography disrupted the user flow. Effective icon design is essential for rapid recognition and minimizing the need for explanatory text, particularly for users with cognitive or learning disabilities.

7.4.4 Insufficient Multilingual Support

Language accessibility emerged as a critical concern, particularly during testing with participants who were non-native English speakers. The absence of Spanish language support created barriers for two users, impacting their ability to navigate and understand the interface effectively. This highlighted a broader challenge of inclusivity, emphasizing the need for comprehensive multilingual support to accommodate users from diverse linguistic backgrounds.

7.4.5 Lack of Persistence in User Actions

Another usability issue involved the non-persistent nature of certain actions, such as hiding elements. Both available modes for hiding or removing content reset upon page reload, creating a disconnect between user intent and system behaviour. This lack of persistence undermines the effectiveness of personalization tools and contributes to user frustration. The challenge here lies in implementing mechanisms (e.g., local storage) that respect and preserve user choices across browsing sessions.

7.4.6 Inefficiencies in Summary Access and Behaviour

Accessing summarized content currently requires two separate clicks: one to reveal the icon and another to expand the summary. This two-step process slows down user interaction and introduces unnecessary complexity. Moreover, summary boxes occasionally remain visible even after the feature has been turned off, leading to inconsistencies in interface behaviour. Streamlining this process, e.g., by displaying summaries immediately on icon click and ensuring proper removal upon deactivation, represents a key challenge in optimizing usability.

7.4.7 Accessibility of Easy Navigation Mode

The easy navigation mode, while helpful in principle, lacked sufficient support for users relying on contrast customization or assistive tools such as grayscale extensions. The inability to modify highlight colours reduced the accessibility of this feature. Supporting a wider range of visual preferences and ensuring compatibility with third-party accessibility tools remains a fundamental challenge in developing a truly inclusive system.

7.4.8 General Interaction and Usability Barriers

Several interaction-level issues were identified that impacted the fluidity of the user experience. These included a slight delay in mouse cursor tracking, suboptimal placement of interface controls (particularly on widescreen displays), and the absence of keyboard shortcuts for critical actions. These shortcomings not only slowed user interactions but also created barriers for users with motor impairments or those who prefer non-mouse input methods. Improving responsiveness and supporting diverse interaction modalities are necessary to enhance overall system usability.

7.4.9 Ad Blocker improvements

A notable technical challenge encountered during development stems from the constraints introduced by the browser extension platform's Manifest V3 specification. These changes significantly affect the architecture and functionality of features related to network request control, particularly for ad-blocking capabilities. As a result, the development of complex or frequently updated ad-blocking logic is no longer straightforward and requires significant architectural compromises. While leading ad blocker providers have developed hybrid filtering engines and proprietary solutions to mitigate these limitations, such implementations were outside the scope and intent of this project. Consequently, the current ad-blocking functionality is implemented as a simplified proof of concept, relying on a fixed, non-updating set of filter rules. This limitation highlights a broader platform-level challenge that may hinder scalability and adaptability in future iterations of the extension.

7.4.10 Further Works and Ideas

The project was initially inspired by several broader ideas, many of which could not be realized within the current timeframe due to time constraints and technical limitations. One of the most promising directions for future development involves making the extension more intelligent and adaptive, for example by incorporating biometric data (such as heart rate variability or eye-tracking metrics) to detect signs of user stress and trigger appropriate features automatically. Another compelling possibility is the integration of machine learning techniques that would allow the system to learn user preferences and behavioural patterns over time. This would enable the extension to apply personalized interface modifications proactively, without requiring direct user input, thereby reducing cognitive effort and enhancing the overall browsing experience in a subtle, non-intrusive manner. These ideas point to a future in which assistive technologies can become more context-aware and responsive to the dynamic needs of their users.

7.5 Final Reflections

Technology alone cannot resolve the complexities of digital inclusion, but it holds the potential to empower. This project demonstrates that, through thoughtful design and a strong focus on user needs, even lightweight and narrowly scoped tools can make a meaningful contribution to improving digital accessibility and fostering greater user autonomy, particularly for individuals with cognitive and neurodivergent conditions.

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9 Annexes

9.1 Web Interfaces Stress Questionnaire Analysis

Briefing Document: Analysis of responses to the "Web interfaces stress questionnaire"

Date: May 26, 2024

Source: Web interfaces stress questionnaire, Microsoft Form

Tool used: Notebook LM has been used to extract information related to the questionnaire. The use of this tool allowed us to ask more open questions thought the questionnaire and avoid as much as possible future in person interviews. This decision was guided by evidence showing that online or computer-based methods can be more suitable for individuals with neurodivergences or cognitive disabilities. Studies have demonstrated that such methods often lead to increased participant comfort, improved autonomy, reduced social anxiety, and comparable or even higher data quality (Lau et al., 2021; Benford & Prince, 2020; McDonald et al., 2014). For example, participants with autism or ADHD reported greater satisfaction and reduced stress with remote methods than with face-to-face formats (Lau et al., 2021), and people with intellectual disabilities expressed a preference for self-paced, accessible online tools that offer independence and control (McDonald et al., 2014). These findings informed our methodological choices to ensure accessibility and data integrity.

Introduction:

This paper presents a preliminary analysis of the responses obtained from the "Web interfaces stress questionnaire". The aim is to identify the main themes and the most relevant ideas expressed by users regarding their experiences with web interfaces and the difficulties encountered. The responses provide valuable insights to understand users' needs and potential areas of improvement for the design of more accessible and usable websites.

Demographic Analysis:

Preliminary demographic analysis of the participants.

- **Language:** Most respondents indicated **Italian** (4 respondents) and **Spanish (Spain, international literacy)** (10 respondents) as their language. There

were also respondents who indicated **English (United Kingdom)** (5 respondents).

- **Gender:** Most participants who provided this information are **female** (13 respondents). There are **5 male respondents**, and **1 respondent preferred not to specify** their gender.

  Studies have shown that women are more inclined to engage in surveys, especially those related to psychological and emotional states (Smith, W. G. (2008). *Does Gender Influence Online Survey Participation?*). This could make them more likely to respond to a questionnaire involving **stress and user interfaces**, which implies both a tech and emotional component.

- **Age:** Estimated based on birth year and the questionnaire date (April 2025):

Birth Year	Number of Respondents	Approximate Age
1974	1	51 years
1977	1	48 years
1989	1	36 years
1991	2	34 years
1993	1	32 years
1999	1	26 years
2002	8	23 years
2004	2	21 years
2006	1	19 years
2025	1	0 years (*likely a data entry error*)

There is a noticeable concentration of participants born in the early 2000s, indicating a predominance of young adults. Concretely, only 2 out of 19 were above 40 years old. 5 out 19 were between 25 and 35 years old, and 11 out of 19, which represents 47% of the total sample were below 25. One was a data entry error.

- **Education level:** Most participants reported a **university education (Bachelor/Master/PhD)** (12 respondents). There were also respondents with **secondary education** (4 respondents), **professional training** (1 respondent), and **higher professional training (FP SUPERIOR)** (1 respondent). One respondent indicated **primary education**.

The population results to be highly educated. This is a good for the purpose of the study that is to develop a tool that professionals or students need to use to make easier the web experience.

- **Technological competence:** Most participants described themselves as having **ordinary (every day)** technological competence (17 respondents). One participant indicated **no experience**, and one **occasional (3-4 per week)** use.
  This point as the previous one is useful since the final system will help people that use technology every day.

Main Themes and Key Ideas:

From the analysis of the responses, several recurring themes emerge that highlight the challenges that users encounter while browsing the web:

1. Difficulty with Complex Layouts and Distractions:

A significant number of participants reported having difficulty with complex web layouts and the presence of distractions such as advertisements and pop-ups. This leads to difficulty focusing on the main content and accidentally clicking the wrong buttons.

Quotes:

- "It depends, if there are many pop-ups on the site it is difficult, since the text is often moved" (ID 2)
- "I mix up the lines if they are "dense" in the text, I often stop focusing on the text and have to go back to what I have already read to understand" (ID 5)
- "I just use AdBlock to minimize the amount of information and see only what I am looking for." (ID 8)
- "Any moving object that is next to a text for me is unnecessary and annoying." (ID 18)

2. Problems with Reading and Processing Long Texts:

Many users' express difficulty reading and understanding long, dense texts, especially if they are presented without a clear structure or with inadequate formatting. This leads to distraction, the need to reread several times, and in some cases, abandonment of the page.

Quotes:

- "If the texts are too long, I'm more likely to get distracted and therefore have to reread" (ID 3)
- "Impatience in getting to the relevant data. It can lead me to reread several times and still miss the essentials." (ID 10)
- "I find it difficult if the text is very small or if it is all concentrated in paragraphs with no or little separation between lines" (ID 13)
- "Yes, I waste a lot of time reading and trying to identify important information, I often leave the page" (ID 14)
- "I cannot concentrate on long same looking like texts" (ID 16)

3. Personalization and Fashion Design:

A significant number of participants would welcome a "special mode" that would allow them to hide unnecessary elements and customize the display of content. This suggests a strong desire for more control over the browsing experience.

Quotes:

- "Yes, the ads" (in response to what he would like to hide with a "special mode") (ID 2)
- "Yes, advertising, then I would like safer navigation and for it to be easier to control more things at the same time" (ID 6)
- "Yes! I would like to see just the fields related to certain words - the same thing I can do within the browser, but it would be useful inside the webpage. I know I can use control F, but I would like the rest of the information to disappear to avoid distraction." (ID 8)
- "Remove links to other related topics. Avoid different colours and formatting around the edges, to add information. They distract from the main text." (ID 10)
- "I prefer that the page always shows an index with hyperlinks to the section or content that I want to consult and that it allows the use of filters to display or hide the different sections or sections of a page, as can be done in Microsoft Word when converting a heading into a title (it gives you the option to click on an arrow that hides or displays the text below the title)" (ID 13)
- "I would like there to be a menu or outline at the top of the page to decide what I want or need to see and hide the rest" (ID 14)

4. Use of Browser Extensions to Improve Experience:

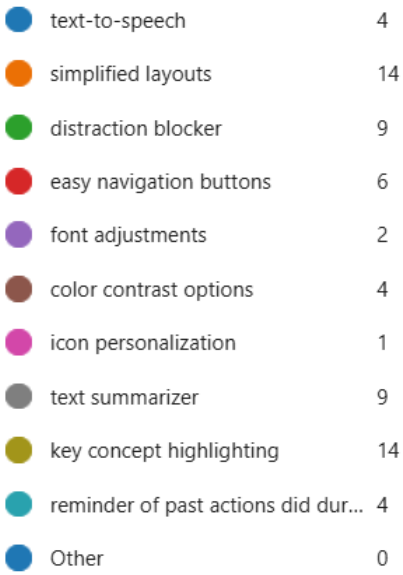
Many users use browser extensions, mainly ad blockers, to counteract distractions and improve their browsing experience. This further underscores the frustration caused by ads and pop-ups.

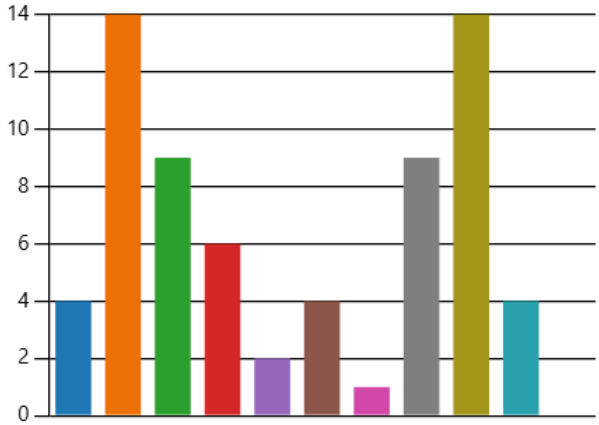
Quotes:

- "AD block" (ID 2)
- "Ad blocker, because it prevents me from getting various pop ups while I'm surfing the web that could be potential viruses" (ID 4)
- "I don't use extensions, but I use brave as a search engine that blocks ads, announcements, pop ups..." (ID 6)
- "I don't; I just use AdBlock to minimize the amount of information and see only what I am looking for." (ID 8)
- "I use AdBlock to block advertising ads and emerging events because they are very annoying and difficult to navigate to the desired page" (ID 13)
- "AdBlock, feed blocker" (ID 17)

5. Desired Features to Improve Navigation:

Users have expressed clear interest in several features that could improve their browsing experience, including:





The main preferences (simplified layouts, distraction blocker, text summarizer, key concept highlighting) align with the answer to the other questions observed in the previous points.

Possible importance order

Let's assume a possible order of importance of features, starting from the most requested features in descending order. For features that have same votes the precedence has been given to the ones that are less present on the market (see the document related to market research).

Order	Feature	Votes
1	Key concept highlighting	14
2	Simplified layouts	14
3	Text summarizer	9
4	Distraction blocker	9
5	Easy navigation buttons	6
6	Reminder of past actions did during the navigation	4
7	Text-to-speech	4
8	Colour contrast options	4
9	Font adjustment	2
10	Icon personalization	1
11	Other	0

6. Examples of Websites Considered Easy to Use:

Some users have provided examples of websites they find particularly easy to use, often citing:

- **Amazon:** for its intuitiveness and ease of use.
- **Wikipedia:** for highlighting key concepts and clear structure.
- **E-commerce websites (generally):** for their user-friendly design.
- **WIPO and EMT:** for large icons, clear interfaces and content organization.
- **Canvas (UOC):** for ease of finding resources.
- **Language websites (WordReference, Linguee, Reverso):** for specific features that speed up searches.

One user also noted that websites designed according to common patterns are generally easy to navigate if the information is well-selected, and that "creative" layouts often become confusing.

7. Frustration with Online Forms and Processes:

Several participants had trouble completing online forms due to timeouts, unclear instructions, or unexpected errors.

Quote: "Have you ever had difficulty filling out online forms due to timeouts, unclear instructions, or unexpected errors? Yes" (Common answer to this question).

Conclusions and Next Steps:

The survey responses clearly highlight the need for simpler, cleaner, and more customizable web interfaces. Users are often frustrated by distracting elements, dense text, and complex layouts. The suggested features and examples of popular websites provide valuable guidance for designing more positive and accessible online experiences.

Navigation Features Desired by Users

The sources highlight several **navigation features desired** by users to improve their web experience. These features emerge both from a dedicated section of the analysis document and from the specific answers of the participants in the questionnaire.

Among the **features explicitly mentioned** as most useful for the browsing experience we find:

- **Simplified layouts**: This wish is expressed by several participants and suggests a preference for less complex interfaces that are more focused on the main content.
- **Distraction blocker**: This is also a highly requested feature, in line with reported difficulties with pop-ups and other distractions.
- **Easy navigation buttons:** Ease of navigation is a crucial aspect for many users. One participant (ID 8) mentions the importance of "Big buttons".
- **Text summarizers:** This feature would be useful to address the problem of reading and processing long texts.
- **Key concept highlighting:** Like text summarization, this feature would help users quickly identify important information within long texts. Wikipedia is cited as a positive example for key concept highlighting.

- **Colour contrast options:** This option would improve accessibility for users with visual impairments and those who find reading on low-contrast screens difficult.
- **Font adjustments:** The ability to customize the font size and type is another desired feature to improve readability. One participant (ID 13) has difficulty with very small text sizes.
- **Reminder of past actions done during navigation:** This feature could help users to orient themselves and resume navigation more efficiently.
- **Icon personalization:** Although mentioned by only one participant (ID 20) in table, it falls within the general desire for interface customization.
- **Text-to-speech:** This feature is reported as useful by some participants and could help those who have difficulty reading long texts.

In addition to these specific features, the desire for a "**special mode**" **that allows hiding unnecessary elements** suggests a strong preference for a cleaner and more customizable interface. Some participants expressed the desire to hide advertisements, links to irrelevant related content, and other distracting elements. The idea of having a **table of contents or an outline at the top of the page** with the ability to expand or hide sections is another desired navigation feature. This would allow users to directly access the information they are interested in and avoid being overwhelmed by irrelevant content. One participant (ID 13) compares this feature to how indexes work in Microsoft Word.

Finally, the appreciation for websites with **large icons, clear interfaces and well-organized content** (such as WIPO and EMT) and for e-commerce sites designed to be intuitive (such as Amazon) highlights the importance of simple and well-structured navigation. On the contrary, "creative" layouts that deviate from common patterns can be confusing.

Browser Extensions & Online Distraction Blocker

The analysis of the responses to the "Web interfaces stress questionnaire" shows that **several participants use browser extensions to improve their browsing experience.** The main reason for using these extensions is **to counteract distracting elements such as advertising and pop-ups.**

Specifically, the following participants mentioned the use of browser extensions:

- **ID 2:** Use **AD block.**
- **ID 4:** Use **Ad blocker** to avoid pop-ups that could be potential viruses.
- **ID 6: Does not use extensions, but uses the Brave** search engine which blocks ads, ads and pop-ups. This suggests an awareness and attempt to mitigate distractions, even if not through a separate extension.
- **ID 8:** Uses **AdBlock** to minimize the amount of information displayed and only see what they are looking for. This is directly linked to the desire for **personalization** and to eliminate distractions. This participant specifies that they only want to see fields related to certain words, a need that AdBlock helps to satisfy indirectly.
- **ID 13:** Use **AdBlock** to block advertisements and pop-ups because they are very annoying and make browsing difficult.
- **ID 17:** Use **AdBlock** and **feed blocker.**

The **widespread use of ad blockers** among participants highlights the **frustration caused by advertisements and pop-ups**. As highlighted in the analysis paper, these elements are perceived as **distracting** and can lead to **inadvertent clicks.** The fact that several users resort to external tools to block these elements suggests a lack of desired control within the web interfaces themselves.

The desire expressed by many participants for a "**special mode" that would allow them to hide unnecessary elements is** closely related to the use of ad blockers. Users who use these extensions are effectively implementing a form of personalized "special mode" to eliminate what they find distracting. ID 8's preference to make the rest of the irrelevant information disappear after an internal search on the page reflects a desire for even more control over the displayed content, like what AdBlock offers but potentially integrated into the website.

In conclusion, the use of browser extensions, especially ad blockers, is a strategy adopted by several participants to **counteract distractions and improve their web browsing experience.** This behaviour highlights an unmet need for cleaner and more customizable web interfaces, a central theme in the questionnaire analysis.

Desire for Personalization in Web Interfaces

The paper "Web Interface Stress Questionnaire Analysis" highlights a **significant desire for customization and a "special mode" that allows hiding unnecessary elements and customizing the content display** by the questionnaire participants. This theme suggests a strong desire of users to have more control over their browsing experience.

Several participants clearly expressed what they would like to hide with such a "special mode":

- **ID 2:** "*Yes, advertisements*".
- **ID 6:** "*Yes, advertisements, but I would also like safer browsing and easier control of several things at the same time*".
- **ID 8:** "*Yes! I would like to see just the fields related to certain words - the same thing I can do within the browser, but it would be useful inside the webpage. I know I can use control F, but I would like the rest of the information to disappear to avoid distraction*".

This highlights the desire to eliminate distractions and focus on relevant information.

The desire for personalization is also manifested in the desire to **eliminate elements perceived as superfluous or distracting.** One participant (ID 10) would like to "*Eliminate links to other related topics. Avoid different colours and formats on the borders, to add information. They distract me from the main text*". This quote highlights how irrelevant visual elements and links can interfere with concentration on the main content.

Some participants suggested **more structured ways of personalization:**

- **ID 13:** "*the page always displays an index with hyperlinks to the section or content that I want to consult and that allows you to use filters to unravel and hide different sections or parts of a page, as can be done in Microsoft Word when converting an entry into a title*" .
- **ID 14:** "*a menu or example at the top of the page to decide what I want or need to see and hide the rest*".
- **ID 17:** "*for me it would be enough to when you click it shows more text like in PowerPoint*".
- **ID 20:** "*well compacted and then you can unfold*".

These proposals recall the idea of more modular and user-controlled navigation.

Many participants answered affirmatively to the question whether a special mode that hides unnecessary elements would improve their browsing experience. Additionally, the answers to the question "Which of these features would be most useful for your browsing experience?" lists several desired features that fall under the scope of personalization, such as:

- **Simplified layouts**
- **Distraction blocker**
- **Font adjustments**
- **Colour contrast options**

The widespread use of **browser extensions such as AdBlock** is a further indicator of users' willingness to personalize their online experience to eliminate unwanted elements.

In conclusion, a strong desire for customization of web interfaces clearly emerges from the sources, with a particular focus on the possibility of hiding distracting elements such as advertisements and pop-ups and of having greater control over the display and navigation of content. The responses suggest that a "special mode" with customization options would be welcomed by many users.

Difficulty reading long texts and proposed solutions.

Many questionnaire participants have **problems reading and processing long texts** on websites. This is one of the main themes that emerged from the analysis of the responses.

Several factors contribute to this difficulty, as indicated in the participants' quotes:

- The **length and density of texts** make it easier to get distracted and lead to the need to reread. One participant (ID 3) states: "*If texts are too long, I get distracted more easily and therefore I have to reread*". Similarly, another participant (ID 16) states that he cannot concentrate on long texts that all look the same ("*I cannot concentrate on long same looking like texts*").
- Lack **of clear structure or inadequate formatting** makes the problem worse. One participant (ID 5) mentions how too "dense" lines in the text cause a loss of concentration and the need to go back to understand ("*I find it difficult to read lines if the text is "gestured" in the text, so I feel like I am reading a text and I have to go back and understand it as it is written by*

lines"). Another (ID 13) finds it difficult to read texts with very small font sizes or concentrated in paragraphs with little or no separation between lines ("*I find it difficult if the text is very small in size or if I am concentrated entirely on paragraphs without any or very little separation between the lines*").

- Difficulty **in identifying important information** within long texts can lead to multiple rereading and even abandoning the page. One participant (ID 10) expresses "impatience to get to the relevant data" and the need to reread several times, risking missing the essential ("*Impatient to get to the relevant data. I can manage to reread several times and still skip the essential*"). Another participant (ID 14) states that he wastes a lot of time reading and trying to identify important information, often leading him to abandon the page ("*yes, I waste a lot of time reading and trying to identify the important information, often I abandon the page*").

To counteract these problems, some participants expressed a desire for **features that improve the readability and accessibility of long texts.** Among these, the following stand out:

- **Text summaries.**
- **Highlighting key concepts.**
- **Colour contrast options.**
- **Font adjustment.**
- The ability to have an **index or outline at the top of the page** to decide what to display and hide the rest (cited by ID 13 and ID 14).
- A **"special mode" that allows to "unfold" compact information** to drill down only into sections of interest (mentioned by ID 17 and ID 20 in the context of hiding unnecessary elements or having very compact information to expand).

In summary, reading and processing long texts poses a significant challenge to many web users, due to their length, density, inadequate formatting, and difficulty in identifying key information. The desire for tools and features that facilitate reading and customization of display highlights the importance of addressing these issues in designing more usable and accessible web interfaces.

Complex Layouts and Distractions

A significant number of questionnaire participants reported having **difficulties with complex web layouts and the presence of distracting elements such as advertising and pop-ups.** This theme is identified as one of the main ones that emerged from the analysis of the responses.

According to the paper, these elements distract users from the main content and lead them to **accidentally click on the wrong buttons.** Several quotes from participants support this observation:

- One participant (ID 2) states: "*It depends, if there are many pop-ups on the site it is difficult, as the text is often moved*".
- Another participant (ID 5) mentions difficulty in maintaining concentration on dense texts, exacerbated by the arrangement of the lines.
- One participant (ID 18) considers "any moving object that is close to a text" as "unnecessary and annoying".

Interestingly, some users resort to using **browser extensions such as AdBlock to minimize the amount of information and see only what they are looking for**. One participant (ID 8) states that he uses AdBlock for this very reason. The widespread use of ad blockers, also mentioned by other participants, further underlines the frustration caused by these distractions.

In the broader context of the questionnaire, the desire expressed by many participants for a **"special mode" that would allow hiding unnecessary elements is** directly linked to the issue of complex layouts and distractions. For example, one participant (ID 2) suggests hiding advertisements, and another (ID 10) would like to eliminate links to related topics and different formatting at the edges that distract from the main text.

In conclusion, the questionnaire responses clearly indicate that complex web layouts and the presence of distracting elements represent a significant source of difficulty and stress for users during navigation. This suggests a strong need to design simpler and cleaner web interfaces, minimizing elements that can distract users' attention from the main contents.

9.2 Planning of usability evaluation

9.2.1 Evaluation goals

Perform a usability testing of the extension, including performance measuring. The results obtained for effectiveness, efficiency and satisfaction will be checked against optimal values that are defined in this document.

9.2.2 Dates, places and roles

Test	Date	Place	Comments
1	12/06/2025	Francesco's	The test will be taken in person; the screen will be recorded during the task execution
2	16/06/2025	Elena's	The test will be taken in person; the screen will not be recorded
3	20/06/2025	Elena's	The test will be taken in person; the screen will not be recorded
4	24/06/2025	Online	The test will be taken on Teams; the screen will be recorded during the task execution

Test	Facilitator	Observers
1	Francesco	-
2	Elena	-
3	Elena	-
4	Francesco	-

9.2.3 Participants

Participants	4

Recruiting	People will be recruited using some contacts get during the first questionnaire (2 people) and through private contacts of the professor. Since we need a specific niche of users, recruiting them could be hard, so we do not expect to have more than 4 users to test the application with.

9.2.4 Sequence

9.2.4.1 Welcome text

Hello, and thank you very much for joining this usability test. I really appreciate you taking the time to help us with this project.

We're testing a **Chrome extension** we've developed to improve the user experience of websites, specifically for people with **cognitive disabilities, neurodivergence, or autism**. The goal of this test is to find out how well the extension supports users and how we can make it better.

This session is not a test of your abilities, **we are evaluating the prototype, not you**. If anything is unclear, difficult, or doesn't work the way you expect, that's completely fine. That tells us something we need to improve in the design. Any problems that come up are not mistakes on your part, they are opportunities for us to learn.

Here's how the session will go:

1. **Introduction:** There is going to be a small introduction part to explain you the general idea of the test.
2. **Task Scenarios:** You'll go through a series of tasks using the extension. These tasks are based on typical things someone might do when browsing the web with support from the extension.
3. **Observation:** While you complete the tasks, we will be **timing how long each task takes**, and we will **take notes** on what you do and how the extension behaves. You're welcome to **think out loud** as you go, that helps us understand your experience.
4. **Feedback:** At the end, I'll ask you a few questions about what worked well and what could be improved.

Please don't worry about getting anything "right", we're here to learn from you. Your feedback is really important and will help make this tool more effective and inclusive.

Thank you again for your time and your help!

9.2.4.2 Process

7. Say the “welcome text” (1.4.1) to the participant.
8. Explain the consent form (1.11.1) and collect the participant signature.
9. Gather personal information (1.5).
10. Explain generally how the extension works (what button does what).
11. Do the usability testing of the prototype. Ask the participant to perform the tasks (1.6), gather data (1.8) and observations (1.8).
12. After using the prototype, ask the participant to fulfil the user satisfaction questionnaire (1.9) and ask for general impressions (1.10).

9.2.5 Personal information questionnaire

Link to the questionnaire: https://forms.office.com/e/v6AFzXe4A3

Intended Use

The questionnaire is intended to be completed electronically using a form tool such as Google Forms, Microsoft Forms, or a similar platform. This format allows for easier data collection, organization, and analysis. However, it can also be printed and used as a paper form if needed.

Questionnaire

Participant ID (assigned by the researcher): _____

Date of test: ____ / ____ / _____

Time of test: ____ : ____ (24-hour format)

---

1. **Age:**
   ☐ Under 18
   ☐ 18-24
   ☐ 25-34
   ☐ 35-44
   ☐ 45-54
   ☐ 55-64
   ☐ 65 or older
2. **Gender:**
   ☐ Female
   ☐ Male
   ☐ Non-binary / Third gender

☐ Prefer not to say
☐ Prefer to self-describe: _____

3. **Educational level**

   ☐ No official education

   ☐ Primary education

   ☐ Secondary education

   ☐ University (Bachelor/Master/PhD)

4. **How much time do you spend using a personal computer (desktop or laptop) on an average day?**
   ☐ Less than 1 hour
   ☐ 1-3 hours
   ☐ 4-6 hours
   ☐ More than 6 hours

5. **How often do you use Chrome extensions in your everyday browsing?**
   ☐ Never
   ☐ Rarely (once a month or less)
   ☐ Sometimes (a few times a month)
   ☐ Often (a few times a week)
   ☐ Daily

6. **How confident do you feel using digital tools (e.g., apps, browser add-ons, accessibility features)?**
   ☐ Not confident
   ☐ Somewhat confident
   ☐ Confident
   ☐ Very confident

7. **Do you regularly use any accessibility tools (e.g., screen readers, text-to-speech, font changers, colour filters)?**
   ☐ Yes
   ☐ No
   If yes, which ones? _____

8. **Any additional information you'd like to share about your web browsing experience or needs?**

9.2.6 Tasks to be performed by participants

Task	T1
Title	Highlight a paragraph at a time

Starting situation	The feature is disabled
Task instructions	Please highlight a paragraph/s.

Task	T2
Title	Highlight all paragraphs at once
Starting situation	The page is not ALL highlighted
Task instructions	Please highlight all paragraphs at once.

Task	T3
Title	Hide elements from the page
Starting situation	The feature is disabled
Task instructions	Please hide an element/s from the page.

Task	T4
Title	Remove elements from the page
Starting situation	The feature is disabled
Task instructions	Please remove an element/s from the page.

Task	T5
Title	Summarize a paragraph
Starting situation	The feature is disabled

Task instructions	Please summarize a paragraph/s.

Task	T6
Title	Use the easy navigation function
Starting situation	The feature is disabled
Task instructions	Please activate the easy navigation function.

9.2.7 Measurements

9.2.7.1 Objective measurements

Measurement	Description
Time	Time required to complete one task
Actions	Number of elemental actions performed (click, tap, …) to complete one task.
Mistakes	Number of mistakes made during one task.
Success	Yes/no (whether the participant succeeds at completing the task).

9.2.7.2 Optimal values

Task	Time	Actions
T1	5s	3
T2	<1s	1
T3	7s	>4
T4	5s	3
T5	7s	>4
T6	5s	3

9.2.8 Observation sheet

Intended Use

This observation sheet is designed for **electronic use (fillable PDF, spreadsheet, or digital form)**, but it can also be **printed and filled out on paper** if preferred during in-person sessions. Using a digital spreadsheet (like Google Sheets or Excel) is recommended for easier sorting and analysis of patterns across participants.

Usability Test Observation Sheet

General Information

Participant ID: _____

Date of Test: ____ / ____ / _____

Start Time: ____ : ____

Observer Name: _____

Task Overview Table

Task #	Actions	Duration	Success	Mistakes Made
T1				
T2				
T3				
T4				
T5				
T6				

General Participant Behaviour

- **Was the participant thinking aloud?**
  ☐ Yes ☐ No ☐ Occasionally
- **Did the participant show signs of frustration or confusion?**
  ☐ Yes ☐ No
  If yes, describe: _____

Post-Test Notes (Observer Summary)

- **What went well for the participant?**
- **Where did the participant struggle most?**

- **Any notable feedback or suggestions from the participant?**
- **Other observations worth recording:**

9.2.9 User satisfaction: SUS questionnaire

Link to the questionnaire: https://forms.office.com/e/mjHc6X4bdJ

Participant ID	
Date and time	

Reply with your degree of agreement or disagreement to the following ten sentences, where 1 means "I totally disagree with the sentence" and 5 means "I totally agree with the sentence".

	1	2	3	4	5
I think that I would like to use this extension frequently.					
I found the extension unnecessarily complex.					
I thought the extension was easy to use.					
I think that I would need the support of a technical person to be able to use this extension.					
I found the various functions in this extension were well integrated.					
I thought there was too much inconsistency in this extension.					
I would imagine that most people would learn to use this extension very quickly.					
I found the extension very cumbersome to use.					
I felt very confident using the extension.					
I needed to learn a lot of things before I could get going with this extension.					

9.2.10 General impressions

Participant ID	
Date and time	
1. What are the main problems you have found while using this extension?	

2. What is the part of the extension that has been more difficult to understand? Why?
3. What have you liked most of the extension? Why?
4. Can you describe your overall experience with this extension?

9.2.11 Annexes

9.2.11.1 Consent form

Informed Consent for Participation in an Interview for a University Practice

Higher Technical School of Computer Engineers (ETSIINF)
Polytechnic University of Madrid (UPM)

I. PURPOSE OF THIS STUDY

The people conducting this study are related to the Computer Engineering Master Degree offered by the Higher Technical School of Computer Engineers at the Polytechnic University of Madrid in collaboration with the Polytechnic University of Turin, Computer Engineering Master Degree as well.

As part of the Master thesis, the student Francesco Bratta (under the supervision of the professor Elena Villalba Mora) developed a Google Chrome extension. One of the steps is to test the application developed and gather data related to possible problems and insights. To achieve this, interviews must be conducted with individuals who may match the profile of a potential user of the system.

It is critically important for you to understand that your responses will not be evaluated or judged in any way. The student is solely interested in understanding how and why you do interact, and discover problems with the extension. Therefore, we kindly ask you to be completely honest during the interview.

II. PROCEDURE

The interview will be conducted in person/remotely through a video call by the student or the professor, who will show you how to install the application and do questions. Respectively the professor or the student will take notes.

To ensure all responses are thoroughly and accurately captured, the interview will be recorded. The sole purpose of this recording is for later analysis and will be deleted after the research.

III. SCOPE OF ANONYMITY AND CONFIDENTIALITY

The interviewee will be assigned an anonymous participant code, and no personal data that could identify them will be collected.

The recording will be securely stored in a Microsoft OneDrive folder managed by the Polytechnic University of Madrid. Access to this folder will be limited to the student and the professors. The recordings will be permanently deleted once the data is formalized in the final thesis document or/and a research publication. Until deletion, the person who signs this consent form will be responsible for the recordings.

IV. COMPENSATION

Participation is voluntary and not compensated.

V. RISKS AND BENEFITS OF PARTICIPATING IN THIS STUDY

There are no anticipated risks associated with participation.

The main benefit of this study is to identify possible issues in the application developed in order to improve it.

VI. FREEDOM TO WITHDRAW FROM THE INTERVIEW

You are free to withdraw from this interview at any time and for any reason, without the need to provide an explanation.

VII. RESPONSIBILITIES AND PARTICIPANT PERMISSION

Yes	No

		I confirm that I have read and understood this informed consent and the conditions of this study.
		I confirm that I agree to participate in this interview under the terms set forth in this informed consent.
		I confirm that I voluntarily accept that the interview will be recorded in the terms set forth in this informed consent.

To confirm, the interviewer and interviewee will sign this informed consent form in duplicate, each retaining a signed copy.

Interviewer signature: Date: Name:	Interviewed firm: Date: Name: Participant Code:

If you have any questions about this study, you may contact the student (Francesco Bratta, f.bratta@alumnos.upm.es) or the professor (Elena Villalba Mora, elena.villalba@upm.es)

ADDITIONAL INFORMATION ABOUT DATA PROTECTION

Who is responsible for processing your data?

- Identity: Francesco Bratta
- Postal Address: E.T.S. de Ingenieros Informáticos, Campus de Montegancedo s/n, 28660 Boadilla del Monte (Madrid)
- Data Protection Officer Contact: f.bratta@alumnos.upm.es

What is the purpose of processing your personal data?

- Your personal data is processed to manage your participation as a volunteer in the study: Master's Degree Thesis.

How long will we keep your data?

Personal data will be retained as long as necessary to fulfil the purpose for which it was collected, to determine potential responsibilities, and in accordance with applicable documentation and archival regulations.

What is the legal basis for processing your data?

The legal bases are set forth in the European Union General Data Protection Regulation (GDPR) 2016/679:

- Article 6.1.a) the data subject has given consent to the processing of their personal data for one or more specific purposes.
- Article 6.1.e) "Processing necessary for the performance of a task carried out in the public interest," which includes the research being conducted.

Are you required to provide this personal data, and what are the consequences of not doing so?

The requested data is strictly necessary for the study. Without it, participation will not be possible, as participation is entirely voluntary.

Who will receive your data?

- Your data will not be shared with third parties or transferred internationally.
- The identities of participants will not be disclosed at any point. Only the student and his tutor at the Polytechnic University of Madrid will have access to the personal data of each participant.

What are your rights regarding the data provided?

- You have the right to access, rectify, request deletion or cancellation, and to object to or restrict the processing of your data, as legally provided.
- You can obtain more information about these rights by contacting the UPM Data Protection Officer (proteccion.datos@upm.es).
- If you are not satisfied with the exercise of your rights, you may file a complaint with the Spanish Data Protection Agency: https://www.aepd.es/en

9.3 Usability evaluation report extras

9.3.1 Schedule update

There were no deviations in the planned work.

9.3.2 Information about the performed usability testing

9.3.2.1 Dates and places

Session	Date and time	Place	Participants	Team members and roles
1	12/06/2025	Francesco's	1	Francesco facilitator
2	16/06/2025	Elena's	1	Elena facilitator
3	20/06/2025	Elena's	1	Elena facilitator
4	24/06/2025	Online	1	Francesco facilitator

9.3.3 Annex A. Gathered data

Usability Test Observation Sheet

General Information
Participant ID: 0001
Date of Test: 12/06/2025
Start Time: 17:35
Observer Name: Francesco

Task Overview Table

Task #	Actions	Duration	Success	Mistakes Made
T1	3	5sec	Yes	0
T2	1	1sec	Yes	0
T3	5	13sec	Yes	1
T4	>5	15sec	Yes	0
T5	4	16sec	Yes	0
T6	3	1sec	Yes	0

Notes

- T1: She understood that the green dotted line on the left was the highlighting, because the text selected didn't got highlighted. When the text was highlighted, she understood. She asked if she could reverse it, and she agreed that the refresh was enough.
- T2: Everything fine here.
- T3: She commented the icon for her it seemed a feature to add something. Here she panicked a bit for a mis click she did. She ad problem to understand what elements where hidden, she thought that she hid one element, but they were three.
- T4: She was confused a bit, but everything fine. She got confused for the blur.
- T5: Pretty smooth.
- T6: She was confused with the pictures highlighted and with their previews. Too much green parts confused her.

General Participant Behaviour

- **Was the participant thinking aloud?**
  Yes
- **Did the participant show signs of frustration or confusion?**
  Yes, with the hiding elements and the easy navigation mode.

Post-Test Notes (Observer Summary)

- **What went well for the participant?**
  Most of the function have been understood fast.
- **Where did the participant struggle most?**
  Hiding elements and easy navigation mode.
- **Any notable feedback or suggestions from the participant?**
  The plus on the icon for the hiding element look like the feature is going to add something.
  Confusion on how many elements were been hidden.
  The blurring is confusing.
  Confused for the highlighted picture
- **Other observations worth recording:**

General impressions

Participant ID	0001

Date and time	12/06/2025 18:20
1. What are the main problems you have found while using this extension?	
Blurring during the removing/hiding of elements was very confusing for the user	
2. What is the part of the extension that has been more difficult to understand? Why?	
The easy navigation mode overloaded the user because a lot of colours appeared on the screen.	
3. What have you liked most of the extension? Why?	
The user loved the summarizer and the highlight all. The user suggested to remove highlight one paragraph and hide elements because useless (she would rather highlight the entire page, is faster because just one click, and removing elements to then just reload the page to get them back).	
4. Can you describe your overall experience with this extension?	
The user said is an 8 out of 10. The user liked and enjoyed in general to use the application.	

Usability Test Observation Sheet

General Information

Participant ID: 0005
Date of Test: 24/06/2025
Start Time: 10:00
Observer Name: Francesco

Task Overview Table

Task #	Actions	Duration	Success	Mistakes Made
T1	5	5sec	yes	0
T2	1	1sec	yes	0
T3	5	7sec	yes	1
T4	>5	10sec	yes	0
T5	4	15sec	yes	0
T6	2	2sec	yes	0

Notes

- T1: She was a bit confused at the beginning, especially when it didn't' highlight.
- T2: She understood this better. She understood that she had to exit this mode, even though is not needed.
- T3: She noticed that she can hide every element. She understood pretty fast the feature.
- T4: She thought the function was to hide everything (maybe she got the same pattern as the T1 and T2 and got confused)
- T5: She noticed that the text is almost the same sometimes. She would use more the highlight than the summarization.
- T6: She loved this. She said she would use it all the time, she was happy. She like the preview, saying that is great. She didn't understand that it needs some time to load the preview.

General Participant Behaviour

- **Was the participant thinking aloud?**
  Yes
- **Did the participant show signs of frustration or confusion?**
  No

Post-Test Notes (Observer Summary)

- **What went well for the participant?**
  Understand fast the functions.
- **Where did the participant struggle most?**
  Nothing really
- **Any notable feedback or suggestions from the participant?**
  She was super happy to use the last function, she was super excited.
- **Other observations worth recording:**

General impressions

Participant ID	0005
Date and time	24/06/2025 11:00
1. What are the main problems you have found while using this extension?	
Nothing	
2. What is the part of the extension that has been more difficult to understand? Why?	
Differences between the first and the second feature, they seemed redundant for her.	
3. What have you liked most of the extension? Why?	
Highlight everything, hiding, previews were perfect. She would like to hide big element and not the small one (for example if there is a container with a lot of elements, she would like to ignore those elements and hide the entire container). She would like to open the link in another tab.	
4. Can you describe your overall experience with this extension?	
She would love to use that again. She asked me if it was possible to keep that on her browser.	

Usability Test Observation Sheet

General Information
Participant ID: 0007
Date of Test: 16/06/2025
Start Time: 17:30
Observer Name: Elena

Task Overview Table

Task #	Actions	Duration	Success	Mistakes Made
T1	2	3sec	Yes	0
T2	1	2sec	Yes	0
T3	5	10sec	Yes	0
T4	>5	10sec	Yes	1
T5	5	15sec	Yes	0
T6	2	2sec	Yes	0

Notes

- T1 much better that T2: having all highlighted at once is too overwhelming
- T3 is her favourite, she spent a lot of time with it, a lot of clicks she used it with www.elpais.es and she removes everything from the page. Specially she liked removing pictures. She would like to have multi-selection.
- T4 she did not understand the difference between that and the previous one, it is too similar. When she tries to remove a link to "X" it went to the page, maybe it is a BUG
- T5: she did not trust it, she though that all this things always try to deceive autistic people as they are though for neurotypical. Also as it is not working is Spanish better not use it. Also, she mentioned she needs all information to understand something.
- T6 she liked the idea a lot. But she noticed that the small image in some cases the name of the title is not the same in the current webpage and in the next one, it is not a problem of our extension but she was annoyed by it.

General Participant Behaviour

- **Was the participant thinking aloud?**
  Yes
- **Did the participant show signs of frustration or confusion?**
  Yes

Post-Test Notes (Observer Summary)

- **What went well for the participant?**
- **Where did the participant struggle most?**
- **Any notable feedback or suggestions from the participant?**
- **Other observations worth recording:**

General impressions

Participant ID	0007
Date and time	16/06/2025 18:55
1. What are the main problems you have found while using this extension?	
AI is not working in Spanish.	
2. What is the part of the extension that has been more difficult to understand? Why?	
Nothing, but T2 is not so useful.	
3. What have you liked most of the extension? Why?	
T3 is the best (hide elements).	
4. Can you describe your overall experience with this extension?	
I would use it a lot, I can focus my attention removing pictures. I would like to be able to save my preferences. I think it would be useful for studying.	

Usability Test Observation Sheet

General Information
Participant ID: 0010
Date of Test: 20/06/2025
Start Time: 14:30
Observer Name: Elena

Task Overview Table

Task #	Actions	Duration	Success	Mistakes Made
T1	2	2sec	yes	0
T2	2	2sec	yes	0

T3	2	<5sec	yes	0
T4	5	>10sec	yes	0
T5	2	>10sec	yes	0
T6	2	<1sec	yes	0

Notes

- T1: super fast. All ok. No problems
- T2: she prefers this one. Only one click and everything is done (she is quite nervous)
- T3: she likes it a lot. She tries to recover one but it is not working
- T4: she does not notice the difference between this one and T3. She prefers the T3
- T5: she likes it although she does not understand it. She would use it TO CHECK IF SHE HAS UNDERSTAND THE CONTENT OR NOT!!!
- T6: she thinks it is not really useful as when the mouse gets over you already notice that this is a link

She prefers the 5th, she is quite nervous during the interview and wants to do it fast. She feels comfortable only with the 5th one, even though she does not understand English but she likes the concept.

General Participant Behaviour

- **Was the participant thinking aloud?**
  Yes
- **Did the participant show signs of frustration or confusion?**

Post-Test Notes (Observer Summary)

- **What went well for the participant?**
- **Where did the participant struggle most?**
- **Any notable feedback or suggestions from the participant?**
- **Other observations worth recording:**

General impressions

Participant ID	0010
Date and time	20/06/2025 15:00
1. What are the main problems you have found while using this extension?	
The main problem is the absent of Spanish version	
2. What is the part of the extension that has been more difficult to understand? Why?	
She does not understand the icons	
3. What have you liked most of the extension? Why?	
She likes the summarisers the most	
4. Can you describe your overall experience with this extension?	
She says at the end this is super good, she feels positive, very good for students but only for those who really need it, the others would try to get advantage	

Demographic questionnaire

1. Participant ID (ask the researcher for it)

4
Responses

Latest Responses
"10"
"5"
"0007"

2. Age

18-24	1
25-34	2
35-44	0
45-54	1
55-64	0
65 or older	0

3. Gender

Female	4
Male	0
Non-binary / Third gender	0
Prefer not to say	0
Other	0

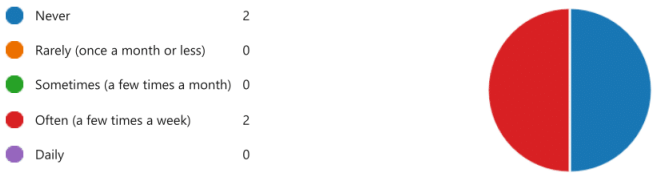
4. Educational level

No official education	0
Primary education	1
Secondary education	1
University (Bachelor/Master/PhD)	2

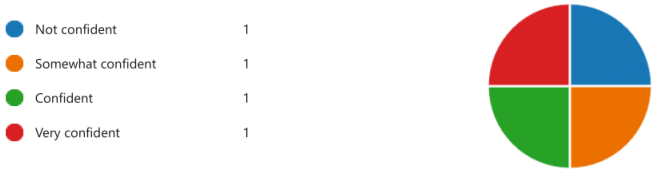
5. How much time do you spend using a personal computer (desktop or laptop) on an average day?

Less than 1 hour	1
1-3 hours	2
4-6 hours	1
More than 6 hours	0

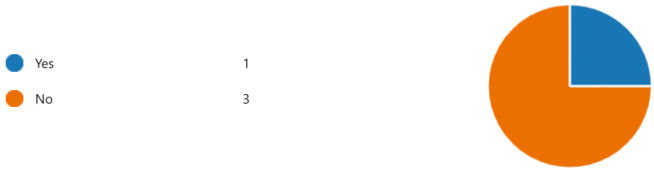
6. How often do you use browser extensions in your everyday browsing?



7. How confident do you feel using digital tools (e.g., apps, browser add-ons, accessibility features)?



8. Do you regularly use any accessibility tools (e.g., screen readers, text-to-speech, font changers, color filters)?



9. If the previous answer was yes, which ones?

1
Responses

Latest Responses

10. Any additional information you'd like to share about your web browsing experience or needs?

2
Responses

Latest Responses

"I struggle when the button is confusion, the contact information get lost. I lik...

SUS results

1	2	3	4	5	6	7	8	9	10
4	3	5	1	5	1	3	1	4	1
4	1	5	1	5	1	3	1	5	5
5	2	5	1	4	1	5	1	5	1
5	1	5	1	3	3	5	1	5	1

Points odd questions	Points even questions
90	29

SUS Score 1	85
SUS Score 2	82,5
SUS Score 3	95
SUS Score 4	90
SUS Average	88,125
SUS Std. dev.	5,54338946

9.4 Expert cognitive walkthrough summary

Meeting Overview

Date: June 17, 2025

Duration: ~30 minutes

Facilitator: Elena Villalba Mora

Purpose: Expert evaluation of a browser extension developed.

Functionality Feedback

9.4.1 Marking Important Information in Paragraphs

- Two modes are justified: fine-grain control (per paragraph) vs. automated summarization (whole page).
- Users need **both detail and flexibility** based on disability type or preference.

"Some people prefer control, others prefer automation. The tool should support both."

9.4.2 Removing / Hiding Distracting Elements

Issue:

- Currently **no real difference** between them. Neither is truly persistent; both reset on page reload.

Suggestions:

- Merge both into a **single "Hide" tool** with a small icon to undo.
- Future version: store user actions via **cookies or local storage** so removed elements stay hidden on revisit.

"There's no value in 'Remove' if it doesn't persist."

9.4.3 Persistent Settings

- Users want to activate favourite features (e.g., mark paragraphs, hide distractions) **automatically** each time the browser loads.

Feedback:

- Critical to include **persistent settings** so users don't need to reconfigure every session.
- Suggested: per-feature memory, possibly per-domain.

"The tool should remember my preferences, that's basic accessibility."

9.4.4 Summarizing Paragraphs ("Summer is Content")

Issue:

- Takes **two clicks** to see the summary: one to show the icon, another to expand.
- Sometimes the summary **lingers** even after feature is deactivated.

Suggestions:

- Remove unnecessary click, show the summary immediately on icon click.
- Auto-collapse or remove summary boxes when the feature is turned off.

"As an expert, I say this interaction has one extra click, not good."

"Summary boxes should vanish when the function is disabled."

9.4.5 Easy Navigation (Link Highlighting)

Suggestions:

- Allow users to **customize highlight colours**, especially for contrast accessibility.
- Ensure compatibility with grayscale/contrast tools (e.g., tested with the "Grey Escape" extension).

"Some users have visual impairments and need to choose their colours."

"It should work even when colour isn't visible, contrast is key."

9.4.6 Interaction & Usability Issues

- **Mouse cursor tracking delay** noted, could confuse users.
- **Tooltip placement** is generally good.
- **Positioning of controls** on the UI could be improved for widescreen devices.

- **Keyboard shortcuts** suggested for accessibility.

"The delay in mouse tracking feels like I lost control, not good for accessibility."

"Should add keyboard shortcuts for full usability."

9.4.7 Future Work Recommendations

1. **Persistent Memory:** Save user preferences and hidden elements per domain/page.
2. **Consolidate Hide/Remove Tools:** Keep only one method with undo and optional persistence.
3. **Streamline Summarization:** Remove extra clicks; improve summary box management.
4. **Colour Customization:** Allow users to pick from a range of accessible colour themes.
5. **Performance Improvements:** Optimize responsiveness of UI, mouse tracking, etc.
6. **Keyboard Navigation & Shortcuts:** Improve accessibility for users who can't use a mouse.

Professor's notes

- try to remember where to locate the extension from the last time in the webpage
- difference between 3rd and 4th not clear, maybe keep only the 3rd one and remove the permanent removal
- in the summarize, avoid the second click, keep only one to have the text summarized
- the speed of the mouse when you move the extension in too slow
- when you try to remove the summarize it keeps there, maybe it is a bug
- the last one about navigation, make the colour configurable to improve accessibility. It is not the same colour when the background is white or another one