Master's Thesis

Designing an Accessible Website for Older Adults with Consideration of Visual Perception

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Abstract

The number and proportion of older adults in the world are rapidly growing every year and the need for Internet use among this age group is also increasing. Older people might face two major types of problems: one, Lack of knowledge in using the internet, and two, physical impairments in areas such as vision, cognition, speech, and hearing. Older adults, like other age groups, have a need and interest in using the Internet, but unfortunately, the designs are not adapted to the needs of this population, and this group is counted among the minorities.

To solve these issues, when designing websites, the problems of this age group should be taken into account, and educational training should be prepared and produced for people with limited Internet skills. These issues will not only affect today's older population or the so-called baby boomers, it should be considered that physical problems will also exist in future older people (today's youth) who might have more knowledge in using the Internet and the design of the webpages must be made accessible for them.

This thesis explores various problems that can arise due to aging and is concerned with the visual design of an accessible educational website and finding appropriate design solutions according to accessibility guidelines. For each visual element of the website, various design solutions are considered to make the website more accessible and usable.

When the designs were prepared, the web pages were evaluated with five participants over the age of sixty, through the usability testing method. The findings indicate that considering accessibility when designing a website can make it easier for the users to work with the website and it increases their self-confidence in using them. As a result, they are able to use the Internet on their own without needing help from those around them.

This paper discusses only the design of visual elements, which can be useful for older users whose vision ranges from low to very good.

Keywords: Accessibility, Older adults, Visual perception

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1. Introduction

According to the United Nations, due to life expectancy and the decreasing birth rate, in each country, the number and proportion of older people are rapidly growing. In 2020, there were 727 million people worldwide aged 65 years or over. It is expected that over the next three decades, the global number of older people will be more than double, reaching over 1.5 billion in 2050 (Kamiya, Mun Sim Lai, & Schmid, 2020).

Considering the aging of the world's population is especially important for designers. In recent years, a lot of older adults around the world use the internet. Especially in 2020 after the COVID-19 outbreak, the need of using the internet and websites has increased (Eurostat, 2021).

The studies by Frees and Koch show that in Germany internet usage among older adults is growing every year. Especially adults older than sixty have the highest increase of daily internet use. Adults aged 60-69 use the Internet 7% more (from 50% in 2018 to about 57% in 2020), and 70-year-olds use it 5% more (from 29% in 2018 to about 34% in 2020) (Table 1) (Beisch & Schäfer, 2020).

| | mindestens selten genutzt | | | | | | | | | | Tagesreichweite Internet** | | |
	1997	2000	2003	2006	2009	2012	2015	2018	2019	2020	2018	2019	2020
Gesamt	7	29	54	60	67	76	80	90	89	94	68	72	72
Frauen	3	21	45	52	60	71	76	89	88	92	66	72	71
Männer	10	37	63	67	75	82	83	92	91	96	72	72	72
14-19 Jahre	6	49	92	97	98	100	100	100	100	100	95	100	97
20-29 Jahre	13	55	82	87	95	99	98	100	100	100	94	97	97
30-39 Jahre	12	41	73	81	89	98	94	99	99	100	89	87	89
40-49 Jahre	8	32	67	72	80	89	92	98	98	100	75	80	83
50-59 Jahre	3	22	49	60	67	77	83	97	95	96	69	70	67
60-69 Jahre	1	8	20	29	39	63	67	82	85	93	50	56	57
ab 70 Jahren	0	1	5	11	16	20	38	65	58	75	29	35	34

Table 1: Internet users in Germany from 1997 to 2020, in % (Beisch & Schäfer, 2020)

1.1. Problem definition

The need for Internet use and digital literacy among adult users is increasing, but designs are not adapted to the needs of this population group. Usability studies by the Nielsen-Norman Group show that older Internet users are affected by poorly designed websites and applications and face particular challenges when they use them (Pernice & Nielsen, 2020).

In April 2021, YouGov company conducted research with 2,031 participants aged over fifty, to find out how accessible the websites were for this target group during the COVID-19 lockdown. They found that one in the four (27%) participants faced issues with the websites:

- 63% said the layout was not easy to understand,
- 12,5% had problems with broken links,
- 20% preferred larger text size,
- 22% found the content complicated (YouGov, Texthelp, 2021).

The older adults, so-called digital immigrants did not grow up with the digital world in contrast to digital natives. They often are afraid and worried about the use of technology. These negative feelings should be reduced in designing modern technology.

As it is shown in Graph 1, fear of fraudsters (47%) and a lack of knowledge (46%) are the main obstacles to using technology, followed by a lack of support (41%) and difficulty in using them (36%). This shows that the target group rates itself as not very competent in using the technology (Digitales Dorf, 2020).

Welche Gründe hindern daran, digitale Technologien zu nutzen?
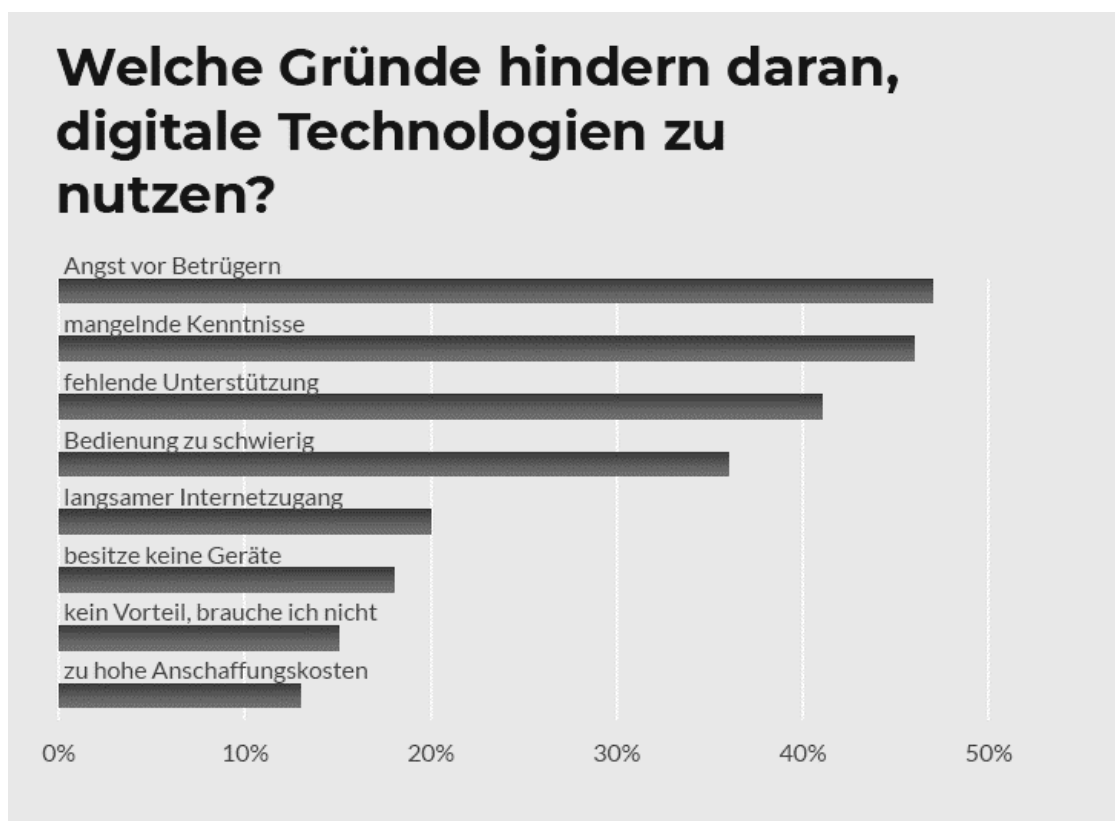
Graph 1: Survey results on the question of which reasons prevent citizens from using digital technologies. Multiple selections were possible (Digitales Dorf, 2020, p. 7).

In addition to these problems, it is important to consider that as people age, they are more likely to suffer from one or more chronic conditions that result in impairment in one or more of the following areas: vision, speech and hearing, cognition (attention, learning, memory), attitude and motor skills (Arch & Abou-Zhara, 2004). A lot of digital products fail to take these changing needs into account. Current designs often feature illegible text, colors with poor contrast, small fonts, incomprehensible interaction elements, and tiny targets. This is a more crucial factor in design because today's younger users will be older and more familiar with technology as the population ages (Nielsen Norman Group, 2021).

1.2. Research aim

The aim of this research is, designing an accessible website for older adults with consideration of visual perception. The primary research question to be answered is: can the self-confidence of older adults in using websites be increased through accessible design?

As mentioned, before, older users may confront one or more of the impermeant problems, e.g., Vision, Hearing, Cognition, and motor skills. Examining all the mentioned cases requires detailed and specialized research, and due to the wide range of cases and time constraints, in this research, only visual perception will be researched. The research is concerned with older users whose vision ranges from low to very good. Blindness is concluded from this study.

The website that will be designed and researched is called "Digio." Digio is an online education website, which offers free and paid courses. Through this website the users will learn how to use different technology, learn a new topic from various categories e.g., arts, history, wellness, etc., and they can choose between one-on-one classes and self-learning courses. The main goal of the design of this website is to help older adults and Retirees use the website with more confidence.

1.3. Structure of the work

This thesis consists of three main parts:

1. **Literature study:** Before making design decisions, it is important to ensure that we are solving the right problems. To understand user problems and challenges, the first part of this paper reviews various research and articles from reliable sources with guidelines and principles of visual design.

2. **Methodology:** The design thinking method was used for designing the website and the second part explains the design process using this method and it covers the accessible designs of the visual elements of the website. In addition, the test procedure and the preparation method for the test materials are described in this section.

3. **Findings:** The last part describes the details of the analysis carried out.

2. Literature study

Nielsen Norman Group has conducted various studies (usability testing, focus groups and contextual inquiry) about senior users, in the United States, Germany, Canada, Australia, and Japan from 2001 to 2019. Their studies show that between the ages of 25 and 60, user's ability to use websites decreases by 0.8% per year. Mainly because the users spend more time on each page as they get older and also, they have navigation difficulties. In comparison, users aged sixty-five and older are 43% slower at using websites. Since they conducted this research for almost two decades, they noticed some behavioral changes. In 2001, seniors were apprehensive and hesitant about their online behavior, whereas in 2019, users are more confident, and their digital literacy is increasing. For instance, they know how to install ad blockers, delete their accounts, and uninstall time-wasting apps. The Baby Boomer generation (born between 1946 and 1964) have now more experience with technology in their retirement age and some of them had used computers during their career (Kane, 2019).

When something goes wrong on a website, users usually blame themselves which is a sign for designers that they made a bad design decision. Due to reduced confidence in using websites, older users are more likely to use search engines like Bing or Google to find what they need (Nielsen, 2013). Readability and inaccessible design are one of the main problems of websites. This is due to the use of small font sizes, small buttons, and links, etc. Furthermore, error messages are often not understandable, either because the wording was unclear or inaccurate, or because the placement of the message on the screen could easily be overlooked in the abundance of other elements.

Older adults sometimes feel that the websites or apps are not made for them, and the research shows that the designs still discriminate against older users. With accessible design and an inclusive content strategy, online businesses can significantly increase the number of customers from this demographic (Nielsen Norman Group, 2021).

Wilhelm et. al. (2019) has conducted a survey that shows that the majority of older users, receive support from their family when they want to use technology. It also shows that when users want to learn something and need support, they mostly prefer exercises with a coach (56%) and attending a digital consultation hour (53%).

Table 2: Survey results on the question of which support offers citizens are looking for. The question was answered by 111 people. Multiple selections were possible (Wilhelm, Jakob, & Dietmeier, 2019, p. 706).

2.1. User experience design

USER EXPERIENCE DESIGN

INFORMATION ARCHITECTURE

ARCHITECTURE

Content (Text, Video, Sound)

INDUSTRIAL DESIGN

HUMAN FACTORS

VISUAL DESIGN

INTERACTION DESIGN

SOUND DESIGN

HUMAN-COMPUTER INTERACTION
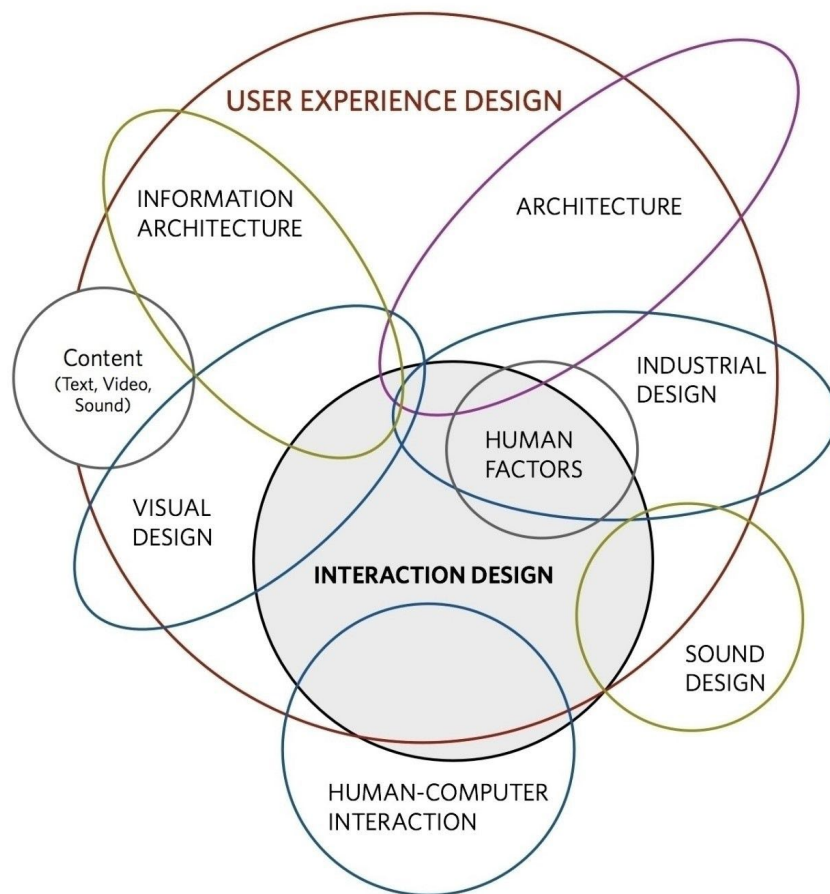
Figure 1: User experience Design (Interaction design foundation, 2020)

User experience can be defined as "Perceptions and reactions of a person resulting from actual and/or expected use of a product, system, or service. [...] User experience includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviors, and accomplishments that occur before, during, and after use. (ISO 9241-210) (ISO, 2019)".

User experience focuses on escalating the enjoyable, satisfying, efficient, and productive aspects of using a product. As Figure 1 shows, the user experience has different disciplines, such as information architecture, human-computer interaction, visual and sound design, and interaction design. The UX designer must provide the necessary functionality for easy and smooth interactions and transitions for all users (Figure 2). A great user experience is composed of three important design skills: Usability, graphic design, and accessibility (Interaction design foundation, 2020).
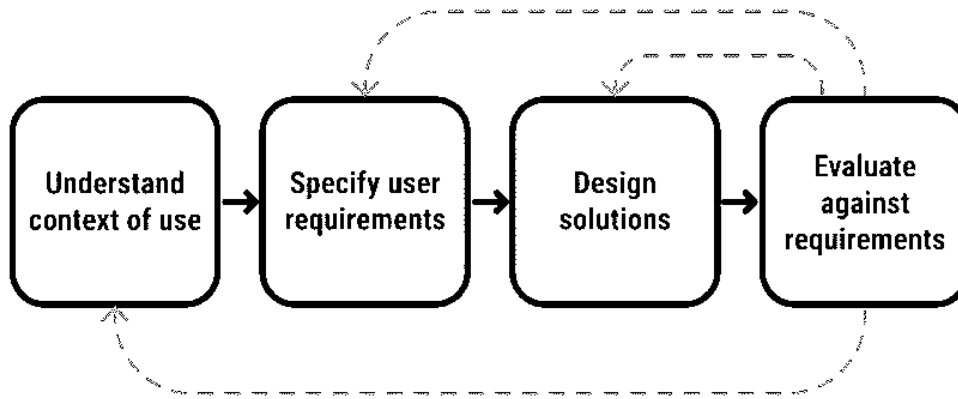
Figure 2: The process of user-centered design (Interaction design foundation, 2020)

2.2. Accessibility

"The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect" said Tim Berners-Lee, W3C Director, and inventor of the World Wide Web (World Wide Web Consortium, n.d.).

Accessibility is a part of user experience design. It is the practice of making the websites or products more usable by all users, regardless of technology, education, or ability, so that all have an equivalent experience. The UN Convention on the Rights of Persons with Disabilities (2007) recognizes access to information and communications technologies, including the Web, for persons with disabilities, as a basic human right.

Accessibility supports social inclusion for all people around the world, e.g., older people or people with disabilities. People without disabilities can also benefit from it. It can also improve and benefit different areas, such as, search engine optimization (SEO), usability, multi-modal interaction, and mobile web design. Businesses that consider accessibility in their websites will have benefits such as, better search results, more visitors and reduced maintenance costs. It is always cheaper to make a website accessible than try to change it later. Another advantage of accessibility is that it requires less user support.

Older adults have different disabilities, and considering accessibility allows them to use the website with more confidence and enjoy it better (Interaction Design Foundation, 2020). Laura Carstensen, Director of the Stanford Center on Longevity says, "The challenge is converting a world built by and for the young into a world that supports and engages a population that lives 100 years and beyond" (Keohane, 2017).

2.3. Physical changes associated with aging

The following describes some physical changes and limitations that often arise during the normal aging process. Since various disabilities can affect the methods of visual design of an accessible website, all major problems are briefly discussed. Visual problems have been examined in more detail.

2.3.1. Motor Control

After the age of fifty, fine motor skills begin to decline in most people, so it becomes difficult to click and move a pointer on a web page. An older adult usually takes longer than younger adults to complete a movement. This decline in manual dexterity could be due to slower mental processing, a tendency to perform movements consciously, or pain that inhibits movement. For older adults, double-clicking can be a problem, due to slow or shaky clicks or by double-clicking the files that require one click. The hand and arm muscles weaken, and less force applies to buttons and keyboards (Johnson & Finn, 2017).

People use their vision to guide their hands to do things like hitting on a target on a webpage or selecting items. This hand-eye coordination declines as people age and older adults will perform tasks slower than younger users. Designing hitting targets or moving pointers follows **Fitts's law**. This law states that the amount of time required for a person to move a pointer (e.g., mouse cursor) to a target area depends on the size of the target and the distance to the target (Interaction design foundation, n.d.). Thus, the larger an object is and the closer it is to us, the easier it will be for us to reach it. Therefore, the movement time to the target is also shorter.

Figure 3 illustrates Fitts's law Formula and three targets. Targets A and C have the same distance, and targets A and B are equal in size. This law indicates that the time required to reach target A is shorter than the time required to reach targets B and C. Because target C is smaller and target B has more distance (Budiu, 2022).

$$T = a + b \log_2 \frac{2D}{W}$$
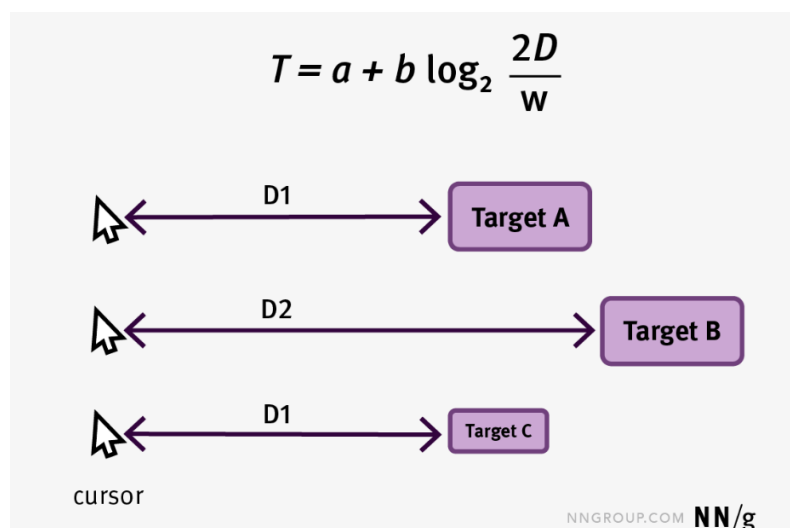
Figure 3: Fitts's law: T (Time) = a + b log2 (2 D (Distance)/ W (Width)) (Budiu, Fitts's Law and Its Applications in UX, 2022).

Arthritis and Parkinson's disease are the primary causes of physical impairment in older adults. People with Parkinson's have issues with the mouse and pointing, for instance: keeping the hand steady while navigating, moving in the desired direction, or slipping off [multi-level] menus (Keates, 2005).

2.3.2. Cognition

Cognitive abilities decline with age and due to genetics and, life experiences vary from person to person. When designing for adults, three important cognitive factors must be considered—working memory, problem-solving, and attention.

People have various kinds of memories. Short-term memory—also known as working memory—and long-term memory, are two main components of human memory. Older adults' working memory capacity is lower than younger adults (Johnson & Finn, 2017). Research shows that accomplishing a complex task can exceed the capacity of working memory and be overwhelming if it involves many steps and there are many things to keep track of. If the task cannot be broken down into simple steps, older adults often want to start over or give up (Fairweather, 2008). Also, a complex sentence that has many clauses or negations can strain working memory (Arch & Abou-Zahra, 2018).

When using a device or website, a mental model of how it works is created in people's minds, so they can remember how to use it. With well-designed applications or information, users can develop mental maps more easily, than with poorly designed ones (Johnson & Finn, 2017).

Numerous studies show that people are more easily distracted by navigation links, advertising, and other screen elements as they get older. They are less able to ignore irrelevant information or avert their gaze from extraneous elements on the screen (Johnson & Finn, 2017; Carmien & Garzo, 2014).

2.3.3. Attitudes toward technology

Older adults prefer to be sure of the outcome of an action before they take it. Therefore, they tend to read and learn everything before they act. Once they know how to achieve a goal, they may hesitate to try new ways (Carmien & Garzo, 2014).

2.3.4. Knowledge gaps

According to the study by Johnson and Finn (2017), 20 years from now, technology will change tremendously, and a greater number of older adults will have experience with digital technologies. In 20 years, older adults will still face a knowledge gap, but it will be a different lack of knowledge. Therefore, in this study, we will only consider the knowledge of today's older adults.

Although computer use is becoming more popular among older adults, for many of them, using IT products isn't a regular part of everyday life, so they have less experience with digital technology (Mariano, Marques, R. Ramos, Gerardo, & de Vries, 2020).

Many older adults are not familiar with technical terms such as gigabyte, upload, login, etc., and they must learn their meanings to understand them. The icons, on the other hand, are unfamiliar to many of today's older adults. The lack of standard use and appearance of icons for common functions makes it difficult for users of all ages to understand what the icons mean. Also, the use of different control gestures - such as scrolling, double-clicking, and swiping with one or two fingers-for applications or platforms makes them difficult to learn (Johnson & Finn, 2017).

2.3.5. Hearing

Aging affects hearing and reduces the ability to distinguish similar sounds that differ in intensity or frequency. About 10% of adults between the ages of 45 and 59 have hearing loss. Between the ages of 60 and 65, the percentage is 33%; between 75 and 80, 55%; and over 80, 89% (Figure 4). Some older people may also experience a decline in other hearing abilities, such as, hearing low-volume sounds, sensitivity to high-frequency sounds, localizing sounds, filtering out background noise and understanding fast speech (Johnson & Finn, 2017).
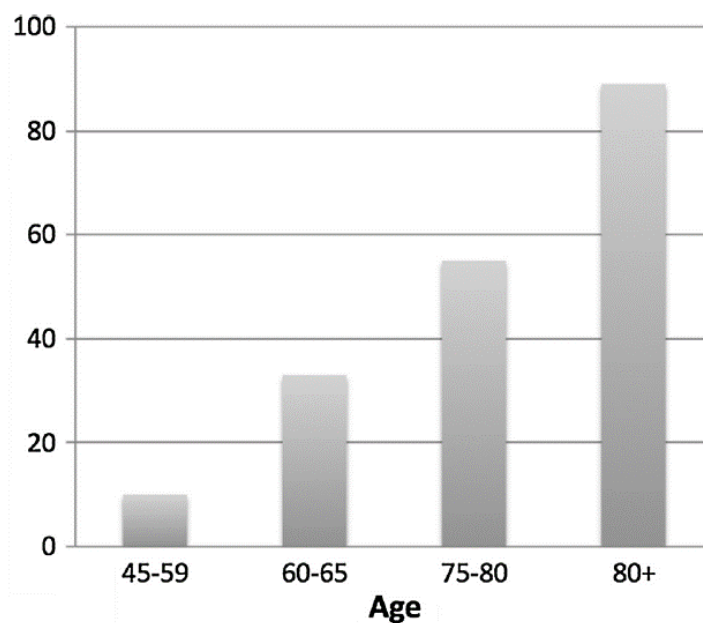
Figure 4: Percentage of people with hearing loss (Johnson & Finn, 2017, p. 75).

When using videos or audio on websites, designers should consider the following guidelines (Johnson & Finn, 2017):

- Avoid high-frequency sounds (Carmien & Garzo, 2014),
- Minimize background noise and avoid distracting sounds,
- Provide text-to-speech,

- Make volume adjustable,
- Make play speed adjustable,
- Make speech output as normal as possible,
- Supplement the video and audio with transcripts or subtitles and make sure the text is easy for older people to read (Hawthorn, 2006).

2.3.6. Vision changes

Human visual acuity declines with aging, but when it occurs and the degree of it varies from person to person. Older adults who experience this, have difficulty reading and seeing the information. Understanding how human vision works, is an important aspect of designing websites (Graph 2).
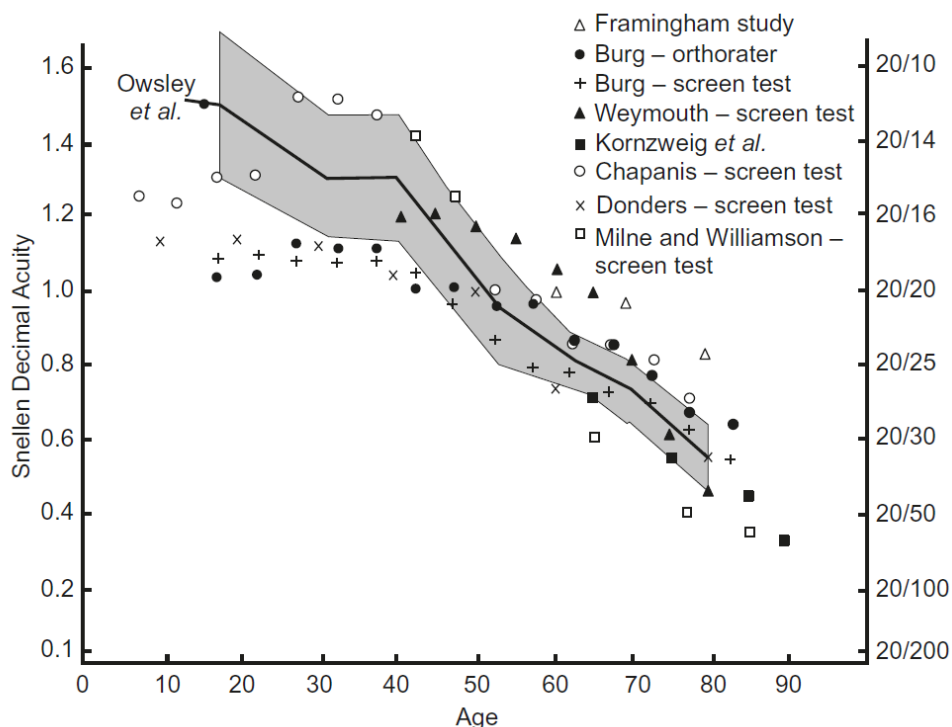
Graph 2: Mean visual acuity as a function of age (Johnson & Finn, 2017, p. 28)

Humans do not simply see a series of photographic images of the environment; as Bruce E. Goldstein, Associate Professor at the University of Pittsburgh and author of Sensation and Perception, states "...we do not just perceive what is out there. We perceive what is out there as filtered through the properties of the visual system". Vision is the result of light energy entering the eye and then being converted into electrical activity. This electrical energy is then transmitted from the retina, a light-sensitive tissue at the back of the eye that contains photoreceptor cells, to the brain via the optic nerve (Figure 5). When this information reaches the brain, it is immediately transformed into a conscious experience of the world (Bradley, 2011).

Approximately in the center of the retina is a small area called the fovea. About 50% of the optic nerve fibers transmit information from this area, and this is where visual acuity is

highest. This suggests that designers should place essential information at the point where the eye is currently centered, so the users will not miss them (e.g., alerts, or error messages) (Bradley, 2011).
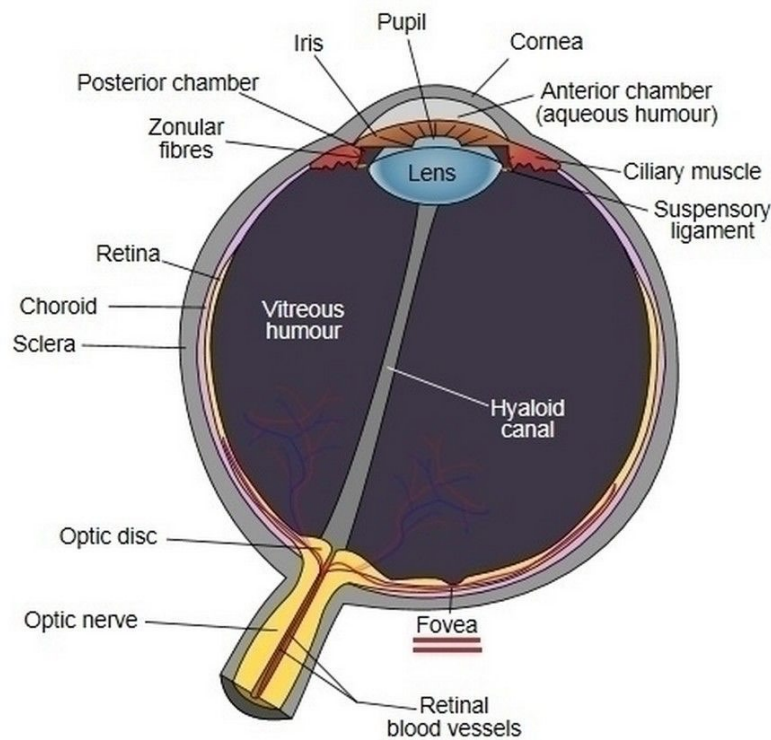
Figure 5: Human eye – Section view (Bradley, 2011)

Decreased ability to focus close (farsightedness or presbyopia)

Around age 40, eyes muscles start to weaken, and it becomes more difficult to focus on nearby objects—known as age-related farsightedness (Johnson & Finn, 2017). The fovea can only focus on a small area at a time (1% of the visual field). The other 99% - the periphery - has very low resolution and is blurred. Peripheral vision can gradually narrow with age and it increases the chance of missing error messages, warnings, or other information that may not appear where they are looking (Hawthorn, 2006).

Reduced peripheral vision can also have negative effects on reading. When reading, people usually focus on a group of words and then jump to the next group to read further. When the peripheral vision narrows, scanning the text is less effective, which slows the reading.
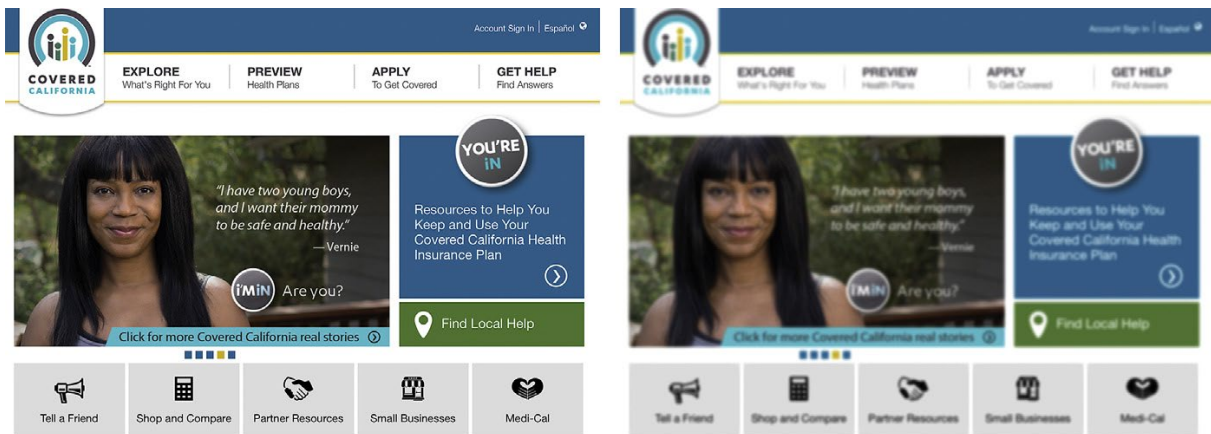
Figure 6: Normal vision (left) and farsightedness (right) (Johnson & Finn, 2017, p. 29).

Slower visual search

When looking at a page, the eyes focus on items one by one until they spot the target. This way, the search time is linear. If an item stands out – e.g., with different color or texture – the visual search time will no longer be linear, and the user can find the target faster. As people get older distinguishing the target items will be harder. Therefore, the visual search time will be linear and time-consuming. There are several methods designers can use to make elements more distinctive, for instance, by changing the color or shape of an element (Figure 7) (Johnson & Finn, 2017).

```
T H O L W N F P F P K L          T H O L W N F P F P K L
J I M W F X P A Q Z F S          J I M W F X P A Q Z F S
L O M P Y R N C M E D            L O M P Y R N C I ME D
P K H N E W K B A M O            P K H N E W K B A M O
```
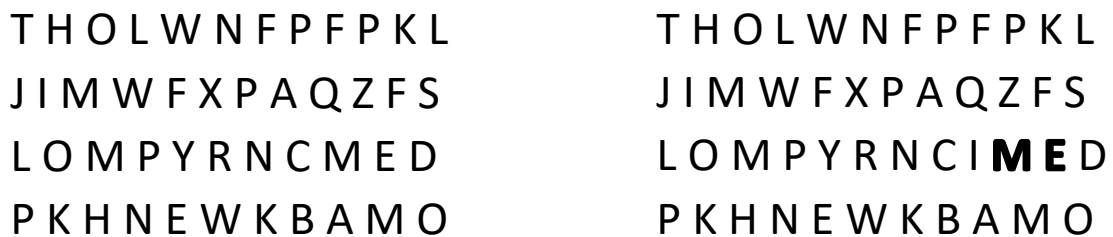
Figure 7: Linear visual search. Find the word ME. (left), Nonlinear visual search (right).

Lower sensitivity to light

With age, the pupil grows smaller and the amount of light that the eyes can receive and register decreases. Therefore, older adults see the web pages darker (Figure 8) and need brighter light, for reading (Johnson & Finn, 2017).
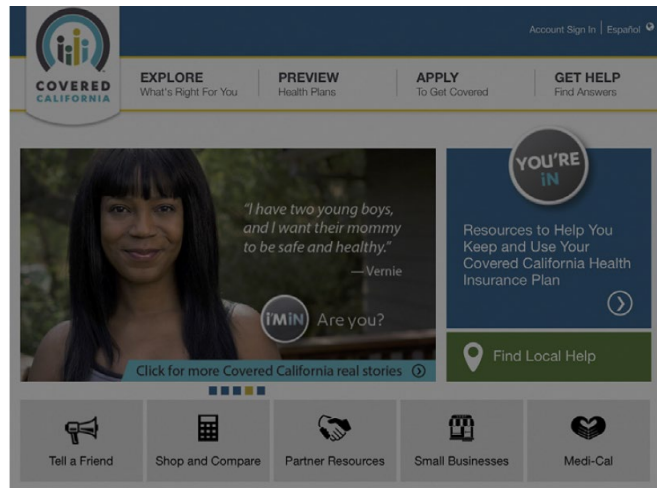
Figure 8: Older users might see the webpages darker (Johnson & Finn, 2017, p. 33).

Reduced sensitivity to contrast and color

The aging eye needs more amount of light. Its contrast sensitivity and the ability to see differences in shades of a color decline. So, people's ability to distinguish objects or read text that is displayed over a poorly contrasted background, pattern, or image decrease.

Constant exposure to ultraviolet light from the sun will cause the lens of the eye to get a yellowish tint and everything will look darker. This will affect how the users perceive colors (Figure 9). E.g., white, and yellow color, dark blue and black, or red and purple, will be harder to distinguish (Johnson & Finn, 2017). The yellowing and darkening of vision in the older population cause a form of color blindness.
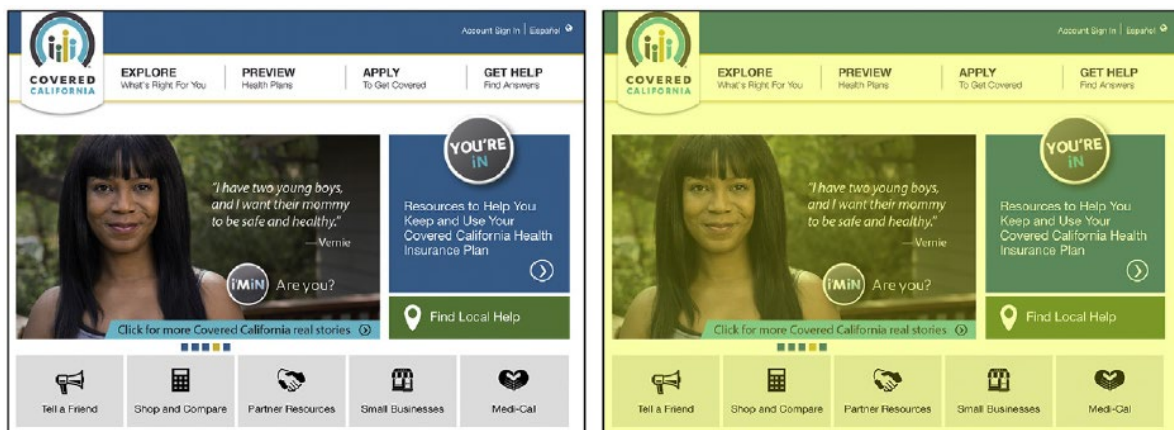
Figure 9: Normal vision (left) and the vision of a person who has yellowed cornea or has an issue with distinguishing blue color from green (right) (Johnson & Finn, 2017, p. 35).

Color blindness is a diminished ability to distinguish certain colors. People of any age may suffer from color vision deficiency. In the general population, it is estimated that about 8% of men and 0.5% of women are color blind (Johnson, 2014). Color vision deficiency varies in severity. There are various kinds of color blindness (Figure 10). The most common color blindness concerns the distinction between red and green, i.e., people with this problem

cannot distinguish red from green. That is why it is suggested to use different color values (very light or very dark color) when using these colors together.

Type	Colors that appear similar
Protanopia	Red and green. Some colors may appear more intense than they would appear to someone with normal vision.
Deuteranopia	Red and green, but colors retain proper intensity.
Tritanopia	Blue and yellow.
Complete chromatopsia	All colors are affected. Users see only shades of gray. Also, users often have poor vision as well.
Incomplete chromatopsia	All colors are affected. Users see colors dimly. Also, users often have poor vision as well.
Protanomaly	Reds are less intense and can appear black.
Deuteranomaly	Greens are muted.
Tritanomaly	Blue and yellow.

Figure 10: Types of color blindness

Decreased ability to detect subtle visual indicators

As people age, their ability to recognize subtle visual indicators and distinctions diminishes and may result in failure to recognize small, subtle elements (Figure 11) or important labels, even if they know where to look (Johnson & Finn, 2017).

Figure 11: The dots under the active apps in Mac OS Dock, are too small for many users.

Increased sensitivity to glare and light

Scratches on the cornea (the front layer of the eye), cataracts, and other corneal changes reduce the amount of light transmitted to the retina and result in increased susceptibility to glare. This makes it difficult for users to read and see details, especially when the contrast is too high (Figure 12) (Johnson & Finn, 2017).

The human pupil changes size depending on the amount of light coming in from the environment. In places with a lot of light, it contracts and narrows; in dark places, it dilates to allow more light to enter. When pupil size decreases, it makes the eyes less susceptible to spherical aberrations and increases depth of field, making it easier to focus on a text, which makes the eyes less likely to get tired. With age, the pupil narrows so that less light enters the eye, affecting the ability to read something – especially at night (Budiu, 2020).
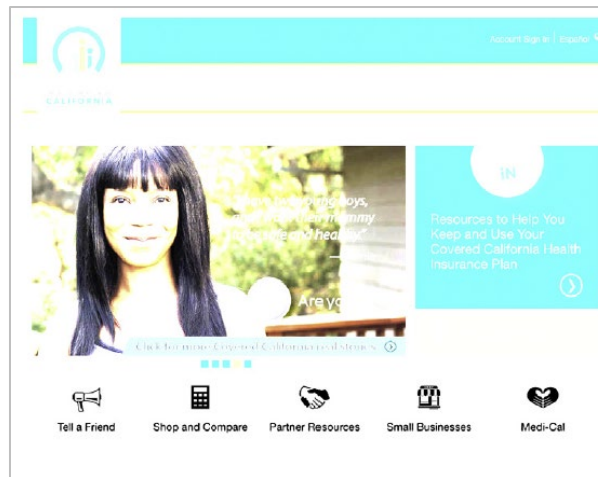
Figure 12: Glare sensitivity (Johnson & Finn, 2017, p. 37)

Some research shows that reading black text on a pure white background for an extended period of time can strain the eyes, suggesting the use of off-black text colors on white backgrounds or using off-white colors instead of pure white for backgrounds with pure black text (Dickinson, 2007).

Using dark mode or light mode in user interfaces

There are several studies on using dark mode or light mode, conducted with normal-sighted and visually impaired users. They tested the users in different environments. The results were different depending on users' vision and environment. In conclusion, the dark mode may have some advantages for low-vision users – e.g., participants with cloudy ocular, whereas light mode leads to better performance in users with normal vision.

Researchers recommend adding the possibility of switching to dark mode in user interfaces intended for long-form reading and because not all users benefit from dark mode, it is recommended that designers allow the user to switch to dark mode themselves if they need it (Budiu, 2020).

Each person may confront one or more of these issues. To improve the accessibility of websites for older users, there are several guidelines and principles that designers can apply. In the next part, we will discuss these guidelines.

2.4.   Accessibility guidelines and principles to design an accessible website

The guidelines and principles help designers create more user-centered designs and avoid accessibility issues. It is also important to consider that, in many countries, websites must legally meet accessibility requirements. In Germany, according to Barrierefreie-Informationstechnik-Verordnung (BITV 2.0), the websites and mobile apps of public bodies, in

particular, are obliged to be accessible and usable for people with disabilities (Bundesamt für Justiz, 2011). Table 3 illustrates different standards in some of the countries.

Country/region	Standard	Legislation	Requirements
Australia	WCAG 2.0 AA	Disability Discrimination Act	All government and nongovernment websites should comply with WCAG 2.0 AA.
Canada	WCAG 2.0 AA SGQRI 008 (based on WCAG 2.0)	Human Rights Act 1977	WCAG 1.0 compliance is required for all government websites. The Jodhan vs Attorney General of Canada ruling requires the Canadian government to meet WCAG 2.0, which was implemented in 2011.
		Ontario: Ontarians with Disabilities Act (AODA)	Ontario: AODA is required for all new Ontario government websites and existing websites by January 2016.
		Quebec: Standards sur l'accessibilité du Web	Quebec: Custom made standard based on WCAG 2.0 with specifics covering websites, downloadable documents and multimedia.
European Union	WCAG 2.0 AA	European Parliament Resolution (2002)	All EU commission websites are required to comply with WCAG 2.0 AA
Japan	JIS X 8341 (based on WCAG 2.0)		Required for all local and central government websites. Commercial websites are also encouraged to use it.
United Kingdom	WCAG 1.0 AA or WCAG 2.0 AA	Equality Act 2010	All U.K. government web sites require WCAG 1.0 AA or WCAG 2.0 AA. Other U.K. websites need to comply with the Equality Act and provide equal access, but no specific technical standards.
United States (federal)	Section 508 of Rehabilitation Act (predecessor to WCAG 1.0)	Americans with Disabilities Act. Section 255 of the Telecommunications Act. Section 508 of Rehabilitation Act	U.S. federal agencies' websites must comply with section 508 guidelines.

Table 3: International web accessibility Policy Comparison (Y. Tony Yang, 2015, p. 859)

2.4.1. Web Content Accessibility Guidelines (WCAG)

The Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C) develops web standards and guidelines for accessible design. They developed Web Content Accessibility Guidelines (WCAG) to improve the accessibility and usability of websites for users with diverse abilities and also the aging demographic. The first version, WCAG 2.0 was published on 11 December 2008 and the second update WCAG 2.1 was published on 5 June 2018. The latest update WCAG 2.2 according to w3.org, will be finalized by September 2022. These guidelines were adopted by the International Organization for Standardization (ISO) in 2012 (W3C, 2022).

Each version of WCAG contains three levels of conformance (Figure 13) (W3C, 2022):

1. Level A (Basic accessibility) is the minimum compliance level and includes thirty success criteria. Websites that do not least meet this level, are hard or impossible to use.

2. Level AA (Strong accessibility) includes all the criteria of level A plus twenty additional success criteria. If websites meet this level, they will be accessible, usable, and understandable for the majority of people. At this level, we can find the most accessibility rules.

3. Level AAA (Excellent accessibility) includes all the criteria of level A and AA plus twenty-eight additional success criteria. This is the optimal compliance level that makes the website accessible and usable for most people.

Web Content Accessibility Guidelines (WCAG)

Level A – 30 success criteria (total)

WCAG 2.0 (25)	WCAG 2.1 (+5)

Level AA – 20 success criteria (total)

WCAG 2.0 (13)	WCAG 2.1 (+7)

Level AAA – 28 success criteria (total)

WCAG 2.0 (23)	WCAG 2.1 (+5)

Level A (30)

Level AA (20)
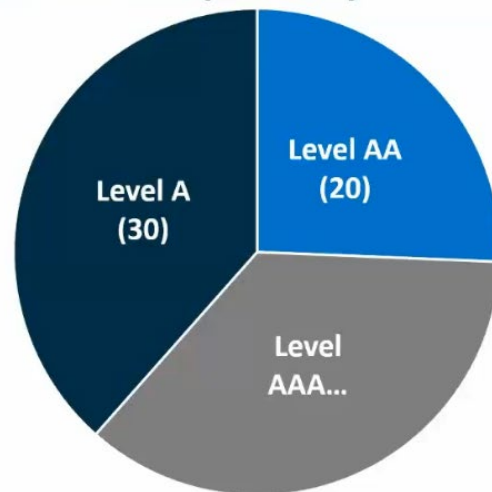
Level AAA...

Figure 13: Three levels of compliance and their success criteria (Deque, n.d.).

The WAI recommends meeting at least all WCAG 2.1 Level A and AA success criteria (Arch & Abou-Zahra, 2018). Conformance to these levels means that the website meets the requirements (success criteria) of the standard.

WCAG 2.1 has four foundational principles (W3C, 2022):

- **Perceivable:** All the information and user interfaces must be presented to users in ways they can see or hear (perceive).

- **Operable:** User interface and navigation are operable so that users can interact with them successfully.

- **Understandable:** Information and user interface operations must be clear and consistent so that the user can understand them.

- **Robust:** The content must be written robustly enough to be reliably interpreted by a wide variety of user agents, including assistive technologies such as mobile technology.

WCAG guidelines will benefit the needs of the aging demographic, but more is needed to define usability or experience and guidelines for issues such as cognitive disabilities. To create the best experiences for older adults, designers must also rely on basic user-centered design thinking and understand users through research such as interviews (Alexiou, 2021). As Martin McKay, CEO of Texthelp explains, "It's eminently possible to have a WCAG AAA compliant website that's still incredibly difficult to interact with and consume for many users" (Alexiou, 2021).

In 2010 W3C/WAI completed the Aging Education and Harmonisation Project (WAI-AGE), which is funded by the European Commission. The goal of this project is to better understand the needs of the aging population in the context of existing Web accessibility guidelines and

to increase the accessibility of the web for older people (Arch & Abou-Zhara, 2004; European Union, 2022).

2.4.2. European Union (EN 301 549)

EN 301 549 is the European standard for digital accessibility. It includes standards of the web and mobile applications and a wide range of other technologies. The first version of the standard "EN 301 549 V1.1.2" was published in April 2015. The latest version "EN 301 549 V3.2.1"is published in March 2021. From version EN 301 549 V2.1.2 the accessibility standards adopted the W3C's WCAG 2.1 guidelines. All web pages must comply with the W3C Web Content Accessibility Guidelines (WCAG 2.1) Level AA (European Telecommunications Standards Institute, 2021).

2.4.3. Universal Design for an Accessible Website

Universal Design is the design of products that are accessible, usable, and understandable for all people regardless of their age or ability. The design should meet the needs of all people who want to use it.

The Universal Design has seven principles that were developed by Ronald Mace and a group of designer researchers at the North Carolina State University (NCSU). These principles were created to guide a variety of design disciplines, including environments, products, and communications. They can be applied to any design style, but it is important to note that sometimes only some of them are relevant to a design (Center for Universal Design, 2011).

Universal Design principles according to NCSU (Center for Universal Design, 2011)**:**

Principle 1: Equitable Use

"The design is useful and marketable to people with diverse abilities."

This principle encourages the designers to think about all groups of users with different abilities. The design must provide all users with the same, equivalent options and does not segregate or stigmatize any users. Privacy, security, and safety precautions should be equally available to all users and the design must be appealing to all of them.

Principle 2: Flexibility in Use

"The design accommodates a wide range of individual preferences and abilities."

The design must be flexible, adaptable, and provide different methods of use so that the users feel freer when they use a website. It must accommodate both right- and left-handed access and facilitate the user's accuracy and precision.

Principle 3: Simple and Intuitive Use

"Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level."

This principle encourages simplicity and comprehensibility of the design. According to the cognitive load theory, humans can only process 3-9 items in a brief time when processing information. To reduce the complexity and decrease the cognitive load, the information should be presented in between 3 and 9 items.

The design must avoid unnecessary complexity and be consistent with user expectations and intuition. It must also provide effective feedback during and after the completion of the task. The information must be understandable for users with different literacy and language skills.

Principle 4: Perceptible Information

"The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities."

For this principle, the following guidelines must be considered:

- For a redundant presentation of essential information, designers must use different forms (pictorial, verbal, tactile).
- There must be appropriate contrast between the essential information and its surroundings.
- The readability of the information must be maximized.
- The design must be compatible with a variety of techniques or devices that people with sensory limitations use.

Principle 5: Tolerance for Error

"The design minimizes hazards and the adverse consequences of accidental or unintended actions."

Design elements must be arranged to minimize hazards and errors. They must be accessible and hazardous elements must be eliminated or isolated. Also, warnings about hazards, errors, and fail-safe features must be provided. Unconscious actions during tasks requiring vigilance must be discouraged.

As Hans-Peter Durr, a German physicist explains, "Human beings should only use technology which if the worst case happens, it leads to acceptable damage. Definitely, nuclear energy is not in that category. I want an industrial world where people are allowed to make errors. Because human creativity has to do with being allowed to make errors. We want an error-friendly environment" (Zheng, 2021).

Principle 6: Low Physical Effort

"The design can be used efficiently and comfortably and with a minimum of fatigue."

People spend a lot of time sitting at the computer, and that puts a strain on the body. Users with physical disabilities have even more difficulty using the Internet than normal users. These problems must be considered when designing a website. The design must minimize sustained physical effort and repetitive actions. All the operating forces must be reasonable.

Principle 7: Size and Space for Approach and Use

"Appropriate size and space are provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility."

It is important to consider not only what the user sees on the screen, but also the environment in which they sit and use the products (desktop and mobile devices). All components must be reachable and presented in varied sizes for different users.

2.4.4. Accessibility overlay tools

After studying the research and problems of older adults, I searched for the solutions that were already being used by other websites. The results were interesting. Most companies change the coding of their website to make it accessible, either with their developers and designers or with the help of consulting companies. Some websites use accessibility overlay tools –which are inexpensive and fast– to make their websites accessible and increase compliance with WCAG, ADA, section 508, and other guidelines or laws. Different companies like Equalweb and Userway offer these tools and claim that they can bring the website into compliance with accessibility standards. Overlay tools detect accessibility issues and attempt to resolve them without the need to modify the source code of the website. They contain a series of controls that let the user modify and make changes, like changing the contrast or font size. To find out whether users can work with these tools without problems, I conducted a test that I explain in the next chapter.

3. Methodology

After researching and reviewing the Problems and Guidelines, an appropriate UX design method should be determined to design an accessible website for older adults. Because of the importance of considering older users in the design, the "design thinking" process was chosen. Brown (2009) explains that design thinking is a problem-solving approach that helps to understand the users and their pain points. It also helps to check the assumptions and redefine problems to create innovative solutions that can be tested.
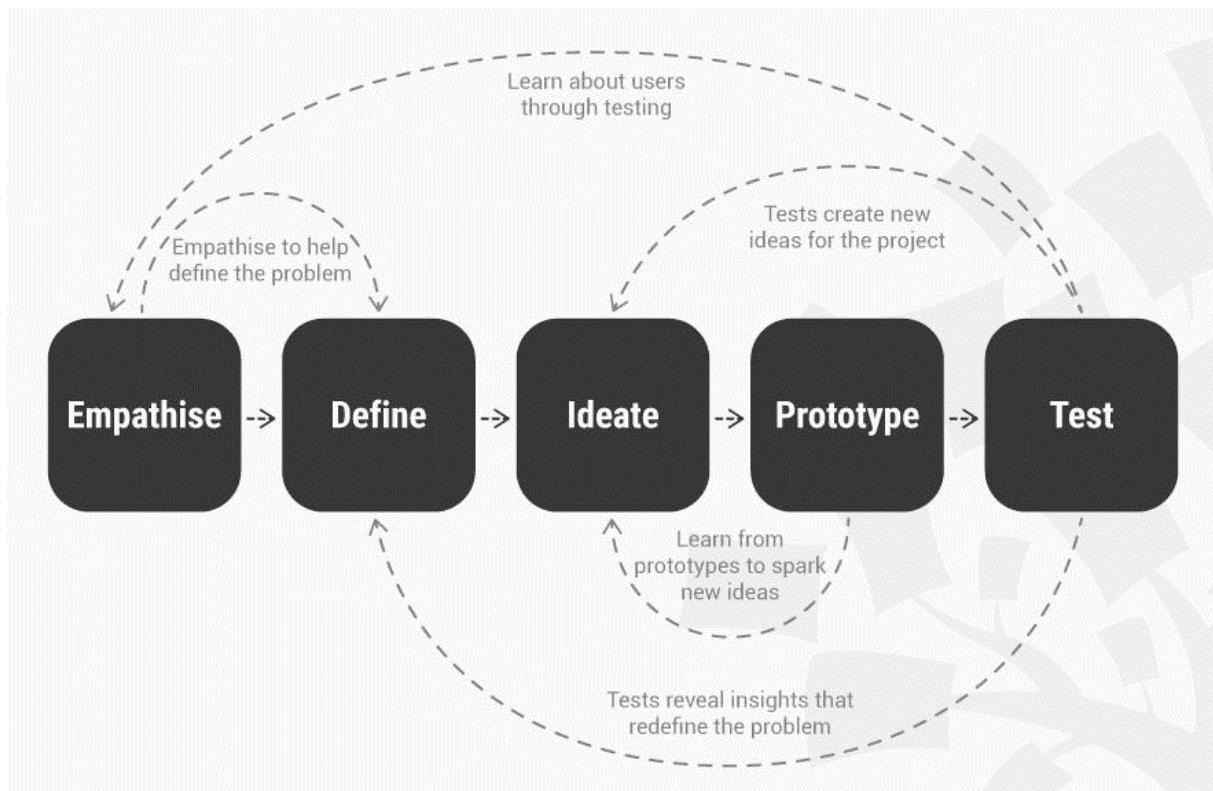
Figure 14: Design thinking process (Interaction design foundation, 2022)

Design thinking is a non-linear and iterative process. It has five key phases: 1. Empathize, 2. Define, 3. Ideate, 4. Prototype and 5. Test (Figure 14).

"Design thinking taps into capacities we all have but that are overlooked by more conventional problem-solving practices. It is not only human-centered; it is deeply human in and of itself. Design thinking relies on our ability to be intuitive, to recognize patterns, to construct ideas that have emotional meaning as well as functionality, to express ourselves in media other than words or symbols. Nobody wants to run a business based on feeling, intuition, and inspiration, but an overreliance on the rational and the analytical can be just as dangerous. The integrated approach at the core of the design process suggests a 'third way'" (Brown, 2009, pp. 10,11).

3.1. Empathy (User research)
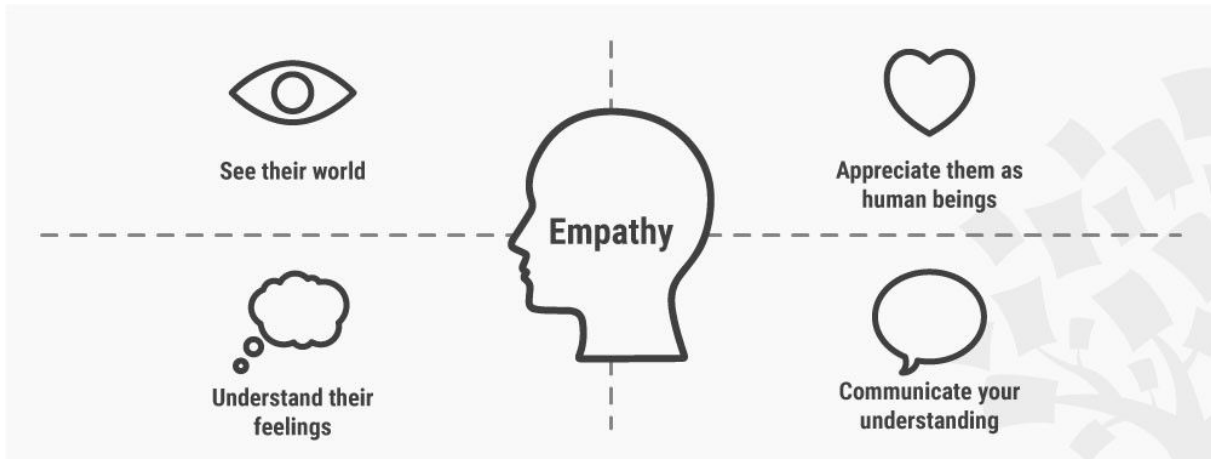
Figure 15: Empathy with target users (Interaction design foundation, 2022)

Empathy is the first step of design thinking. It focuses on user-centric research and helps to see the world through the user's eyes (Figure 15). IDEO's Human-Centered Design guild (2015, p. 22) describes that "empathy is the capacity to step into other people's shoes, to understand their lives, and start to solve problems from their perspectives. Empathizing with the people you're designing for is the best route to truly grasping the context and complexities of their lives. But most importantly, it keeps the people you're designing for squarely grounded in the center of your work."

Empathy means, conducting research to gain knowledge about what the target users think, say, do, and feel. The various research studies (in chapter one) have helped to empathize with older users and get to know them and their needs and problems better. But before going to the next step of design thinking, which is defining the problems, one question needs to be answered. As mentioned in the last chapter, there are still some questions about accessibility tools that need to be researched. Therefore, two websites that have the accessibility tools are evaluated with two participants.

Testing accessible tools

The following shows the test procedure:
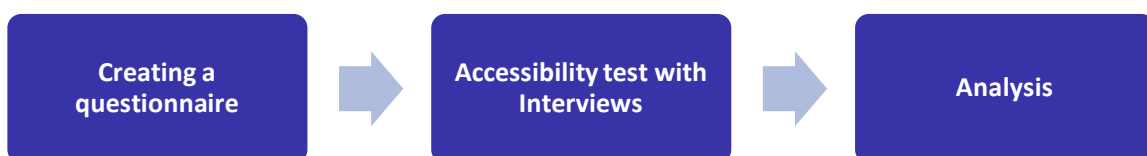
After creating the questionnaires, on the seventh of May, the accessibility test was conducted. The purpose of this test is to find out if the accessibility tools are useful and understandable for older users. At first, the participants were asked to fill out a questionnaire to collect basic information about them, their experience, and knowledge about accessibility tools. Then they had to complete some task scenarios and answer a few open-ended questions.

The websites that were tested are CNIB Foundation (https://cnib.ca/en?region=on) and UNICEF data (https://data.unicef.org/). CNIB website has various accessibility options on top of the page (Figure 16). The UNICEF data website has an accessibility menu at the bottom right of the page (Figure 17).
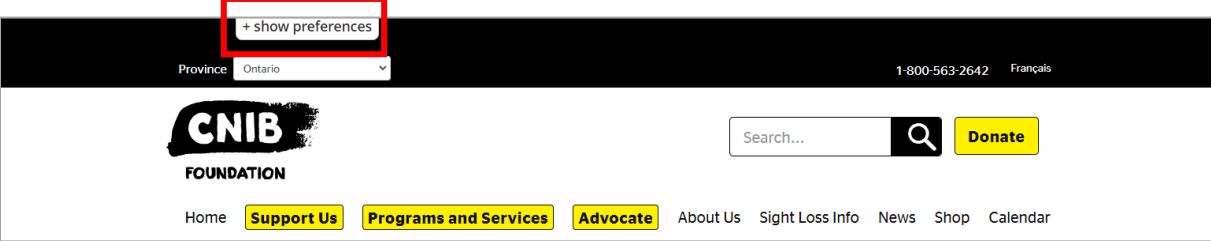
Figure 16: A screenshot from the CNIB Foundation website. *+ show preferences* tab (the red rectangle on top of the page).
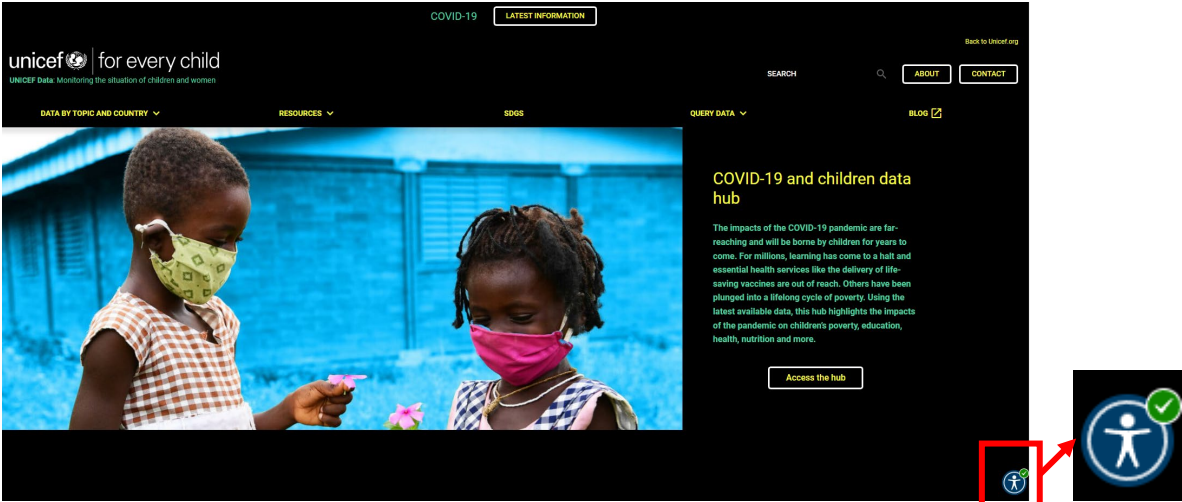
Figure 17: A screenshot from the UNICEF data website. The accessibility tool is located at the bottom left of the page (the red square).

Analysis of the results

To solve the tasks, the participants had to find the accessibility tools. But both of them could not find the tools of the two websites. One user gave up searching after 56 seconds. The other participant hoped to find them in the menu bars and read each drop-down menu. They needed the moderator's assistance to continue with the first task.

The goal of the first tasks on the two websites was to find out if the user understood the accessibility controls. On the CNIB website, one user was able to successfully understand the controls, except for the *enhance inputs* tool (Figure 18). To understand this tool, he had to click on it several times to see the changes. The other participant could tell what the button does, but she could not easily find where the changes are happening. On the UNICEF data website, the participants could find the option to change the font size, but they had to click on it (*Bigger Text* button) to understand how it works (Figure 19).
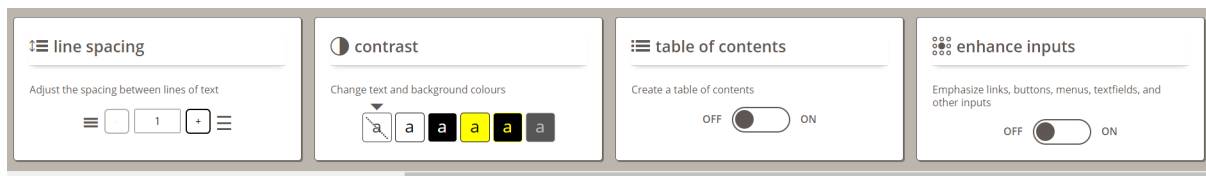
Figure 18: A part of the accessibility tool on the CNIB Foundation website.
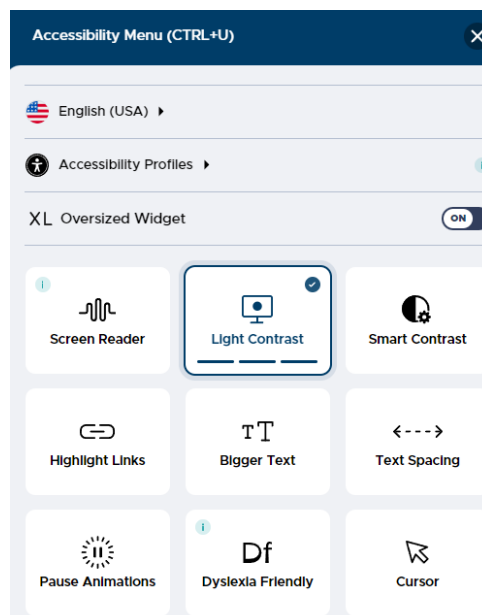
Figure 19: A part of the accessibility menu on the UNICEF data website.

The next task was changing the background color on the UNICEF data website. This task was unsuccessful; one participant clicked on different options to find which button was for changing the color. The other user first tested the contrast buttons incredulously, until he found the button *Light contrast* (Figure 19). Other options on this website were also hard to understand for the participants. At the end of the test, participants said that they did not understand some of the buttons and that they found these tools complicated, especially the accessibility menu on the UNICEF data website.

As the result shows, the users were not able to find and access the tools without assistance. Also understanding some of the tools were hard for them. These tools can be a potential barrier if the users cannot find them which is against accessibility standards. Also, since they are not a part of the website, they may decrease the speed of the website – which is a ranking factor in Google. These tools may improve compliance in some areas but full compliance with standards like WCAG cannot be achieved with these tools and therefore overlays are not an effective means of ensuring accessibility.

Even if users understand the meaning of these tools, they may not have the time or desire to change or design the appearance of a website. They want to find what they are looking for on a website as quickly and easily as possible. Users are not designers, and it is the designers' responsibility to design a website that is visually appealing and simple to use and comprehend.

The issue of accessible overlays was discussed, however adding some of the options to a webpage (as a part of the page) could be useful for some users. For instance, adding a font size button and giving the user the possibility to change the font size if they need larger fonts might be useful. Also as mentioned in chapter one, adding the possibility of switching to dark mode, e.g., a button, in user interfaces intended for long-form reading, can benefit some users.

3.2. Define

Define is the next step in design thinking. "The define mode is when you unpack your empathy findings into needs and insights and scope a meaningful challenge. Based on your understanding of users and their environments, come up with an actionable problem statement: your Point of View. More than simply defining the problem, your Point of View is a unique design vision that is framed by your specific users" (d.school at Stanford University, 2018).

In this phase, the information gathered during the empathy phase is organized and the core problems regarding the visual design are identified. This helps the designer develop ideas to create features and other elements to solve the problems. To define the user's problems, a list of the user's pain points and needs was created. This list can be found on page 70 (Figure 64). After that, the user's problem statement, also called user need statement or point-of-view statement was created. This statement is used to summarize who a particular user is, what the user's need is, and why the need is important to the user. The statement has three parts: one: User, two: their need, and three: their goal.

The following are two user's problem statements:

- As a retired dentist, Lisa needs to learn about WhatsApp so that she can call her friends, family, and granddaughters.

- As a teacher, Frank needs to learn how to deposit money in online banks so he can use it without asking his children for help.

3.2.1. Personas

Personas help focus on user needs and goals to ensure users are always at the center of attention. To empathize with users, two personas are created based on the information collected. The first persona (Figure 20) is a user who uses the Internet rarely and does not have the confidence to use it, the second persona (Figure 21) uses the internet every day.

	Lisa
	Age: 72
	Gender: Female
	Occupation: Retired Dentist
	Marital status: Married
	Location: Berlin
	Computer(s): MacBook
	Internet usage: 0.5-1 hours
Background	Lisa's friends and family always make video calls on WhatsApp, but she does not know how to call them back or add their phone numbers. She misses her grandchildren, who live in another city, and wants to learn how to use apps like WhatsApp.
Worries	She is afraid of doing something wrong. She does not know how to find courses about WhatsApp.
Obstacles Lisa faces	Being a beginner using the Internet Cannot read when the font is small She needs glasses for reading
Questions Lisa will ask	Where do I find the courses? How can I find the courses I am looking for? How can I search for something? How can I print a text or an article?
Goals, motivations	Learn to use WhatsApp to call her daughter and grandchildren (because they use it). Learn an easier app or find an easier way to contact her friends and family. Learn new things about technology.
Keywords	Grandchildren, contact, text, video call

Figure 20: Persona 01

	Frank
	Age: 64
	Gender: Male
	Occupation: Teacher
	Marital status: Married
	Location: Leipzig
	Computer(s): Sony VAIO
	Internet usage: 1-2 hours

Background	Frank has never used online banking, but during the Corona pandemic, he needs to learn how to deposit money with online banks so he can use it without asking his children for help.
Worries	He is afraid of using online banking. He is concerned about depositing money into the wrong account.
Obstacles Frank faces	He needs glasses for reading. He forgets his username and password. He does not understand the payment methods. He does not understand the courses.
Questions Frank will ask	How can I find the online courses to learn it? Can I save the courses for later? How to make an account?
Goals, motivations	Learn how to use online banking. Find a reliable website to learn it.
Keywords	Online courses, security, online banking

Figure 21: Persona 02

3.3. Design and Ideation

After understanding the needs and expectations of the users, it is time to develop ideas and find solutions for these problems. Five important pages of the website are selected for this study:

- Home page
- Sign in
- Join
- Course category
- Course page

The following describes the procedure for designing the pages:

Low/Medium-Fidelity - Prototypes → Testing → High-Fidelity - Prototypes → Clickable wireframes
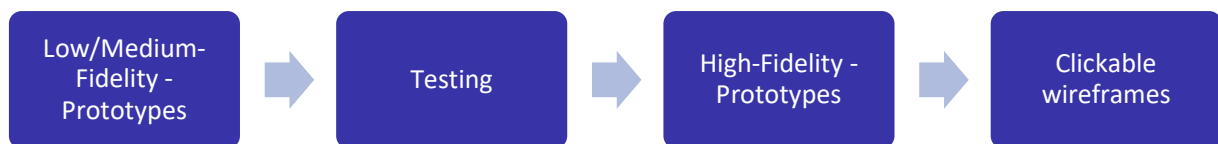
3.3.1. Low-fidelity prototypes

To sketch ideas quickly, various wireframes on paper were created for each page of the website (Figure 22). Then the sketches are imported into Figma to create low-fidelity prototypes.
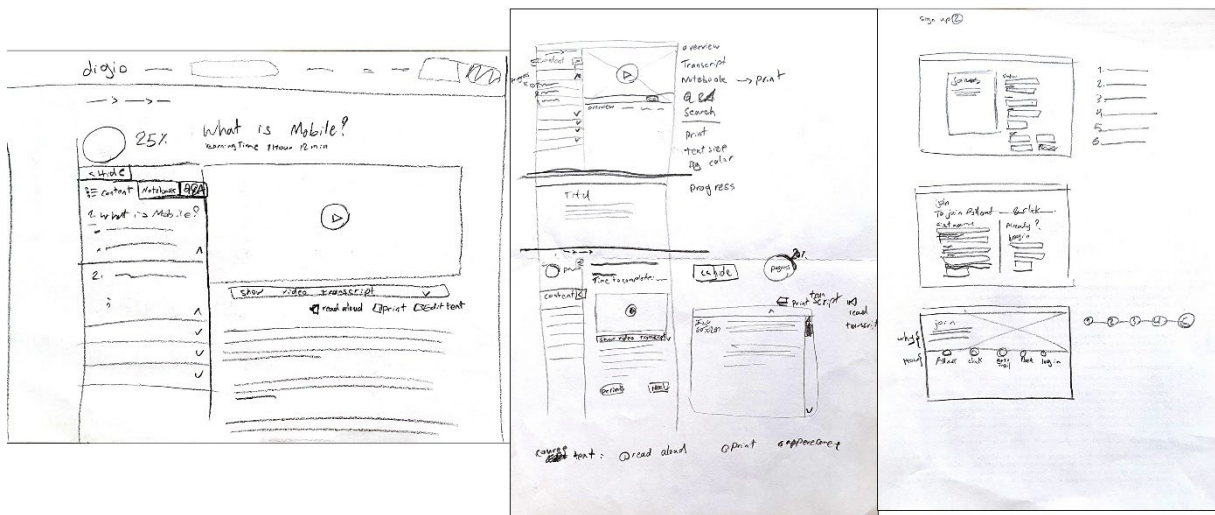
Figure 22: Examples of sketches

The first page to be designed is the homepage. Homepage is the heart of a website. It is the first page viewed by most visitors. The design of this page will affect the business goals and the user's decisions. It will show the visitors, who you are and what you do, and users will decide if they want to know more, or they will just leave. This project aims to help the users

have more confidence in using the web, therefore this page will help them to understand who we are, what we offer, and find what they need and how to use them (Figure 23).
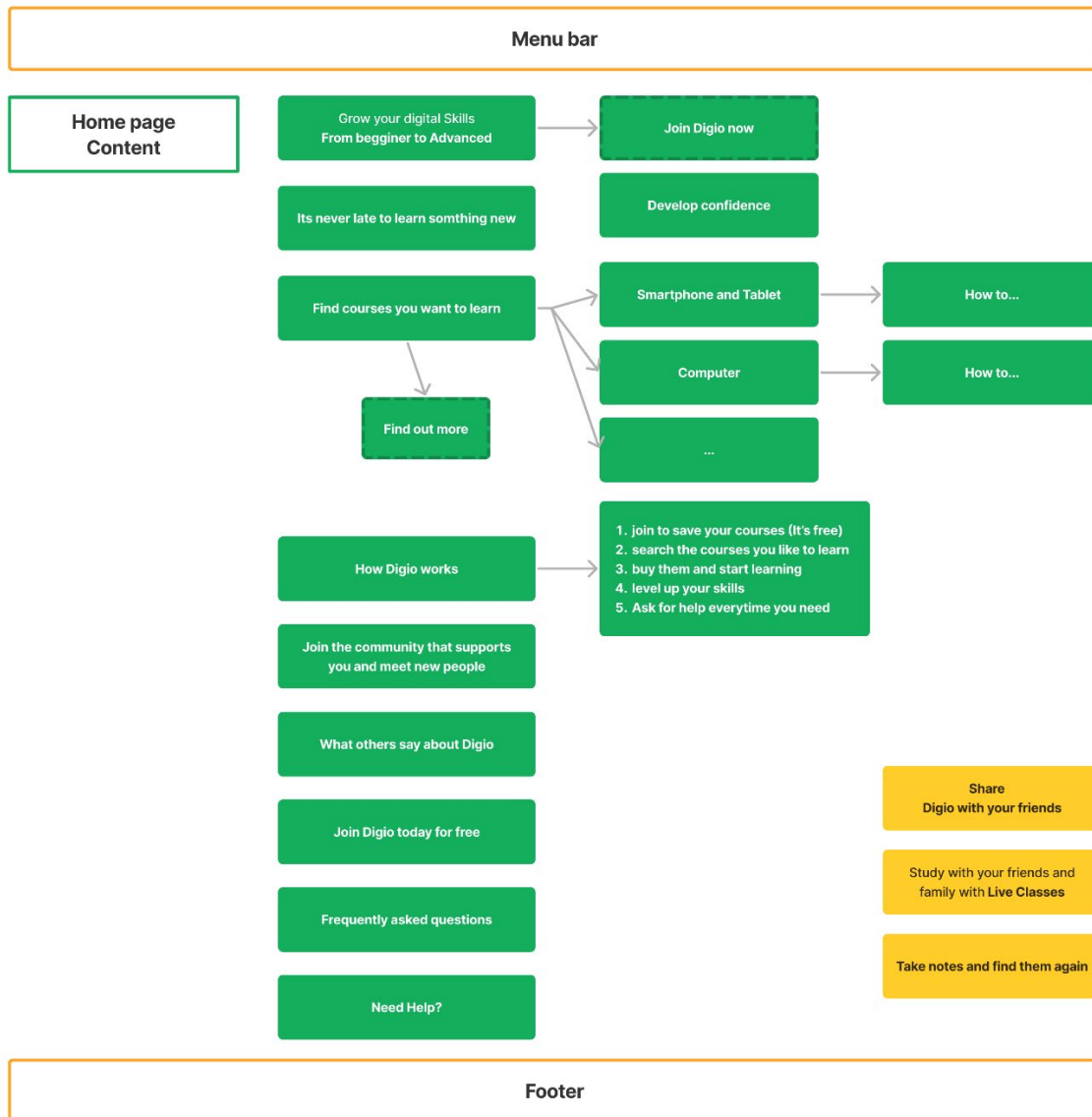
Figure 23: Home page content, made with Fig Jam.

After the prototypes were created (Figure 22) and additional design ideas were outlined for each section, a design style was chosen for each section to keep all elements integrated. As an example, to design a section that shows users how to work with the website, a section called *How Digio works* was created. Figure 24 show some of the different prototypes that were created for this section. The next step is to evaluate the designs and select them to create high-fidelity prototypes. The criteria for choosing the designs were:

- the designs must be easy to understand,
- they must be consistent across all pages,
- design and placement of elements should make it easy for the user to navigate,
- they must be flexible and efficient,
- designs should have visual clarity,
- they must prevent errors.

Figure 24: Low-fidelity prototypes for the "How Digio works" section.

3.3.2. Evaluating the sketches

To ensure that the ideas and designs were functional, the designs were tested using personas. With the User's Journey, according to the needs and goals of each persona, the designs were examined. First, the initial sketches were evaluated, and after importing them into Figma and drafting more ideas, they were tested again before turning them into high-fidelity prototypes.

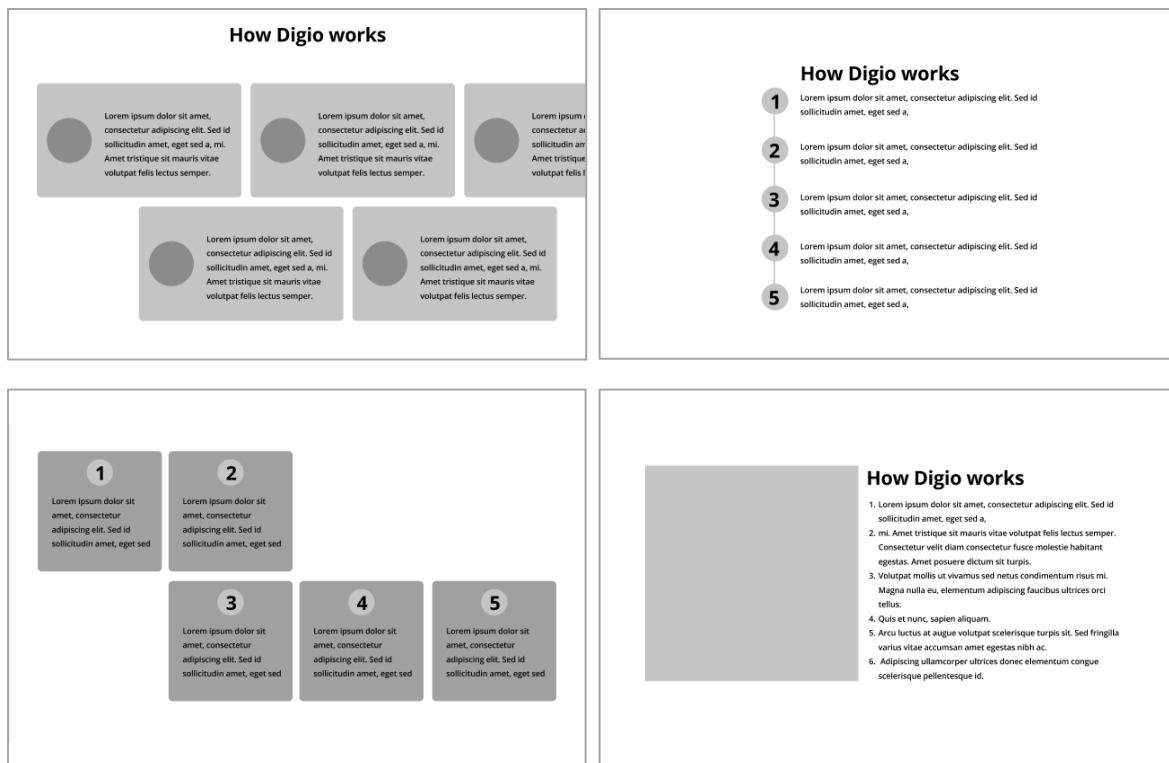User's Journey tells users stories and can provide a holistic view of the user experience when interacting with the website. It helps the designer to discover potential problems and create a better experience for the users (Gibbons, 2018).

3.3.3. High-fidelity prototypes (Visual design)

After ensuring that the design was usable, high-fidelity prototypes were created (all high-fidelity prototypes can be found on pages 72 to 78). The goal of this project is to design an accessible website with consideration of visual perception. Therefore, it is crucial to make high-fidelity prototypes that are accessible before testing them with the target users. All the designs were created with consideration of the target group "Older adults." Also, people with vision problems e.g., with low vision benefit from these designs.

To decide on the accessibility of the designs of the Digio website, numerous studies have been conducted. In the following, it is explained how each section was designed according to usability and accessibility guidelines and studies.

3.3.3.1. Texts on the Digio website

Font type

The font of the website is Open Sans, an open-source sans-serif typeface. Sans-serif fonts are more accessible and legible across web, mobile interfaces, and print. This is important because on our website the users will be able to print the content of the courses. In general, the use of light or bold-weight fonts, such as Helvetica light or Arial Narrow, font styles like italic or condensed and all caps for body text should be avoided. It makes it harder for people to read the text (Zakharenkov, 2020; Johnson & Finn, 2017).

Font size

WCAG has no minimum font size requirement, but it is still important to be sure that the text is legible for the target users. Numerous studies suggest that the font size should be at least 16 pixels (12 points), but 19 pixels (14 points) is even safer (Ann Becker, 2004; Johnson & Finn, 2017; Interaction Design Foundation, 2020; Arch & Abou-Zahra, 2018; Nielsen, 2002). On the Digio website, the body font size is twenty pixels.

Text spacing (WCAG, 2022; Keohane, 2017; Zakharenkov, 2020)

The following shows the text spacing of the website according to WCAG guidelines:

- Line spacing is at least 1.5 times the font size,
- Space after a paragraph should be at least two times the font size,
- Letter spacing is at least 0.2 times the font size,
- Word spacing is at least 0.16 times the font size.

Text style

All text on the website is left aligned. Justified and center-aligned text is not used because centered text decreases the reading speed as the user has to figure out where the next line starts. Justified alignment may cause a large space between words, making the text harder to read (Arch & Abou-Zhara, 2004; Trzepla, 2019).

The text size of the website is easily controllable for the users. WCAG 2.0 success criteria suggest that text must be enlargeable without assistive technology, up to 200 percent without loss of content or functionality (Zakharenkov, 2020; Arch & Abou-Zhara, 2004; Keohane, 2017; W3C, WCAG 2, 2022). Text or titles that have a background image will be placed above the image and not embedded in it, so users can control the size and it will also be responsive (Johnson & Finn, 2017; Arch & Abou-Zhara, 2004). To ensure that the text on the images is legible, a high-contrast ratio is created between the text and its background by using a dark black overlay below the text (Figure 25).
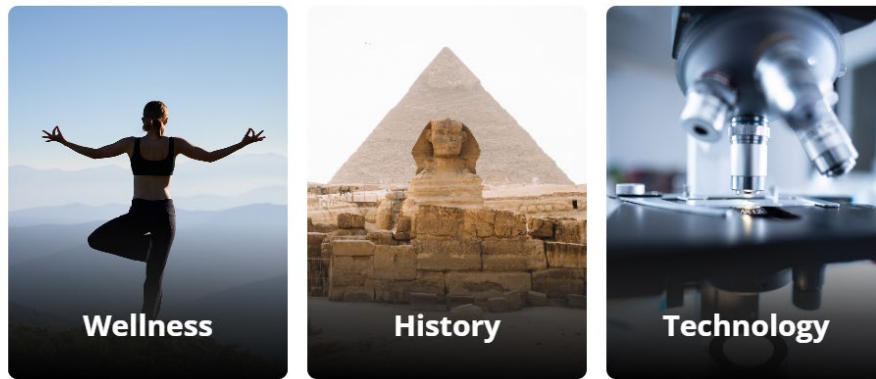
Figure 25: The dark black overlay below the white text on the course category boxes.

3.3.3.2. Color and contrast

The colors of the website follow the 60-30-10 rule, which provides balance and does not distract users. The main colors of the website are, 60% white (#FFFFFF), 30% blue gem (#3834A8), and 10% violet (#DB0084). The blue color represents the clickable areas or links on the website. The violet color is the accent color and is used mostly for the hover effect.
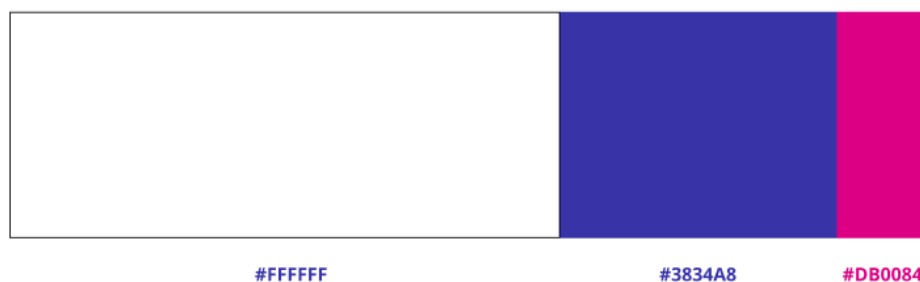

| #FFFFFF | #3834A8 | #DB0084 |

Figure 26: The color of the Digio website: 60% white (#FFFFFF), 30% blue gem (#3834A8), and 10% violet (#DB0084).

As explained in chapter one, to avoid eye strain it is important to use off-black text color on white backgrounds. The text color of the website has an off-black #1F1F1F color. The contrast ratio between the texts and the background behind them is at least 4.5:1 (recommended by WCAG (W3C, 2022). The accessibility of all the colors (text-background combinations) and contrasts is checked with the websites, accessible-colors.com and webaim.org. It is recommended to always evaluate the colors with older users (Johnson & Finn, 2017), which is to be done during usability testing.

3.3.3.3. Buttons

Buttons are important because they give the users options to perform an action or make a choice. To avoid confusing the users, the buttons must have the same shape throughout the website.

According to material design, there are three important principles for designing buttons:

1. **"Identifiable:** Buttons should indicate that they can trigger an action.

2. **Findable:** Buttons should be easy to find among other elements, including other buttons.
3. **Clear:** A button's action and state should be clear" (Google, 2018).

States of the buttons:

Buttons can have different states, which help the users understand their interactive meaning (Rae, 2020). The following states are common CSS button states (Figure 27), which are used on the Digio website.

- **Default or Normal:** when the button is not being interacted, it is in a default state and the color is blue (#3834A8).
- **Hover:** on desktop hover is when the mouse cursor goes over the button. Its color is the website's violet color.
- **Active:** This state can be used for clicks or down press of a button.
- **Disabled:** If a button is not available for interaction, its color will be gray.
- **Focus:** an important state for accessibility. When someone uses tabs on the keyboard for navigation. When they use tabs to navigate, a violet dashed line will appear around each section, which indicates where the user is.
- **Loading / Processing:** when an action has been taken and the system is processing that, a dotted animated circle appears next to the button name.

Figure 27: States of the buttons on the Digio website.

Types of buttons used on the website

Call to action (CTA)

These buttons are particularly important because they can guide users toward the business goals. They can get the visitors to click and complete a conversion such as "Join now" or "add to cart" (Figure 28).

Figure 28: Samples of call-to-action buttons.

Primary buttons

Primary buttons should be a strong visual indicator and help the user surf the website and accomplish their goal (Rae, 2020). For instance, the buttons that let the user go to the next lesson. These buttons have the blue gem color (# 3834A8) to catch the user's attention (Figure 29).

Figure 29: Samples of primary buttons.

All primary and secondary buttons must have thirty pixels horizontal padding and twenty pixels vertical padding. If the button has both label and an icon the spacing between the item should be four pixels. The buttons have a corner radius of three pixels. The padding gives the user enough space to read, and the use of a consistent shape (the rounded rectangle) ensures that the user recognizes it (Figure 30).
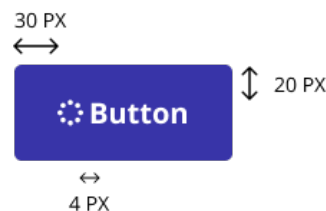

Figure 30: Button size

Secondary buttons

These buttons let the user choose an alternative path, e.g., "Cancel" or "previous lesson" (Figure 31). They have a white background, so they do not attract as much attention as primary buttons and the user can discern them.

Figure 31: Secondary button samples

Tertiary buttons

These buttons are for actions that are important but miscellaneous, for instance, "clear filter" or "delete." The design of these buttons depends on their functions. Their color is blue to indicate that they are clickable.

Figure 32: Tertiary buttons samples

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Back-to-Top

It is better to use the *Back to Top* button for pages that are longer than four screens. Because for short-length pages, people can quickly scroll back to the top. It should not appear until the user scrolls down a few screens and feels that they need to scroll back up. The Button must be located on the bottom right of the screen. It is the place people expect to see it. It must stand out visually, so people can notice it (Loranger, 2017). This button has rounded corners to distinguish it from other buttons on the page. Using just an icon, like arrows on the button can be ambiguous and may not convey the correct meaning. The label of this button is *Back to Top* with a font size of sixteen pixels (Figure 33).

Figure 33: Back-to-Top button

This button should not cover the content of the page, and therefore must be small. But for small screens, like mobile phones, it must be big enough so people can tap it (Loranger, 2017). This button has a vertical and horizontal padding of twelve pixels. Here, smaller padding is used to save space for important content on the page. Like other buttons spacing between the arrow and the label should be four pixels. It should also be motionless. If it moves, it will cause distraction.

3.3.3.4. Global navigation

Figure 34: Menu bar

On top of all pages, there is a horizontal menu bar. On the home page, the menu bar is "sticky" because this page is long, and the user may have to scroll a lot before returning to the menus at the top. Another reason is that the users can always see the help button and the search bar at the top when they need them. On other pages, the menus are not sticky.

The *courses* dropdown menu is placed on the left side of the menu bar because this is the most important navigation option and users start looking at a page from the left side. The down-arrow on the right of the *course* indicates to the user that this is a dropdown menu.

Because the Digio website offers two diverse types of courses, the dropdown menu is divided into two columns. At the top of each column is a brief description that helps the user understand the difference between them. The menu links have a blue color and are listed alphabetically. The color of the categories is blue to indicate that they are clickable (Figure 35).

Figure 35: Dropdown menu
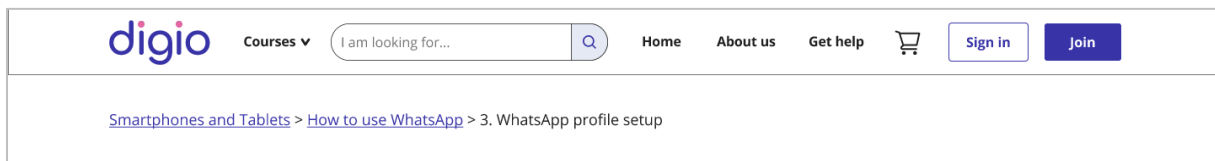
3.3.3.5. Breadcrumbs

Figure 36: Breadcrumbs under the menu bar

Another way to let the users navigate easily and help them know where they currently are is using the navigation element-breadcrumbs. Breadcrumbs are meant to show the hierarchical structure of the website. It is located at top of the page, below the global navigation. The current page will be the last item on the breadcrumb trail, and it should not be a link (Figure 36). The pages are separated by the ">" symbol, which is recommended by Nielsen Norman Group (Laubheimer, 2018). This gives the users a clear understanding of where they are. Breadcrumbs must have enough space, so the users can click on them easily. As Figure 36 illustrates, on the breadcrumbs trail there is no link to the homepage because there is a *Home* link located on the global navigation.

The homepage does not have breadcrumbs. If the user opens the homepage, the *Home* navigation tab turns to a violet color (#DB0084), which indicated that this page is now selected and open (Figure 37).

Figure 37: Menu bar on the home page

3.3.3.6. Links to the Homepage

The logo of Digio is located on the top left side of the page. This is the place where most people expect to find it. Research shows that right-aligned and centered logos degrade the usability of websites to some extent and impair brand recall (Whitenton, 2016 a; Whitenton, 2016 b). The website logo is linked to the home page. Some users are familiar with the fact that clicking on the logo leads them to the home page. This is in line with user expectations and reduces confusion (Loranger, 2017). But it is important to consider that not all users understand this, especially less technical users. Therefore, a *Home* link is presented on the site's global navigation.

3.3.3.7. Search bar

Figure 38: Search bar

Search Inputs should be easy to find. The search bar is always on the menu bar in the same place on every page, so the users can find it easily. This is important because search bars can help the users find what they need faster.

Placeholder text:

Providing a placeholder text on input fields that describes the action can help the users understand the context of it. Like other placeholders on this website, to avoid accessibility issues, the text color must have at least a contrast ratio of 4.5:1 (W3C, 2022). Here the color of the text is #737373 and the background is white (#FFFFFF), which has a 4.74:1 contrast ratio.

Submit search:

Users should be able to submit the search using the Enter key and by clicking on the button. It is recommended to put a button for users because many users still have the habit of clicking on a "search" button (Nielsen, 2001). For this button, a *search* label, or a magnifying glass icon, can be used (Figure 39).

Figure 39: Search button with magnifying glass icon (left), Search button with the label *Search* (right). On the Digio website, the left search bar is used.

The magnifying glass has become associated with search because many applications and websites have been using it and users have learned to recognize and understand this icon (Sherwin, 2014). For better understanding, the simplest version of magnifying glass should be used (Nielsen, 2001).
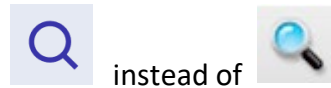
 instead of

Figure 40: The simple magnifying glass on the left is easier to understand than the one on the right.

The search icon and the text input field are located next to each other. If the field is far away from the icon, users need to put in extra effort to find the search box. It is also against the Gestalt law of proximity. According to the research by Nielsen Norman Group (2001), using the magnifying glass icon alone, without an open text-entry field, makes it harder for users to locate the search. Using this icon alone takes up less space but visually it is less prominent and less noticeable and not recommended for desktop websites. Also, if input fields are hidden behind a button, the users should take an extra action to click or tap to open it.

Input field size:

The input field width should be large enough to fit the typical search query. If the field is too short only a part of the text is visible, and the users are not able to review or edit their full query which results in bad usability. For a fixed-size search box, the Nielsen Norman Group (2001) recommends making the text-entry area at least twenty-seven characters wide, so that people can easily see their queries and correct spelling without having to scroll the text in the field.

3.3.3.8. Forms

A form that is not designed properly can confuse users, most significantly those who are unfamiliar with completing such forms. The guidelines in this section help users understand the form and fill it out more easily.

Form structure

The order of the form (the information that the user should enter) must be logical. If a lot of information is requested, it is better to group them into logical blocks. The forms should be in a single column. The problem with multiple-column layout is that the users are likely to interpret the fields inconsistently and will scan it in a Z pattern (Figure 41). This slows down the speed of comprehension and completion (Babich, 2020).
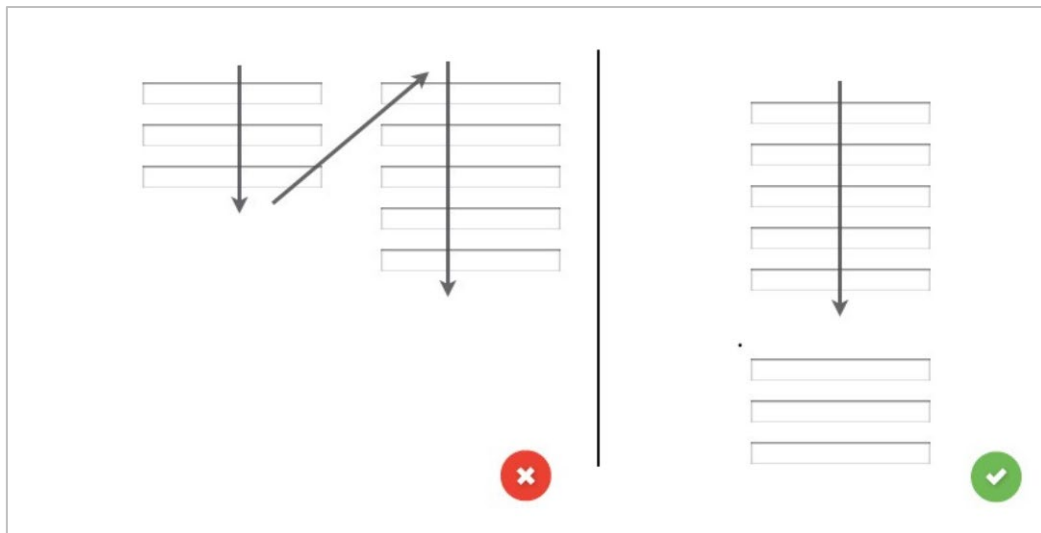
Figure 41: Multiple-column layout (left), Single-column layout (right) (Babich, 2020).

Form labels

The forms should be visibly labeled. The labels should be short and descriptive so that the user can read it faster. Labels must not be written in capital letters, as this causes reading difficulties and makes scanning harder. Also using title case words, which is capitalizing every word, like "Please Enter Your Name." is not recommended. The sentences better be sentence case, i.e., capitalizing the first word, like the sentences written in this article (Sherwin, 2018).

Inline labels (placeholder text)

Placeholder texts are generally not good for accessibility, because it disappears when content is entered, and they have usually light-grey color which has poor contrast and is not suitable for people with vision impairment. Using placeholders in a form field that by clicking (tapping or selecting) disappears will strain users' short-term memory and makes it difficult for them to remember what information they must enter. If they forget the information, they must delete what they wrote to see what the label was (Sherwin, 2018).

Figure 42: Form with placeholder text

To avoid these problems, the following must be considered in the design process:

1. **Placeholder text with enough contrast**. Here the placeholders have the same color as texts (black #1F1F1F). Due to the text color, users might think that the field is already filled. To avoid this, a colon is placed after the label, e.g., Email**:** (Figure 42).

2. **Floating labels:** The placeholder text has a font size of twenty pixels. When a field is in *focus*, the label input will move up to the right corner of the field with a smaller font size (14px) and stay visible (Figure 43).

3. **Help the user understand the field is in focus:** When a field is in focus the cursor blinks constantly and the field's stroke (1px) and its color (Eerie black #1F1F1F) turn to a thicker blue line (stroke: 2px, color: #3834A8)(Figure 43).

First name

This name will be used in communities and on your certificates.

Email

Please enter a vlid email address. We need your email address to check if it is you who is logging in and to send you important information.

Figure 43: Two examples of focused fields

When a field is in focus, a short assistance text will be displayed under each field. This text helps users understand why and how the fields should be filled in and decreases the chance of errors (Figure 43). This assistive information should be visible throughout the time the field is selected.

Password fields

The password requirements are stated under the fields when they are focused like other fields. When users type their password, they will be able to see what they typed by clicking on a link labeled *show password*. This will unmask the password and let the users check them. When they see the password, it supports their short-term memory and avoids increasing their cognitive load. Here the text "Show password" is used instead of symbols such as the eye icon, because the meaning of the symbols might not be understandable to all the users (Figure 44).
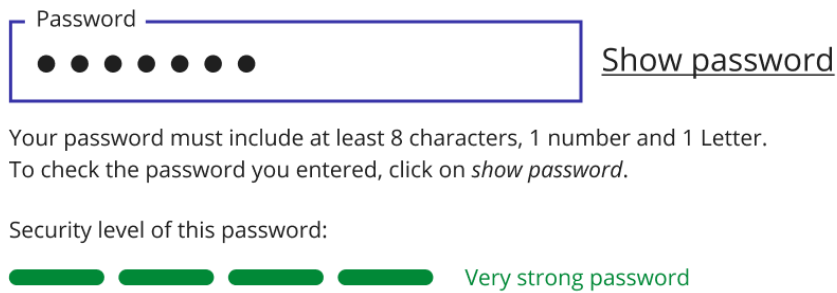
Figure 44: Password fields

When a website forces users to choose a strong password, people will follow the system's arbitrary command and choose easy passwords to get past the login screen (Sherwin, 2015). A study by Egelman et al. shows that if we use strength meters that tell the users if a password is weak or strong, people get motivated to create stronger passwords. Visually showing the strength of the user's password and indicating that it needs improvement, changes motivation (Egelman, 2013). This is good gamification that benefits the users by helping them create a secure password. Digio's registration page shows these metrics in different colors to increase users' comprehension.
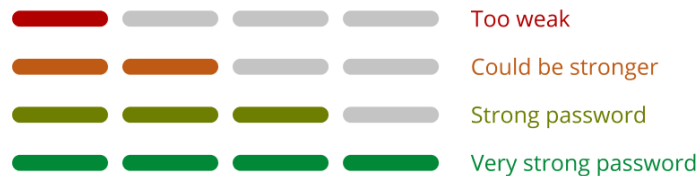

Figure 45: Strength Meters for passwords

If the users forget to complete one or more fields or type invalid data, they will be notified with an error message (Figure 46). The error validation is an inevitable part of a form. The error messages appear near the relevant field with red color (#B20000). This helps the user to find the problem faster.
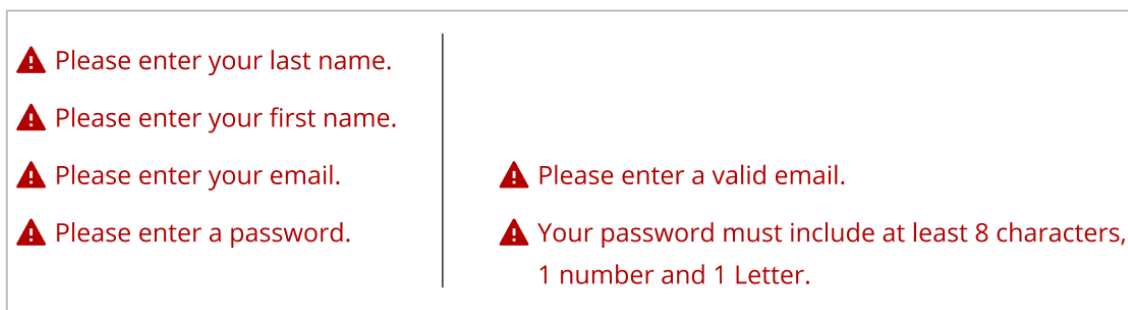

Figure 46: Error validation

3.3.3.9. Filters

Filters narrow down high-volume content and enable users to select and manage the options they want. On the filter menu, the most frequently used filters are listed first and are expanded. The filter checkbox is 18 x 18 pixels, and the clickable target area contains the checkbox, the label, and the area around them. When the user clicks on the filter name or near the field, the filter is selected (Figure 47). This benefits users with reduced motor skills who may have difficulty checking the small boxes.

Figure 47: Red area is the target area the users can click to select the field.

Here batch filters are used to let the user adjust multiple filters and then click on *apply filter* button to see the results or click on the *clear filter* button, to remove filters easily (Figure 48).

Figure 48: Buttons to let the user adjust the filters.

The results will be listed on multiple pages (traditional pagination), each containing seven items. To see more results, the user must click on the arrow buttons at the end of each search result (Figure 49). This way, they do not have to scroll down and up as much and can find what they are looking for faster.
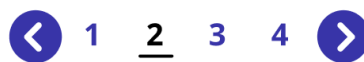

Figure 49: Pagination controls

3.3.3.10. Visited Links

It is important to help the users understand which pages of the website they have already visited. This prevents users from unintentionally visiting the same pages over and over again. Users often have difficulty remembering which links they have clicked due to their short-term memory, and they often overlook the difference between two similar links if they are not sure which one, they have already visited, which reduces their confidence in using the website.

The links on the website have a blue gem color (# 3834A8). To help the users know what links they have visited, the visited links change to an unsaturated light purple color (#9A5BA5) (Figure 50).

Defult (#3834A8)　　**Hover** (#DB0084)　　**Visited** (#9A5BA5)

Figure 50: Various color states for links

Course pages

The course pages are one of the important pages that need an accessible design because users will interact and spend more time on these pages. A course page on the Digio website normally has three main parts: course video and transcripts (Figure 51-1), tabs with course content, Notebook and Q&A (Figure 51-2), and accessibility options (Figure 51-3). If a course does not have any text, then the accessibility options will be removed.

The courses on Digio are a mix of video and text. Some people find it easier to learn from video-based content, others prefer text-based content. According to the Interaction Design Foundation, learning with a mixture of the two will improve users' memory of content (Interaction Design Foundation, 2016). To see the full course page, please see Figure 71 and Figure 72 on pages 78 and 78.
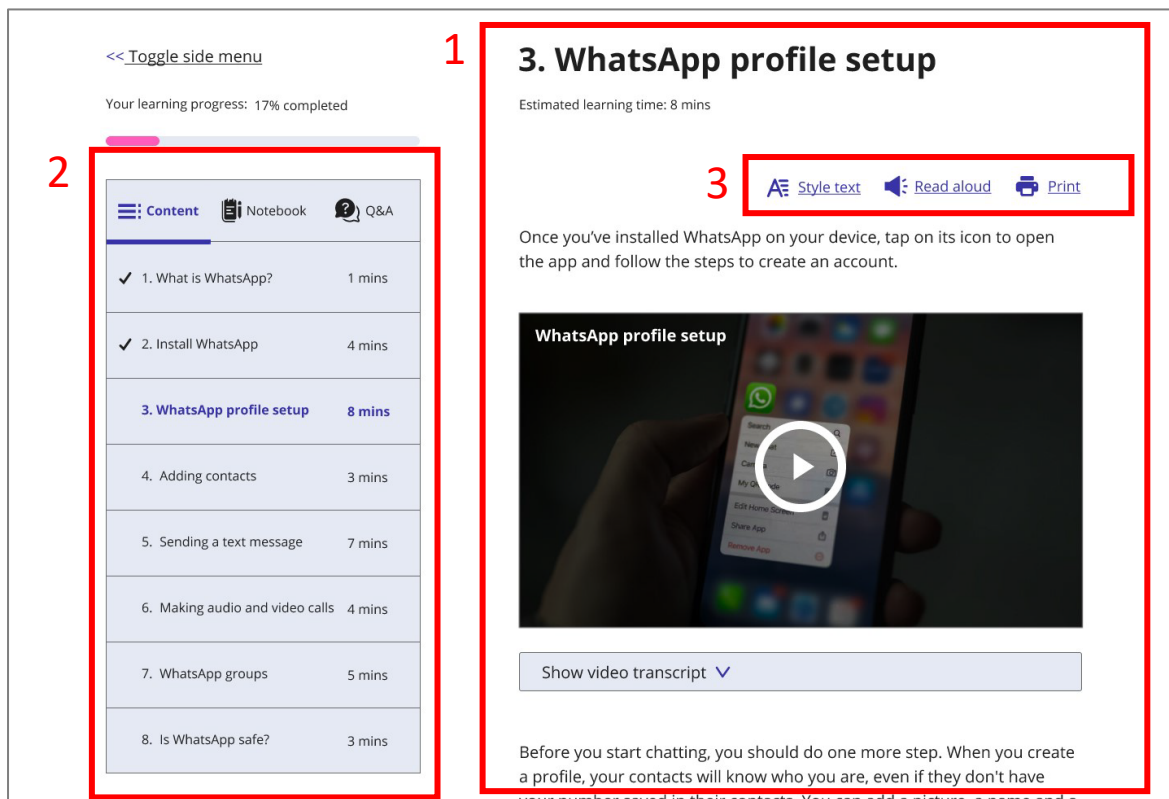

Figure 51: a part of a course page. 1: Course video and transcripts, 2: Tabs with course content, notebook, and Q&A 3: Accessibility options.

3.3.3.11. Tabs

Tabs on the left side of the course pages are designed to let the user alternate view without navigating to different areas of the page. The currently selected tab is highlighted with a blue color (#3834A8) and a blue line under the label of the tab (violet color (#DB0084) in dark mode). This helps the users identify which tab is selected. The tab labels include text with an icon. They are at the top of the panel because research shows that people usually look for them at the top (Nielsen, 2016).

To help the users remember which courses they already watched, a black checked icon (white color in dark mode), appears near the course name. The currently selected course has a bold font and blue gem color (# 3834A8) (violet color (#DB0084) in dark mode) (Figure 52).

The Notebook and Q&A tabs have placeholder texts. The text has the same color as the placeholder text of the search bar. The buttons under the text fields are grayed out, which indicates that they are not clickable. They turn blue (like other primary buttons) when the user starts typing in that field.
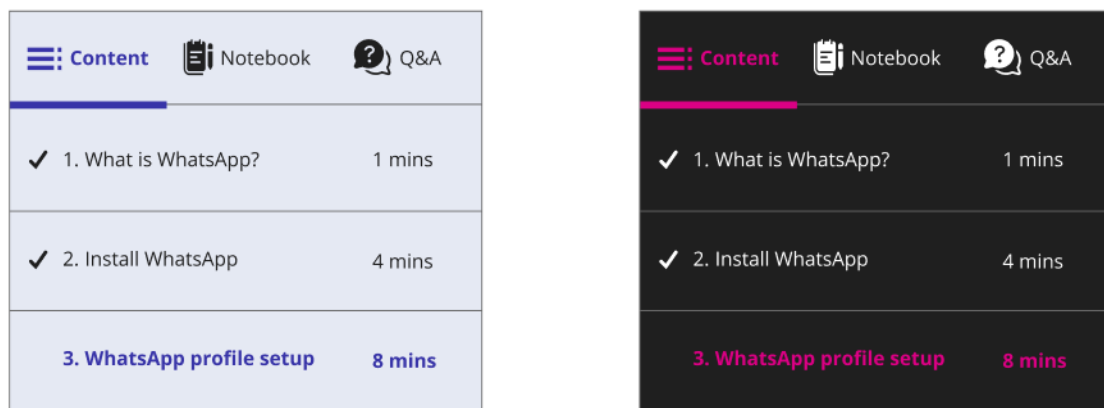

Figure 52: tabs on light mode (left), tabs on dark mode (right)

3.3.3.12. Accessibility options

As mentioned in the Empathy section, adding some accessible options on pages intended for reading long texts might be beneficial for some users. Since users will stay longer on this page to read the content, four accessible options were added to allow users to personalize the page. Each course page has three button controls, *Style text*, *Read aloud,* and *Print* (Figure 51-3). These are placed on the top right side of the course content. These options will help them have a better experience learning something new.

Style text has two tabs:

- **Text:** This allows the user to control the text size and, if necessary, the spacing between lines (Figure 53-a).

- **Background:** It lets the user choose one of three background colors: white, beige, or black (Figure 53-b).
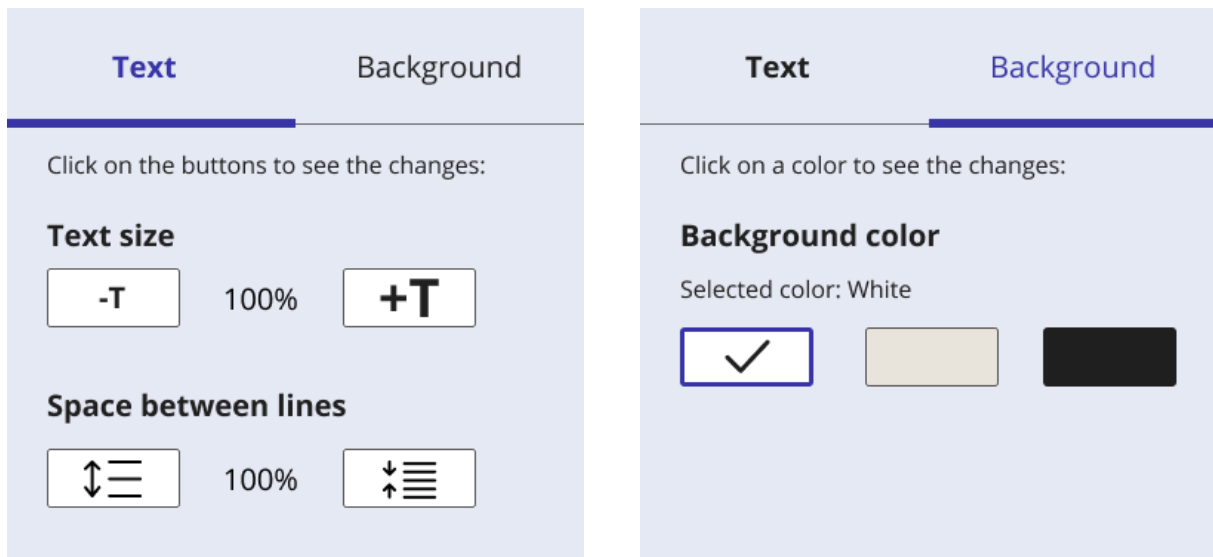
Figure 53: Style text options, a:text controls (left), b: Background controls (right).

If users want to hear the text instead of reading it, they can click the *Read aloud* button and the course text will be read aloud. This is mainly for sighted people because blind users use screen readers to hear the content of a page.

Print is another controller, which lets the user print just the text of the course. This function is intended for users who prefer to read the text on paper rather than on the screen.

Under the videos, there is a *Show video transcript* button. By clicking on that, the users see the transcript of the video they are watching. When the video plays, the texts of parts (sentences) of the video being played are underlined. This way, the user can find the narrated text more easily. On top of the transcript, there is a search bar and a print button (Figure 54).
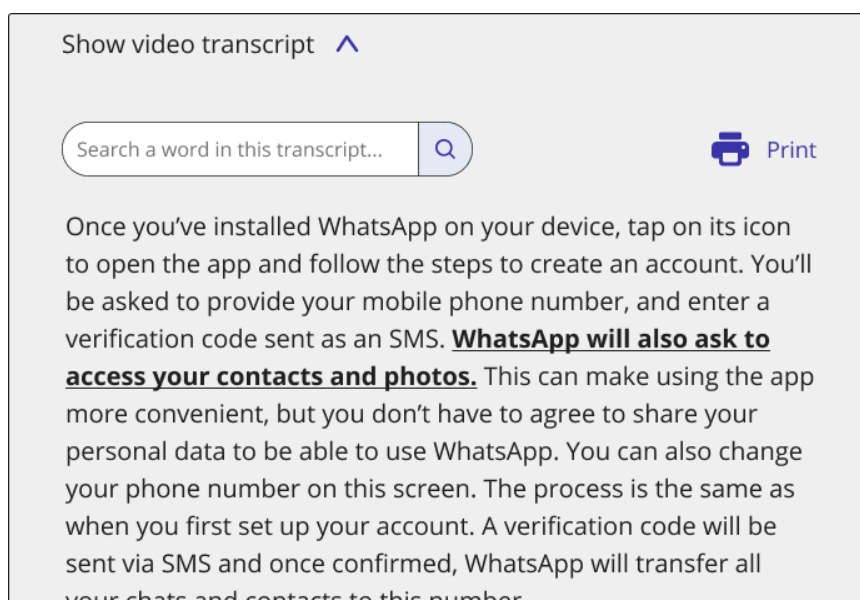

Figure 54: Video transcript

With the search bar, users can find a specific word they are looking for. For instance, by typing the word "verification" in the search bar and clicking the search button (magnifying glass icon),

the word *verification* will be highlighted in the text. Under the search bar the number of results found, is shown and the users can press the up and down arrow buttons under the search field, and it will jump to the next instance where the word appears (Figure 55). To cancel the search, users must click on the **X** on the left of the bar.
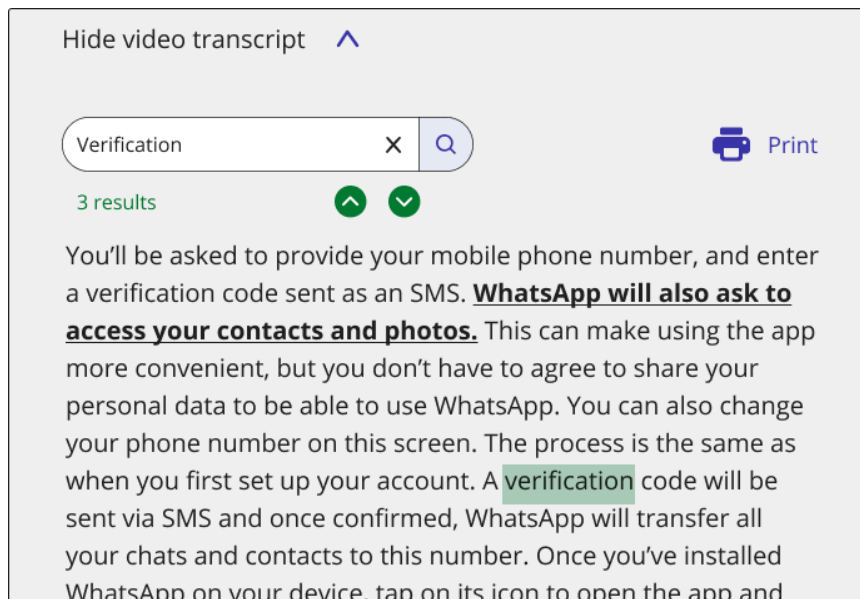

Figure 55: Search results

If no results are found, the message "No results were found for...." appears under the search bar (Figure 56). The color of this message is red (#B20000).
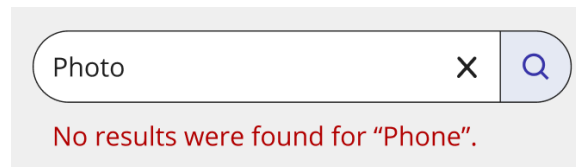
Figure 56: No search result found.

The *Print* button in the video transcript section functions similarly to the button at the top of the course. But it will only print the video transcript (Figure 55).

Clickable prototypes

To get better results when testing the accessibility of the website, the pages were turned into clickable prototypes. To evaluate the hover effects and add some animations, the *Homepage,* and *Course category page* were turned into realistic prototypes using the visual editor platform, Webflow. This platform also enables us to test the Back-To-Top button on the homepage. The other pages needed coding and since we want to test the designs before creating the real website, the *sign-in*, *Join* and *Course* pages are turned into clickable prototypes using the Figma application. In the end, these five pages were linked together for real interaction.

3.4. Testing

To identify the problems and find the errors and confusion in design, the usability testing method was chosen. This method allows to collect qualitative data and gain real behavioral insight into how older adults use the website. Observing the users helps to discover new ideas to improve the website.

3.4.1. Problem Statement and Test Objectives

The goal of this test is to learn from our users if there are design issues or accessibility problems on the website. To plan and identify the test objectives and write the test scenarios, "Whitney Quesenbery's 5Es criteria (Barnum, 2011)" are considered.

Dimension	Definition
Effective	How completely and accurately the work or experience is completed or goals reached
Efficient	How quickly this work can be completed
Engaging	How well the interface draws the user into the interaction and how pleasant and satisfying it is to use
Error tolerant	How well the product prevents errors and can help the user recover from mistakes that do occur
Easy to learn	How well the product supports both the initial orientation and continued learning throughout the complete lifetime of use

Figure 57: Whitney Quesenbery's 5Es criteria (Barnum, 2011)

The 5 Es criteria only cover the usability of a website or software. Therefore, accessibility is also considered as another criterion in this study.

- **Accessible** — Can the user read and see the content of the page easily? Is the website easy to use?

Due to time constraints, the questions and task scenarios had to be prioritized. The following are the most important questions for our research:

1. Do the users understand:
   - the buttons
   - clickable areas
   - Back-to-top button

2. Will they use them without fear and doubt?

3. Do they know how to search for a course? Can our design help them to search easier?
4. Do they know how to register and make an account? Can they do it without any help?
5. Can they fill up the forms without any problem? Will they read the hints; do they need them?

On course pages:
6. Is it easy to understand or work with the tabs on the left?
7. Do they understand what the notebook is and how to use it?
8. Do they understand the Q&A tab?
9. Is it easy to understand or work with the accessibility options?
10. Do they need more accessible options, such as a contrast editor?
11. When they change the background color, are they satisfied with the changes?

3.4.2. Planning the usability testing

The following describes the procedure of the usability test:

Preparing the test materials → Recruiting participants → Conducting a Pilot Test → Testing → Analysing

This will be a moderated test. Tests will be conducted either remotely or in the participant's location (field study). The remote testing is conducted via a video conferencing app. The link to the meeting and the test materials will be emailed to the participants beforehand. During the remote test, the participants share their screens, and the test and interviews will be recorded with their permission.

The participants use their computer or laptop for this test. The advantage of this is that the users are at their home, in the environment where they normally use the Internet. This helps the researcher see and learn about the actual context of using the website in various situations that affect user behavior, such as lighting conditions, the type of computers used, Internet connection, as well as distractions, and interruptions that may affect users' experience.

3.4.3. Preparing the test materials

The test materials were developed to organize and structure the test. The contents of the test materials are prepared according to the objectives and questions of the research. The main materials are the moderator's script, pre-test questionnaires, task scenarios, post-task questionnaires, and interviews.

Moderator's script

The script is used throughout the test session. It contains all the scripts and steps that the moderator must use during the test session. It helps the moderator ensure that the most important points are not forgotten and that the same points are said to all participants. The information presented to the participants is identical, so they are exposed to the same conditions for the test.

 The script covers the following topics:

Introduction to the participant (welcome and purpose of the test), video consent form, pre-test questionnaires, introduction to the test (describe the test process and thinking out loud), task scenarios with post-task questionnaires, and the interview after the test (see Figure 73 to Figure 75on pages 79-81).

Introducing the test procedure and thinking out loud technique

After welcoming the participant, the test procedure is described to the participant. Then the moderator explains the thinking out loud technique. This helps the participant understand how to verbalize their thoughts as they use the website. Thinking out loud helps the researcher understand how the user thinks at each step of the test and how the process works for them. It also gives them the opportunity to ask contextual questions. As Jakob Nielson in his book Usability Engineering explains, "Thinking aloud may be the single most valuable usability engineering method." (Nielsen, 1993).

Participants should understand that we are not testing their skills or knowledge. The moderator invites them to share their honest opinion, whether it is negative or positive.

Pre-test questionnaires

Before the usability test, the participants should answer some questions. These questions provide additional information about participants, such as their age, experience using the Internet, knowledge of accessible options, etc., which helps to better understand their performance and behavior. For instance, a participant who has taken an online course before or knows some accessibility options will perform differently than a person with no experience (see Figure 76 to Figure 81 on pages 82-87).

Post-task questionnaires

After each task, the users answer some close-ended questions. These questions relate to the objective of the study and have a positive/ negative format, which represents the two ends with antonym adjectives and participants select the appropriate answer. The participants should choose one of the answers. As Robin et al. (2008) point out that close-ended questions speed up the completion of the questionnaire and reduce the number of incomprehensible answers. If the moderator has questions about the user's behavior, she can ask before the

next task. For instance, questions such as: What is preventing you from completing this task? Or I noticed that you did [something]. Why? (see Figure 82 to Figure 84 on pages 88-90)

Task scenarios

These task scenarios are actions that the participant performs on the prototype. Each scenario needs to provide a goal for the user and engage them with the interface. For the first scenario, Carol M. Barnum, a UX research expert, in her book "Usability testing essentials," recommends asking participants to look around the homepage and share their impressions by responding to some questions. Carol M. Barnum calls this type of scenario a "look and feel scenario" (Barnum, 2011). For this usability test, this method is used to capture users' first impressions.

Scenario 1:

You want to learn more about computers and smartphones. One of your friends has recommended the learning platform "www.Digio.com" to you. You open the homepage of this website to see what kind of website it is. Take a moment to look at the home page without clicking on anything. Please scroll down to the bottom of the page.

Once you have seen the page, answer the following questions:

1. What type of courses are offered on this site?

2. Do they offer online courses with a personal teacher?

The goal was to help the users get familiar with the page and understand what kind of website they are looking at. It helps the participants to do the upcoming tasks faster and with more confidence and get comfortable with it.

Scenario 2:

You have found a course on the Digio website that you would like to learn, but you do not have an account yet, so you would like to create one. How would you do that?

The goal of the second scenario is to ensure that the user can fill in the input fields without any problems and that the help hints are understandable.

Scenario 3:

Your friends sometimes call you on WhatsApp, but you do not know how to add new contacts and how to call them back on WhatsApp using your smartphone. You check out the homepage of this website to find out if this website offers any course about this.

After you complete this scenario, let me know you are done.

The goal of the third scenario is to find out if the user understands the categories or if they will use other methods such as the search bar or the menu bar to find a course. If they use the search bar, the user must be able to use it without help. If the user wants to search with filters, their comprehension of filters will be measured.

Scenario 4:

You have found the course "How to use WhatsApp". Take a moment and look at this page to get familiarized with it.

After you have familiarized yourself with the page, tell me what you see on the left side of the page (What options are there?)

Because the prototypes of the tabs on the left (content, Notebook, and Q&A) are not completely functional, the user is asked to explain what they see and think. The goal is to determine whether the user understands the tabs and their functions.

Scenario 5:

On this page, you have seen the third video, "Set up WhatsApp profile". Now you want to read the course text below this video. The white background and font size bother you and you wonder if you can change the background color to a darker color and make the font size bigger so you can read the text better. See if there are ways to do this.

Scenario 6:

You prefer to read the course text on paper. On this page, find an option to print the text.

The accessibility options might be new to the participant. The goal of the scenarios five and six is to see if the users confront any problems with these options.

Interviews

At the end of the test, to get richer information, the moderator askes the participant some open-ended questions. With this method, users share their motivations and reveal their mental models, giving us more information and perhaps some unexpected answers to help us make new design decisions. At the end of the session, the moderator checks whether the participants have questions.

3.4.4. Recruiting participants

The participants of the usability tests are five older adults. A study conducted by Nielson and Landauer (Nielsen, 2000) shows that testing with five users of one target group gives all the data needed for the test. Figure 58 shows that zero users give zero insights, and three users will find 85% of the usability problems. With a single user, one-third of the data needed is collected. The second and third person will do some of the same things the other users did, and they will also add new insights. After the fifth test user, the curve is straight and will no longer provide useful data (Jakob Nielson, 1993).
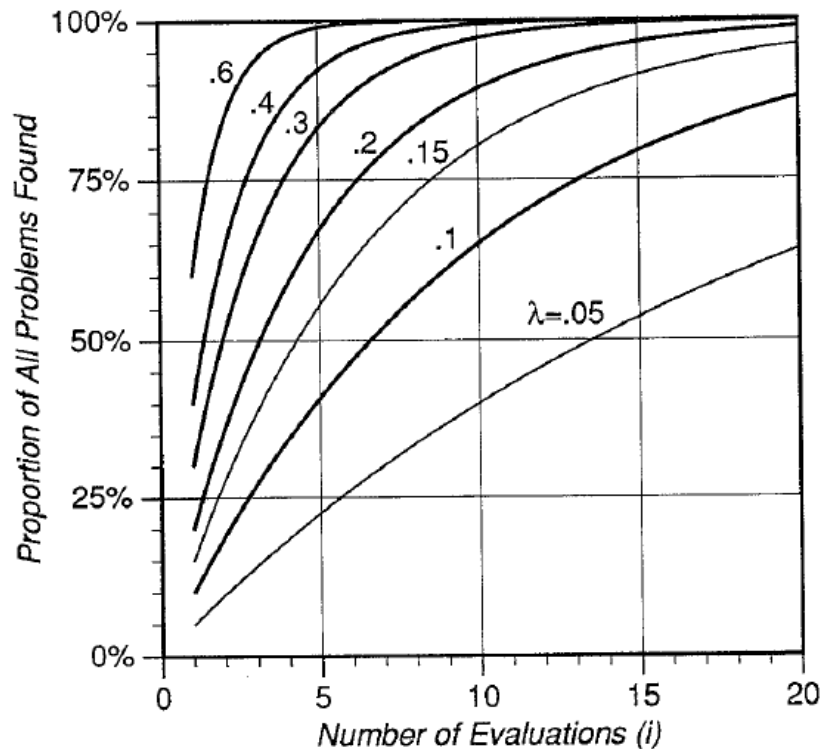
Figure 58: Nomograph showing the proportion of usability problems found by various numbers of evaluations. Each curve represents a certain value of λ, from .05 to .6 (Nielsen, 1993).

For this test it is important that the participants meet the following criteria:

- Be between the ages of 60 and 87 (older boomers and the Silent generation),
- have a home computer or laptop with a network connection,
- minimum one year of Internet experience.

3.4.5. Conducting a Pilot Test

A pilot test is a test session before the main, scheduled study. It allows the moderator to practice the test plan and helps to determine if the tasks are confusing or misleading for the participants or if the questionnaires are not understandable. In this way, errors and problems can be identified, and the prototype can be revised without the need for further confirmation through the actual test (Rubin, Chisnell, & Spool, 2008). This test enables estimation of the

time required for the tasks, which allows effective prioritization of the tasks for the actual study.

3.4.6. Analyzing the test results

After conducting the tests with the participants, the data is compiled and summarized. The test analyses were performed according to the techniques suggested in the books by Jefferey Robin et al. (2008) and Carol M. Barnum (2011). All the data are collected in a form, in order to find patterns in them. For each individual task, all the important comments of the participants and the notes written by the moderator are collected. After all sessions have been reviewed, the data are summarized in spreadsheets.

The qualitative testing results are collected with four metrics:

- **Success rate:** can the participants complete a task without help?

- **Time on task:** How fast can they do the task?

- **Error rate:** How often do they do something wrong?

- **Confusion rate:** How often are they confused or not sure how to do the task?

4. Findings

A moderated remote test was conducted with two participants on the second of July. Testing with three other participants took place at the user's location on July 16 and 17.

Qualitative and quantitative data were collected from the tests. Due to the small size of the study, the quantitative data (pre-test questionnaires) were only used to better understand the users and their behaviors. Instead of mentioning the names of the participants in the results, numbers (01, 02, 03, 04, and 05) are used.

4.1. Pre-test questionnaire

Table 4 below shows the responses of participants to the pre-test questionnaire. The participants are three women and two men between the ages of 60 and 73. This is the first time that they participate in a usability test. Three participants (01,03,04) are short-sighted, participant 02 is long-sighted and participant 04 is well-sighted.

	P 01	P 02	P 03	P 04	P 05
Age	63	60	73	69	62
Gender	male	female	female	male	female
Have you ever participated in a usability test?	no	no	no	no	no
How much time do you spend online every day?	1 to 2 hours	5 hours or more	1 to 2 hours	1 to 2 hours	1 to 2 hours
How would you rate your knowledge of using websites?	basic	good	basic	very good	good
Which of the following best describes your vision?	Short-sighted	long-sighted	Short-sighted	well sighted	Short-sighted
Do you use the internet to learn something new?	yes	yes	yes	yes	yes
Do you use online education websites or apps?	yes	yes	no	no	yes
Have you heard about accessibility on websites or mobile phones?	no	no	no	no	no
Do you use accessibility options on your mobile phone or computer?	no	no	no	no	no

Table 4: Pre-test questionnaire analysis

Most of them use the internet for 1 to 2 hours, except for one user (participant 04) that uses the internet for 5 or more hours. They have diverse types of internet knowledge from basic (participant 01, 03), good (participant 02, 05) to very good (participant 04). They all use the internet to learn something new, but only three of them use educational websites such as Habmann.info and Skillshare.com. The participants have not heard about accessibility on websites or mobile phones and do not use any accessibility options.

To the question "What type of education do you prefer?" users chose different answers. Three of them prefer present courses and two of them, online courses (Graph 3). Most of the users like learning a course alone (Graph 4) or with a teacher (Graph 5).
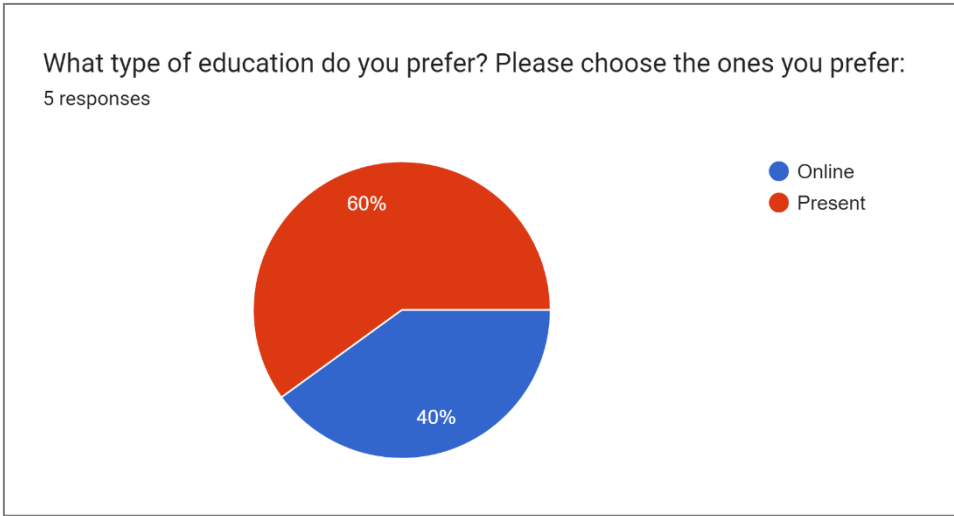
Graph 3: Answers to the question "What type of education do you prefer? Online or present."
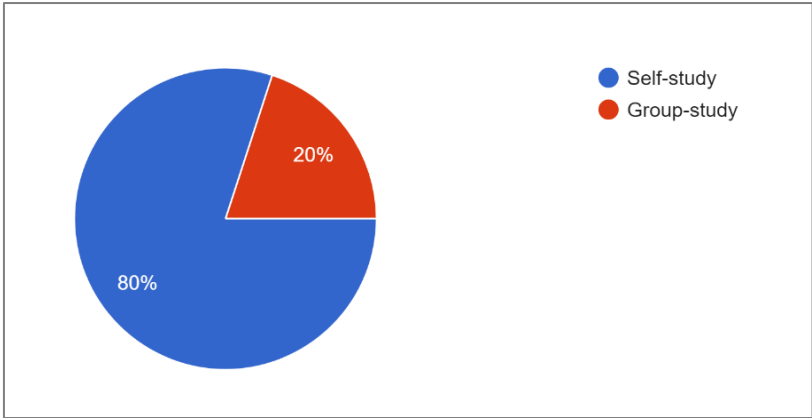
Graph 4: Answers to the question "What type of education do you prefer? Self-study or group-study."
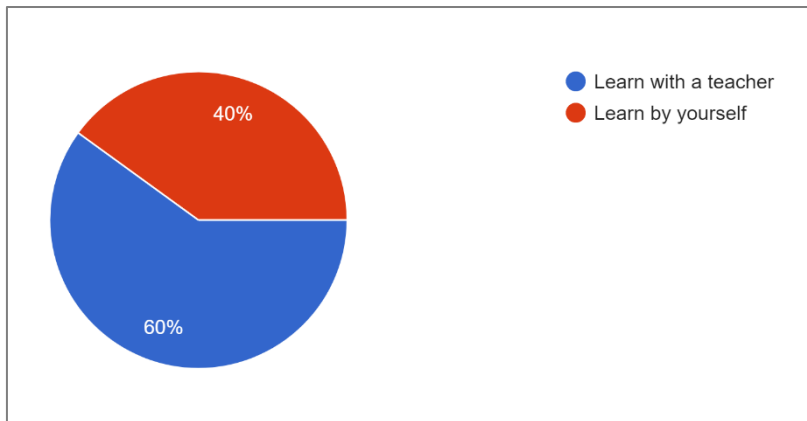
Graph 5: Answers to the question "What type of education do you prefer? Learn with a teacher or learn by yourself."

As Graph 6 illustrates, all users prefer learning with videos over reading texts or listening to audio. Only one participant chose all of the content types.

Which type of content do you prefer in order to learn something new? (you can select more than one answer)

5 responses
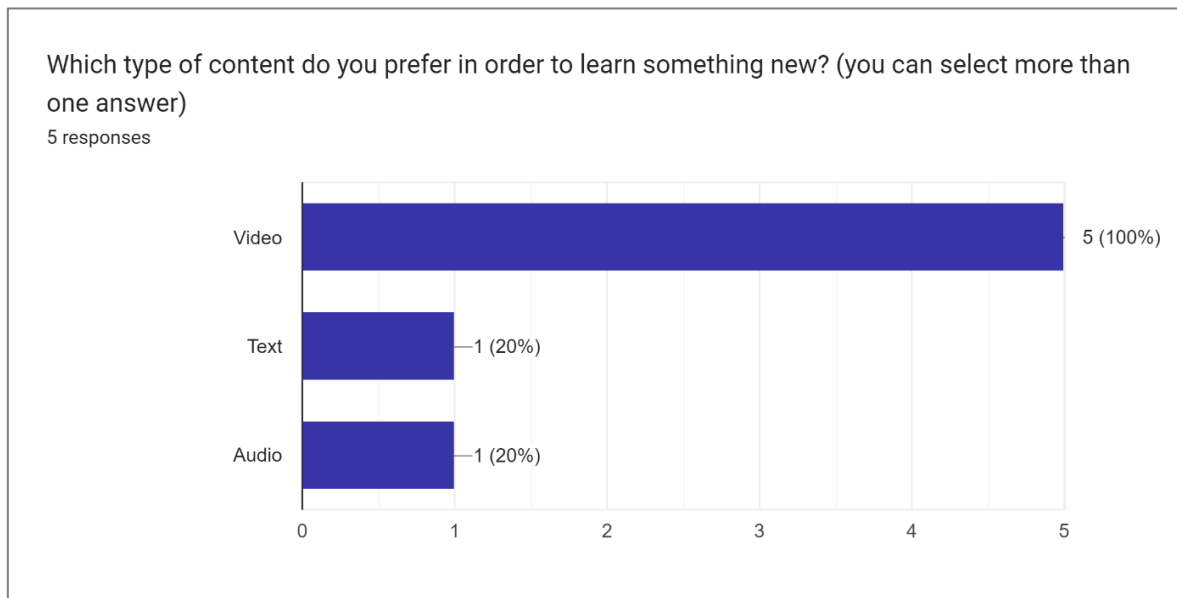
Graph 6: Which type of content do you prefer in order to learn something new?

4.2.   Usability testing results

Each participant was first evaluated separately for each task scenario, and at the end, they were all compared together. The information is presented in graphs to facilitate understanding of the results.

Graph 7 provides information about the success rates of the test users in each scenario and the average time taken to complete each task. The vertical axis on the left shows the task success rate in percentage and on the right, the average time users needed to complete the tasks in seconds. The horizontal axis represents the scenarios.

All users could answer scenarios 01, 03, and 06, 100 % successfully. They needed less time for the third and sixth tasks, but the first scenario took more time (132 sec.) because they had to browse the entire page to familiarize themselves with the website. Scenario 05 has the least success rate, and it took more time to complete it (188 sec.). Task 04 was 90% successful, and since it was a long task, it also took more time to complete.

Task success rate and time- all users

	Scenario 01	Scenario 02	Scenario 03	Scenario 04	Scenario 05	Scenario 06
Success rate	100%	80%	100%	90%	50%	100%
Time AVG (in Sec.)	132.2	114	40.2	168.6	188.8	24.8
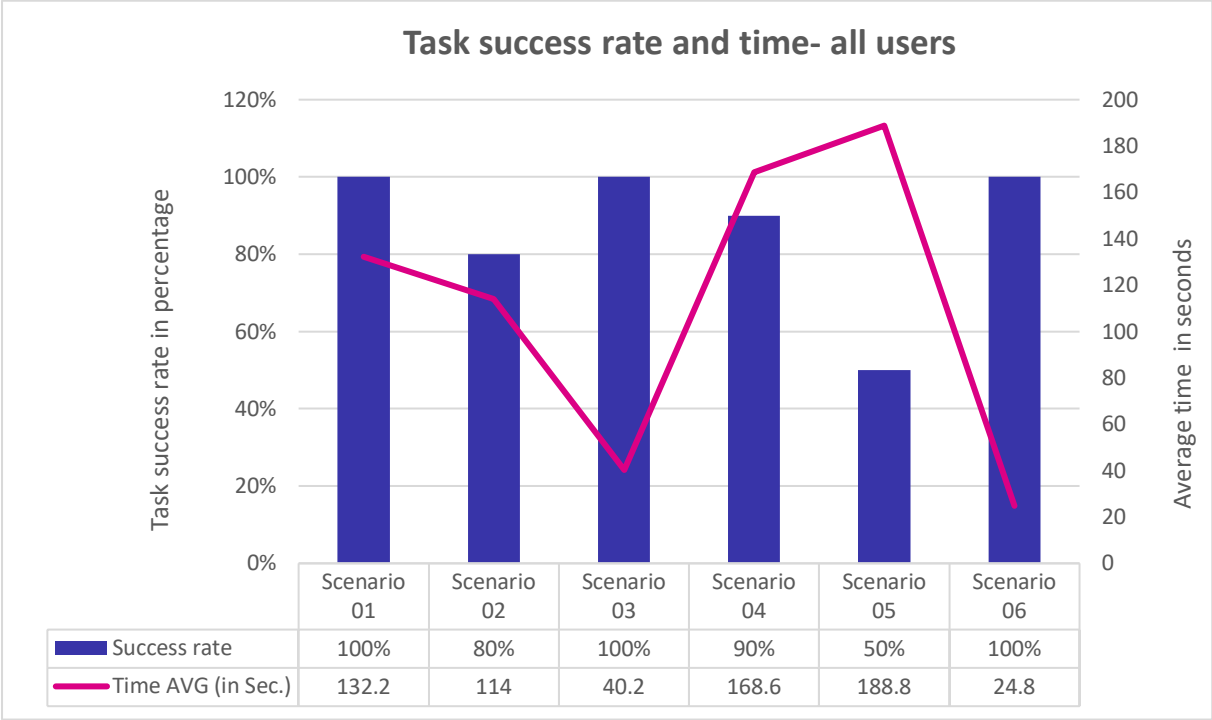
Graph 7: Task success rate and time for all users

Graph 8 illustrates how successful each participant was and how long they needed to complete all the scenarios. Participant 01 had the lowest success rate (75%) compared to the other participants and also needed more time (180 sec.) to complete the tasks. Participant 02 was 92% successful and could complete the tasks in approx. 92 sec. Participants 03 and 04 were 83% successful. Participant 03 needed more time (average 109 sec.) than user 04 (average 88 sec.) to accomplish the tasks. Participant 05 was 100% successful and completed the tasks faster than other users (approx. 87 sec.). By comparing Graph 8 with Table 4, it can be seen that participants 02 and 05 are the youngest and have more experience in using the Internet, and they were more successful in completing the tasks.

Task success rate and time- per user

	P01	P02	P03	P04	P05
Success rate	75%	92%	83%	83%	100%
Time AVG (in Sec.)	180	92.16666667	109.1666667	88	87.83333333
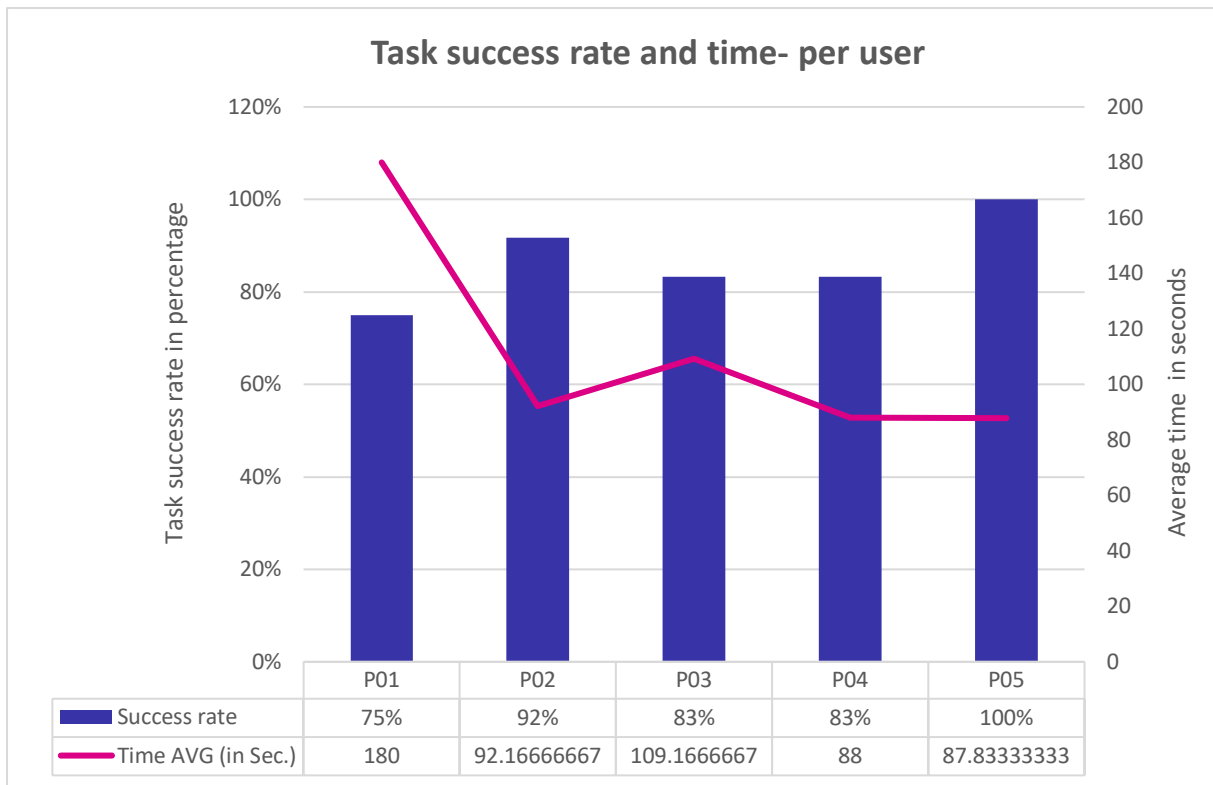
Graph 8: Task success rate and time user

Table 5 shows the post-task statements and the number of participants who selected a response. For the first task scenario (understanding the website), scenario 4b (understanding the Q&A), and the last scenario (printing the page), all the users chose the respond "very easy". Scenarios 2b, 3, and 4c were either "easy" or "very easy" for most participants. Opposite to this, all the participants found scenario 5a, Changing the Background color, "somewhat difficult" or "very difficult". Only participant 05 found this task easy.

For scenario 2a, creating an account, users responded very differently. Two participants chose "very easy," one user (participant 01) selected "easy", and one (participant 03) "somewhat difficult". Scenario 4a (understanding the content) was for three participants very easy and for two participants easy. Scenario 5b, changing the font size, was for three participants easy. For participant 01 it was somewhat difficult and participant 04 chose "very difficult".

	Very easy	Easy	Neither easy nor difficult	Somewhat difficult	Very difficult
Scenario 1: Understanding the website was	5 (All)				
Scenario 2a: Creating an account was	2 (P02, P04, P05)	1 (P01)		1 (P03)	
Scenario 2b: Understanding the input fields was	4 (P02, P03, P04, P05)	1 (P01)			
Scenario 3: Fining the course was	4 (P01, P02, P03, P05)	1 (P04)			
Scenario 4a: Understanding the "Content" is	3 (P02, P04, P05)	2 (P03, P01)			
Scenario 4b: Understanding the "Notebook" is	5 (All)				
Scenario 4c: Understanding the "Q&A" is	4 (P01, P02, P04, P05)	1 (P03)			
Scenario 5a: Changing the Background color was		1 (P05)		3 (P01, P03, P02)	1 (P04)
Scenario 5b: Changing the font size		3 (P02, P03, P05)		1 (P01)	1 (P04)
Scenario 6: Printing the page was	5 (All)				

Table 5: post-task statements and the number of participants who chose a rating

Graph 9 illustrates the errors and confusion rate of all users for each task scenario. The vertical axis on the left shows the number of errors and confusion of all users. The horizontal axis represents the scenarios. If an error repeats among several users, it is counted as one error. The errors are the issues that users encounter or when they are unable to successfully perform a task. The confusions are the number of time users are confused with a part of the website or when they must search too long to find what they are looking for.

As shown in Graph 7, task scenarios 01,03 and 06 were completed 100% successfully. There were also no errors or confusion in these tasks (Graph 9). Scenario 05 (changing the background color and font size) has the highest error rate (five) with a confusion rate of two. On the contrary task 04 has the highest confusion rate and only one error. Task two has only one error and one confusion rate.

Error & confusion rate - all users

	Scenario 01	Scenario 02	Scenario 03	Scenario 04	Scenario 05	Scenario 06
■ Errors	0.00	1.00	0.00	1.00	5.00	0.00
■ Confusion	0.00	1.00	0.00	4.00	2.00	0.00
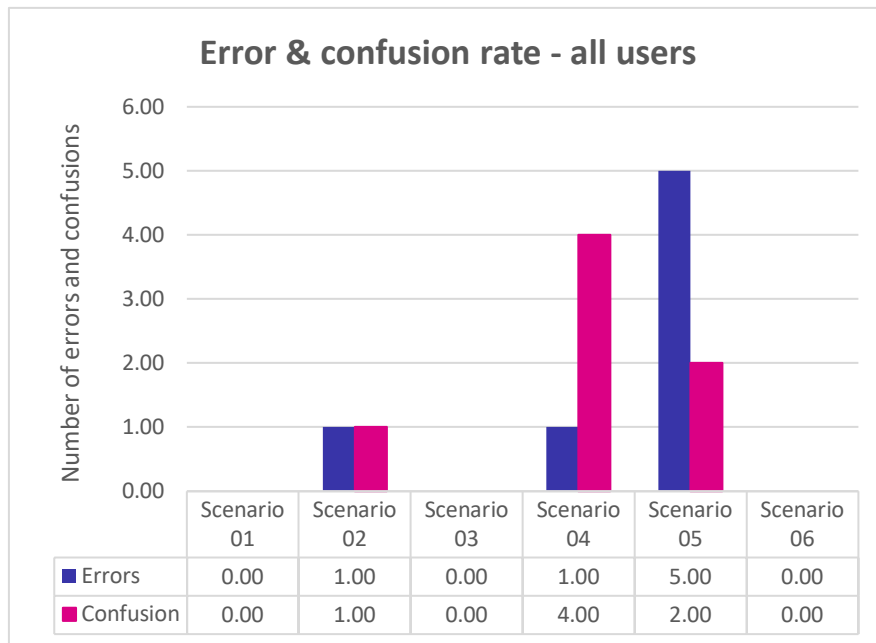
Graph 9: Errors and confusion rate of all users for each scenario

Graph 10 illustrated the error and confusion rate, per user. Participant 01 has the highest confusion rate. Participants 01, 03, and 04 have 33% error rate. Participant 05 has no error rate and participant 02 has only 17% errors.

Error & confusion rate - per user

	P01	P02	P03	P04	P05
■ Errors	33%	17%	33%	33%	0%
■ Confusion	50.00%	0.00%	33.33%	16.67%	16.67%
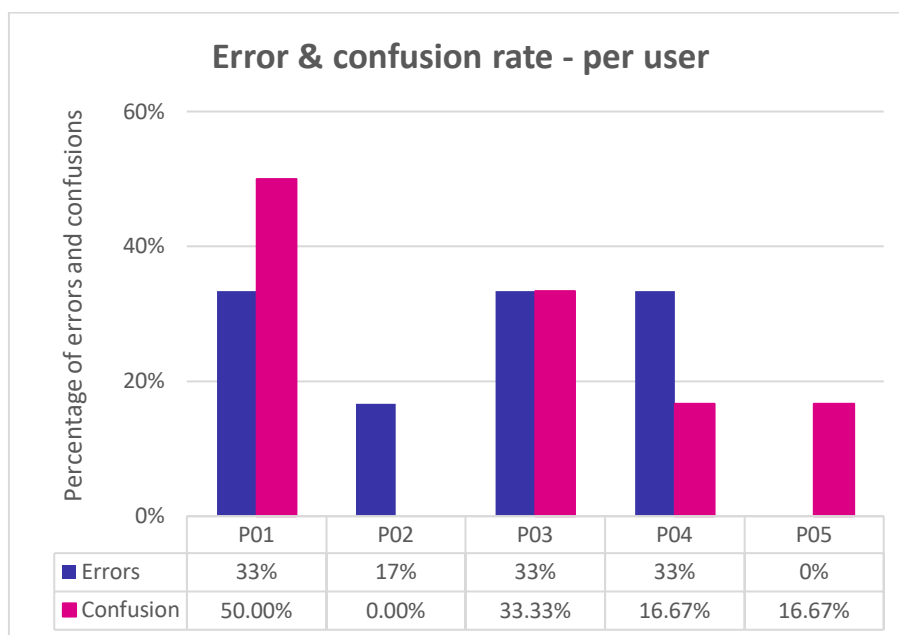
Graph 10: Errors and confusion rate of each participant

4.3. detailed analysis of the task scenarios and Interviews

4.3.1. Scenario one

Success rate: 100%

Number of errors/ confusions: 0/0

Finding: All users could easily understand the website's goal and contents.

4.3.2. Scenario two

Success rate: 80%

Number of errors/ confusions: 1/1

Findings:

Participant 01: In order to create an account, he wants to type in the search bar. After five seconds he notices the "join now" button in the banner (Figure 59) and he says, "I believe if I click here, I can create an account." On the join now page, he understands each field and reads the assistance texts under them. He then notices the "Facebook" login option and says, "I could also use this button to join the website."
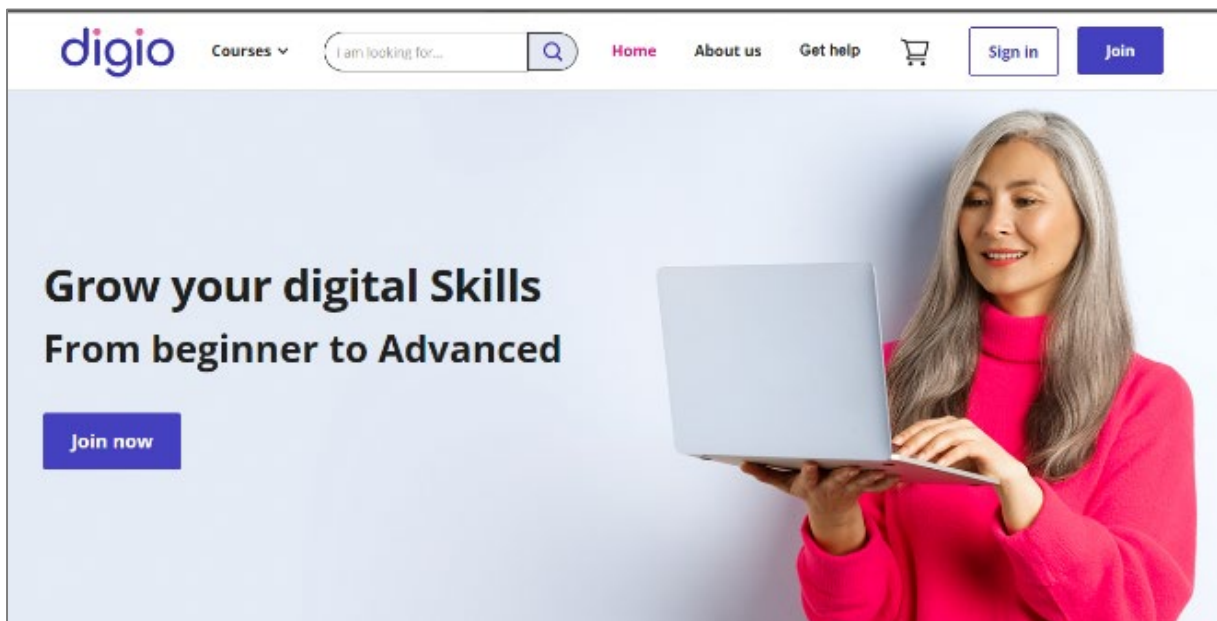
Figure 59: Homepage of the Digio website

Participant 01 does not like to join any website, because of their terms of use, and prefers to see a video about them. He also suggests putting an introduction video about how to join the website on the registration page.

Participant 02: She could join the website without a problem and reads the assistance texts under each field. She also likes the registration options under the form.

Participant 03: She does not know how to create an account and would like to type "how to create an account" in the search bar to find an answer. She also said that if she does not find anything there, she will look in the "Frequently Asked Questions" section. She stated she has never set up an account on a website before, and her daughter always does that for her, but she knows how to log in.

The participant was then asked to look on the home page to see if she could find another way to create an account. She saw the sign-in button and said, "I know I can sign in with an account if I click here; usually the sign-in page says if you don't have an account, click here." On the sign-in page, she sees the "Join for free" link under the form and clicks it (Figure 60). She understands and fills out the form without any problems. The user has not read all the assistance texts, but only the text under the password.
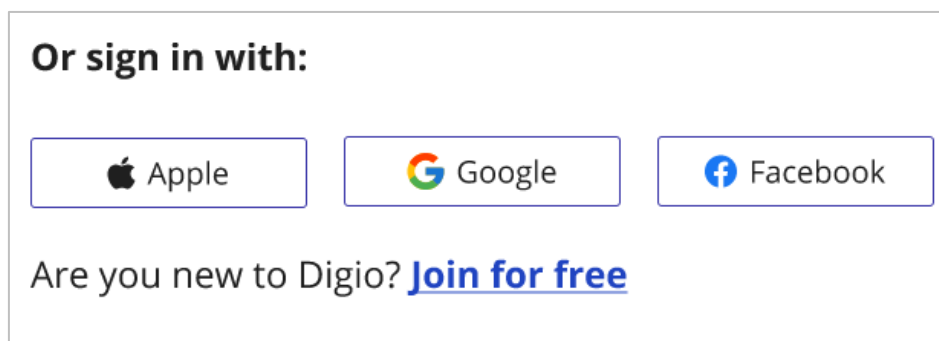
Figure 60: Log-in options under the sign-in form

Participant 04: He looks for a "Sign In" button and ignores the "Join" button. Like participant 03, he clicks the "Sign in" button to create an account. Then he sees the "Join for free" link, clicks it, and fills out the form without a problem. He also is familiar with the alternative way to create an account by clicking on the buttons below the form. This user read all the assistance texts.

Participant 05: She clicks on the "Join" button in the menu bar. On the registration page, she clicks on each field and reads the assistance text. The user had no problem with this task.

4.3.3. Scenario three

Success rate: 100%

Number of errors/ confusions: 0/0

Finding: All participants were able to find the course. Participant 01 found the category from the drop-down menu and others clicked on the course box "Smartphones and tablets".
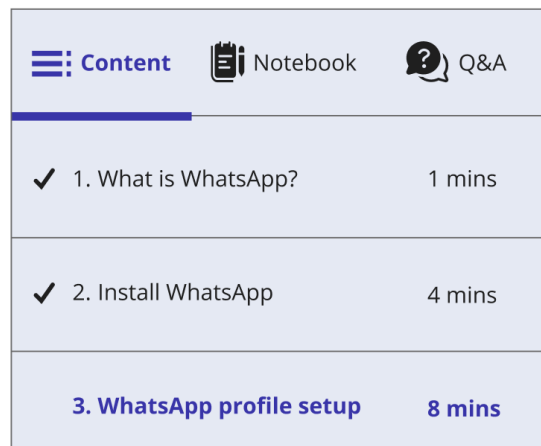
4.3.4. Scenario four

Success rate: 90%

Number of errors/ confusions: 1/4

Findings:

Participant 01: He does not comprehend that there are three tabs on the left side of the page. He thinks that there is just one tab (Content tab), and he considers that this section is like a table and the information on it is incorrect. He is also uncertain what the numbers in front of the names of the courses mean (Figure 61) and says, "Maybe this is the time we need to learn a course."

Figure 61: The tabs on the left side of the page. Under the *Content* tab, there is information about the course names and the estimated learning time for each course.

This user notices that the "Notebook" and the "Q&A" are clickable when he accidentally sees the cursor change to a hand pointer. But without clicking on them, he says, "I don't know what the Notebook does." After clicking on this tab, he reads the description of the notebook and understands its function. He stated that he prefers to write his notes on paper. He also understands the Q&A tab.

Participants 02, 04, and 05: They understand that there are three tabs on the left side of the page. They have no problems understanding the meaning and functions of each tab.

Participant 03: She understands all the tabs and their functions. She thinks that under the Q&A tab, she can type and find not only her questions about the course but also other questions, such as questions about the website.

4.3.5. Scenario five

Success rate: 50%

Number of errors/ confusions: 5/2

Findings:

Participant 01: He cannot find the tab that changes the Background color. But changing the font size was easy for him. After he found the font size, he noticed the background tab, and this time he understood that it is a tab and clicked on it. Then he could change the background color.

Participant 02: She cannot find the Background tab but finds the text size option. She found the background tab like participant 01. She prefers the white color and does not like the beige background.

Participant 03: Like other users, she did not find the background tab, but she was able to change the font size. She likes all background colors.

Participant 04: He can neither find the background color nor the font size tabs. He never tried to click on them to see their functions, but he recognizes that they are clickable.

Participant 05: She guessed that the background color might be under the "Style text" button and could successfully change it. She also changed the font size without a problem.

4.3.6. Scenario six

Success rate: 100%

Number of errors/ confusions: 0/0

Findings: All participants found the print option easily.

4.3.7. Interviews

Question 01: Could you tell me, what other options you see on this page?

Three participants (02, 03, and 04) understand the function of the "Read aloud" button. Participant 05 also guesses that by clicking on the "Read aloud" button, the text will be read aloud and wants to click it to make sure of its function. On the other hand, participant 01 thinks that the "Read aloud" button functions like volume control and that he can use it to control the volume. All users understand other parts of the page, such as toggling the side menu, viewing video transcript, and learning progress.

Question 02: Is there anything that you disliked about the design of this page?

- Participant 01 suggests changing the tabs, so it will be more understandable.

- Participant 05 suggests separating the background and text style buttons.
- Other participants liked the design of this page.

Question 03: (On home page) Do you find the interface easy to understand?

The participants found the interface easy to understand. Two users thought that the two pictures under the *How Digio works* section, have buttons ("Join" in Figure 62 and "Get help" in Figure 63). They wanted to click on them and asked the moderator why the cursor does not change to a hand pointer (which indicated that the button is clickable).
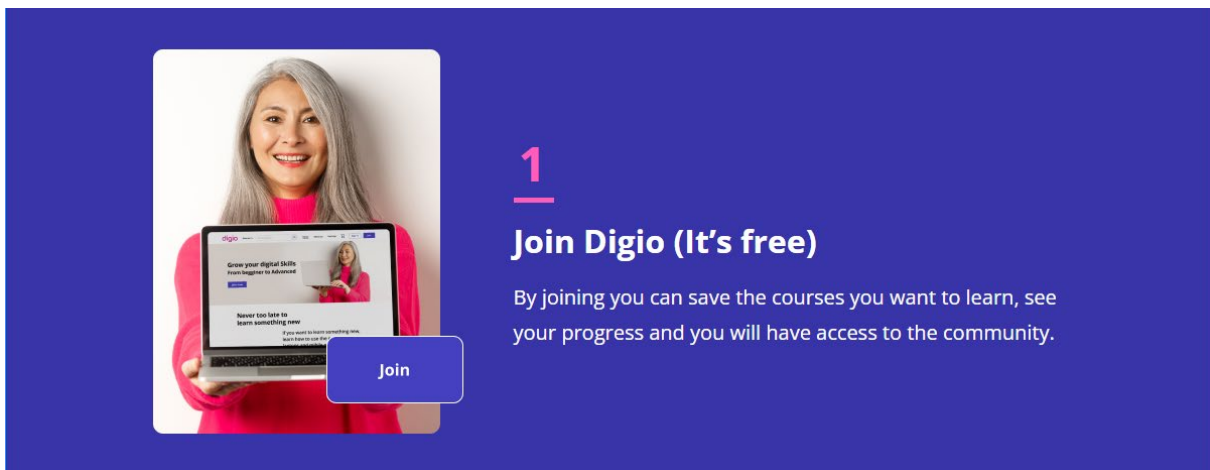
Figure 62: The picture of the "Join" button on the image.
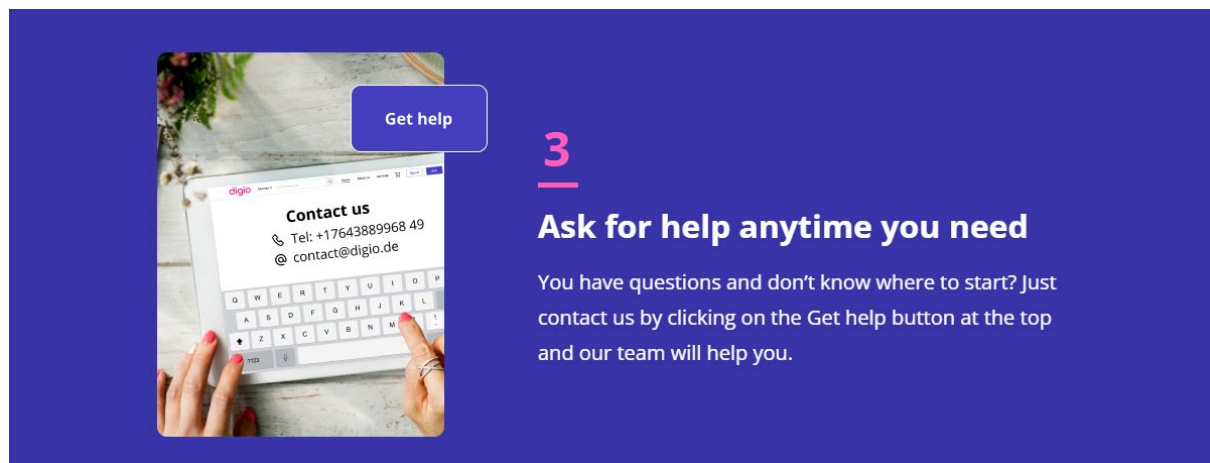
Figure 63: The picture of the "Get help" button on the image.

Question 04: Do you find the texts easy to read?

All the participants stated that they could read the text easily. Two of them mentioned that they do not need to wear their glasses to read the text, which made them feel good.

Question 05: Could you show me which parts of this page are links and clickable?

All users could recognize the clickable areas. As mentioned in the answer to the third question, some of them thought that two pictures (Figure 62 and Figure 63) are also clickable.

Question 06: Would you change the font size, contrast, or background color if there was an option like on the course page?

All the participants responded "No" to this question. They found the contrast and color of the website to be pleasant.

Question 07: How would you scroll back to the top of the page? / What other options do you see on this page that could quickly take you back to the top of the page?

All participants understand the *Back to top* button. Two of them used this button during their response to the first task scenario.

Question 08: On this page (Course page), could you tell me how would you use the filters?

All of them had experience using filters, and the function of the filters was obvious for all the users.

Closing Interview:

Question 01: If you could change one thing about the design, what would it be and why?

One of the participants prefers watching videos instead of reading texts. He suggests adding more videos to the website. He says, "All my life I've read a lot of books, now I prefer to watch a video to learn something, because they show the steps, and I understand better..."

Despite participant 05 that likes the photos on the home page participant 02 does not like the pictures of the old people with white hair. She prefers a mixture of young and old people. Participant 04 mentions the picture of the buttons. Participant 03 did not want to change anything.

Question 02: Did you have confidence as you were working with the website?

In general, all participants had confidence. They found it easy to understand and it was important for them to find the courses that they want to learn fast and without any help.

5. Discussion

The results of the usability testing indicate that the accessibility consideration on the Digio website was easy to understand for the participants. All users were able to do more than 70% of all tasks successfully.

On the home page, users were able to quickly learn about the website. They found the text legible and could read it without their glasses, which made them very satisfied. All the links and clickable areas, e.g., buttons and course boxes as well as Back to top button, were identifiable. On the menu bar, some of them used the search bar to find their questions and some used the drop-down menus to explore the website. This indicates that their design was understandable. The only issue on the home page was the design of the images in the *How Digio works* section. The image of the buttons was intended to help users understand where to click to perform an action such as joining the website, but due to their identical design to the buttons, it was not recognizable to users.

Users understood the structure of the website and were able to navigate without assistance (except for user 03 in task two). In task two, to create an account and join the website, four users clicked the Join button, but one user could not understand the purpose of this button. This user is the oldest (73 years old) in this study and rates her knowledge of website use as basic. She has also never registered on a website before, as she and user 01 are afraid of fraudsters on websites. This reflects that the word "Join" does not convey the meaning of creating an account for all uses, which points to the importance of the UI copy alongside the design of the elements.

On the join page, all five users were able to successfully complete the fields of the registration form. The assistance text under each field of the form helped them understand what they must enter in each field, which shows the design was accessible and usable. Users were also familiar with the registration options below the form, e.g., the Apple or Facebook buttons, and some of them preferred to use these instead of completing the form.

As mentioned previously, the design of the course pages is particularly important, since they provide users with various options, such as selecting a course, writing notes, asking questions, or even changing the font size or background color. On this page, four users could understand the tabs on the left side of the page except for one user (participant 01), but this user noted that the tabs were clickable. When I asked him to click on them, he was then able to understand the function of each tab. He also found the estimated time before the course names ambiguous.

On one of the tasks, the users should find the background control tab. One of the key findings on accessibility buttons was that users had difficulty locating the *Background* tab. This tab is located with *Font size* under the *Text Style* tab. Only one user was able to find it. Having found this tab, its functionality was easy for all users to understand. User 01 could also recognize that there were two tabs under the *Text style* button, which indicates that the user quickly became familiar with the design of the website (the tabs).

Users did not mention any difficulties regarding elements like color or font size. Other visual elements, e.g., filters and breadcrumbs, were also comprehensible to all users.

Based on these conclusions, to make the design more accessible, there are some improvements that need to be made:

1. On the home page, the pictures of the buttons should be replaced with a different shape or design so that users do not misunderstand them.

2. On the course pages, the tabs should be more recognizable.

3. On the *Content* tab, beside the estimated learning time of each course, it is better to add an icon or text that helps users understand what exactly they mean.

4. The Change Background tab needs to be placed separately near other options (not in a drop-down button) so that it will be obtainable.

Further suggestions that can make the website and design more understandable:

1. A different icon can be used on the course pages instead of the speaker icon for read aloud to better convey the meaning.

2. As one user suggested, an introductory video could be placed on the join page to help users understand why and how to create an account.

6. Conclusion and future work

This study aimed to investigate if accessible design can increase the confidence of older adults in using the websites. Therefore, an accessible website with consideration of visual perception was designed and tested.

Based on a quantitative and qualitative analysis of the responses to the usability test, it can be concluded that by integrating accessibility throughout the development process of a website, older users can use the websites with more confidence.

In this research, due to budget constraints, finding participants for the test was hard. Qualitative testing was required for this study, and this type of testing takes more time. It was difficult to find a user who was interested in taking part in the test for 45 minutes. The participants of this test were from different cities, and the test was conducted with two of them online and with the other three in person. The usability test was conducted with task scenarios, questionnaires, and interviews. The use of eye-tracking in usability testing is recommended for further studies to gain real physiological insights into the conscious and unconscious behavior of the participants.

One of the participants mentioned that he prefers watching videos rather than reading texts on websites. For instance, to create an account, he prefers watching a video to learn how to do it rather than reading the information or assistance texts. In the pre-test questionnaire, most participants also preferred to learn the courses by just watching videos instead of

reading or listening to the course. Future research on the use of videos instead of text on websites is essential to confirm that users benefit more from videos on educational websites.

Considering accessibility in design benefits not only older users but also people with disabilities and younger users. However, we must keep in mind that the implementation of the guidelines like WCAG is not enough to achieve accessibility. It is important to test each design with target users to make sure of its accessibility. Making an accessible design does not mean the design is uninteresting. Websites can be accessible and usable and at the same time beautiful. Beautiful design is what the user perceives, but accessible design means that this design can be used without problems, i.e., smoothly, and quickly.

By creating inclusive and accessible websites, in a world that is becoming more dependent on technology every day, we can make the world a better place.

Attachments

Figure 64: Defining the user's pain points and needs from the research.

Pain points	Needs
Finding a course	Learning something new
Not trusting the websites to register	Learn how to use technology
Fear of fraudsters	Finding the course, I am looking for
Font is too small and blurry	Trusting the website
No confidence	Reading the texts easily
Too complicated	Gaining more confidence when using the website
Contacting customer service	Using the website without any help from friends and family
Understanding the website	
Do not notice the things on the edge	Contacting the customer service
Cannot see the errors	Easy structure
The screen is too dark	Easy inputs
Links and buttons are not understandable	Understandable icons and photos
Cannot click on target objects	
Buttons are too small	
Hard to understand where to click	
Cannot see the detail because of glare	
Search: forgets which pages have visited	
Animation on website bothers	
To learn something new, I must do it over and over	
Cannot understand the meaning of the icons	
After searching I forget which results, I have already looked at	
Do not understand the input fields	
Do not know how to sign up	
Cannot understand the categories	
Getting lost on the website	

Figure 65: Task scenarios for accessibility overlays

Task scenarios
For accessibility
overlays

Please open the following link:

https://data.unicef.org/

Task 1:
You want to read the articles on this UNICEF page.
Before reading you want to:
1. Change the size of the fonts on this page,
2. Change the background to a darker color.

Expectation: The user can find the controls and change the color and contrast that fits him/her.

Task 2:
You want to find out what the controls on usability menu mean.

Goal: To find out if the users can find and understand the usability controls.

Please open the following link:

https://cnib.ca/en?region=on

Task 3:
You open CNIB website and want to read the news. When you find the news page, you want to change the color and font size, so you can read the content better.

Expectation: User finds the page and changes the color and font size.

Goal: To find out if the users can find and understand the usability controls.

Task 4:
You want to reset all the changes you made (font size and color).

Expectation: User can reset the preferences.

Goal: To find out if the users can find and understand the usability controls.

Figure 66: Home page of Digio website (a)

Figure 67: Home page of Digio website (b)

Figure 68: Sign in page on Digio website
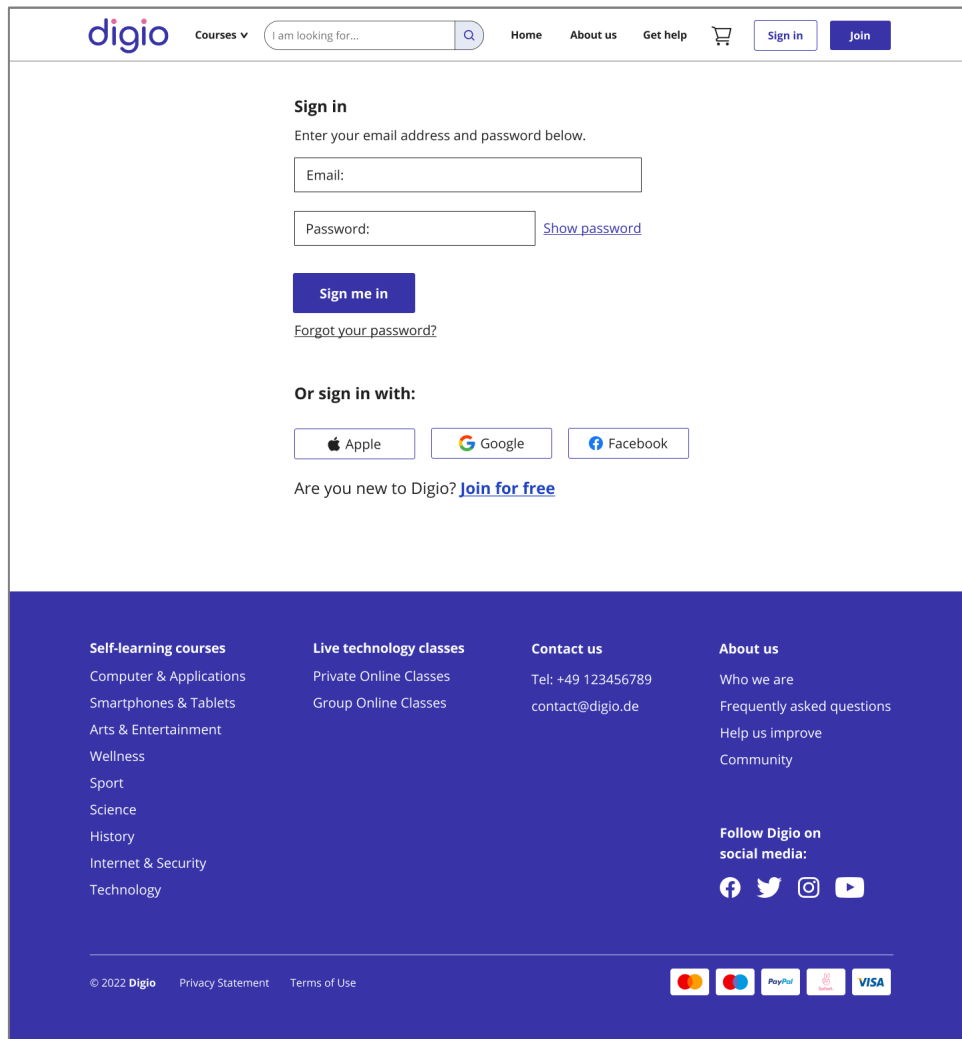
Figure 69: Join page on Digio website
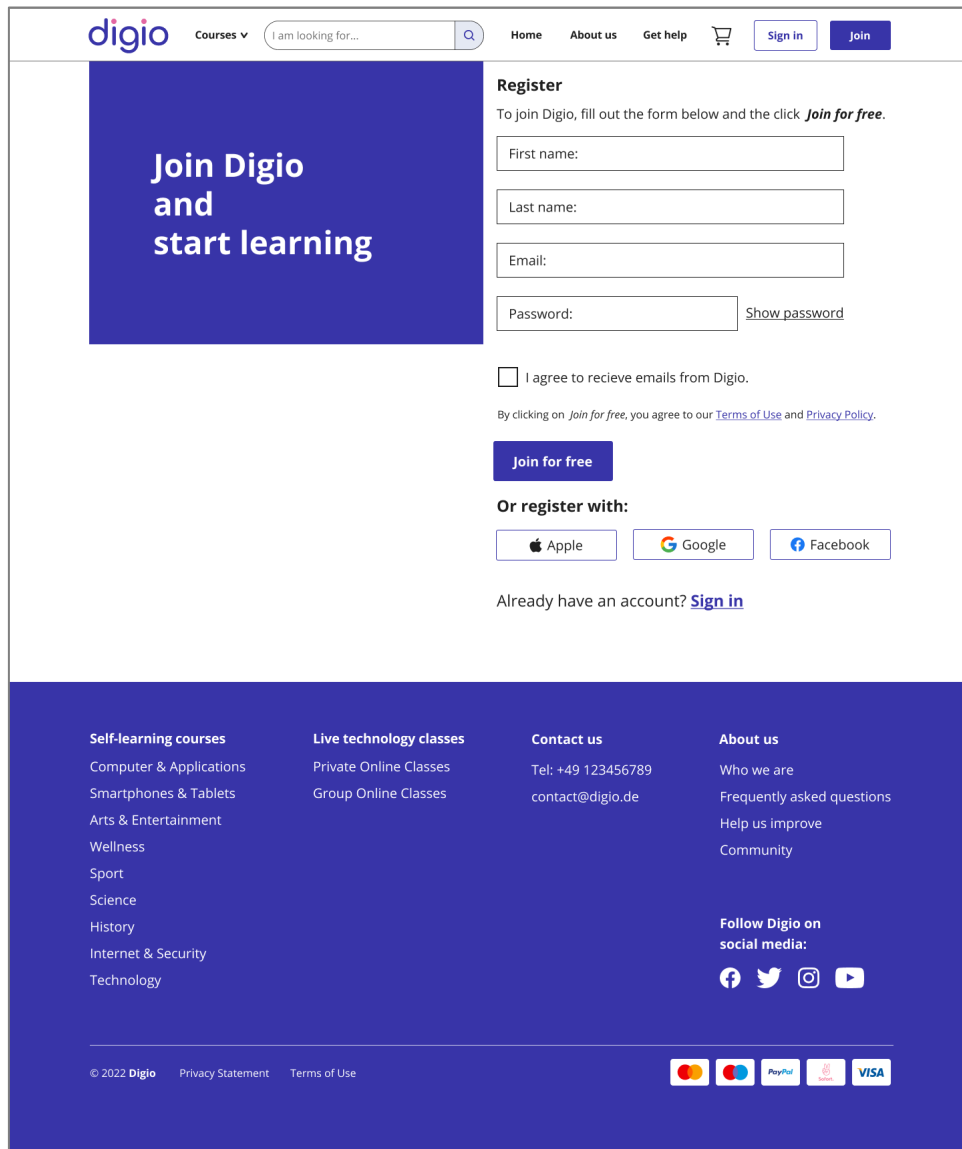
Figure 70: Course category (Smartphones and Tablets) page on Digio website

Figure 71: Course page (3. WhatsApp profile setup) of Digio website with white background

Figure 72: Course page (3. WhatsApp profile setup) of Digio website with dark background

HoME HOCHSCHULE MERSEBURG University of Applied Sciences

Moderator script
Usability test

digio

The total duration of each session is about one hour, including:

- Welcome and pre-test questionnaire: 10 minutes
- Task scenarios: 35 minutes
- Interview: 10 minutes

Test procedure

The test will begin with an overview briefing, followed by the two pre-test questionnaires, scenarios, post-task questionnaires, and interviews.

Introduction to participant

Hi! Welcome to the usability test. Thank you so much for your participation. Your participation will help our team and our cooperation partner to get a lot of useful feedback to improve the website you will be working with today. My name is Shiva and will guide you through the test.

Video recording

We will be video recording this session. The reason of the recording is so that we can review the session if we have any questions. Here is a permission form that you allow us to record this session. Are you comfortable with signing this form? (If yes, give them the form/ the link to sign).

☐ Video recording permission form

Pre-test Questionnaire

(For remote tests) To begin I would like you to open the link with the title "Pre-test Questionnaire" answer the questions. It will help us understand your experience better. If you have any questions, just let me know.

☐ Pre-test Questionnaire

Introduction to the test

Before we start the usability test, I would like to give you a brief information about the test. Today you will be working with the "Digio" website. I will give you some task scenarios and at the end, I will ask you some questions to get your feedback.

(For remote tests) I will send you two links. Please open them.

☐ The link to the task scenarios ☐ The link to the Digio website

During the test, I would like you to think out loud and tell me what you are doing and why are you doing it. You may say something like, "I will click here to see…", "I don't like…", or "I like this…". Remember we are testing the website; we are not testing you. There is no right or wrong action or answer. If a task is difficult, we need to know it so we can make better designs that are easier to use. Please let me know when anything comes in your mind, whether it's positive or negative. All your feedback will be helpful to us.

When you are done with a task scenario, please inform me when you are done with the task.

If at any time you feel you need help, just let me know.

The test will take about 35 minutes.

Post-task questionnaire

That was great, thank you! Before going to the next scenario, please (for remote tests) go to the scenarios link and answer these questions.

☐ post-task questionnaires

Interviews

Your feedback and answers will help us a lot. I would like you to answer some questions.

Questions about course page:

1. Could you tell me, what other options you see on the right side of this page?
2. Is there anything that you disliked about the design of this page?

Questions about home page:

3. (On home page) Do you find the interface easy to understand?
4. Do you find the texts easy to read?
5. Could you show me which parts of this page are links and clickable?
6. Would you change the font size, contrast, or background color if there was an option like on the course page?

7. *(if the user did not use the "Back To Top Button"):* How would you scroll back to the top of the page? *(if they don't say BTT:* What other options do you see on this page that could quickly take you back to the top of the page?
8. On this page (Course page), could you tell me how would you use the filters?

Closing Interview:

1. If you could change one thing about the design, what would it be and why?
2. Did you have confidence as you were working with the website?

After the test

That was great. Thank you for your participation. We learned a lot from you today.

Pre-test Questionnaire

Thank you for taking the time to participate in our usability test. Your participation will provide valuable feedback about your experience using an educational website.

Before we begin, we would like you to fill out this brief questionnaire so that we will have more information about your experience using the Internet and, more specifically, about your experience learning new topics online.

* Required

1. Your age: *

   _____

2. Your gender: *

   Mark only one oval.

   ◯ Male

   ◯ Female

   ◯ Non-Binary

3. What's your highest level of education? *

   _____

4. Have you ever participated in a usability test? *

   Mark only one oval.

   ◯ Yes

   ◯ No

5. How much time do you spend online every day?

   Mark only one oval.

   ◯ 10 to 30 minutes

   ◯ 1 to 2 hours

   ◯ 3 to 4 hours

   ◯ 5 hours or more

   ◯ I don't use internet every day.

6. What device do you usually use to access the Internet? *

   Check all that apply.

   ☐ Computer
   ☐ Laptop
   ☐ Tablet
   ☐ Mobile Phone

7. how would you rate your knowledge of using websites? *

   Mark only one oval.

   ◯ Non/low

   ◯ Basic

   ◯ Good

   ◯ Very Good

   ◯ Excellent

8. Which of the following best describes your vision? *

   Check all that apply.

   ☐ Well sighted
   ☐ Short sighted
   ☐ Long-sighted
   ☐ Low vision
   ☐ No vision

   Skip to question 9

Pre-test Questionnaire 2

9. Do you use internet to learn something new? *

Mark only one oval.

◯ Yes

◯ No

10. Do you use online education websites or apps? *

Mark only one oval.

◯ Yes

◯ No

11. Which of the following learning platforms do you know?

Check all that apply.

☐ Udemy
☐ LinkedIn Learning
☐ Skillshare
☐ Coursera
☐ I don't know any learning platform.
☐ Other: _____

12. What type of education do you prefer? Please choose the ones you prefer: *

Mark only one oval.

◯ Online

◯ Present

13.   What type of education do you prefer? Please choose the ones you prefer: *

Mark only one oval.

◯ Self-study

◯ Group-study

14.   What type of education do you prefer? Please choose the ones you prefer:

Mark only one oval.

◯ Learn with a teacher

◯ Learn by yourself

15.   Which type of content do you prefer in order to learn something new? (you can select more than one answer)

Check all that apply.

☐ Video
☐ Text
☐ Audio

16.   Could you explain why you prefer this content/ these contents?

_____

_____

_____

_____

_____

17.   When you want to read a book, which type of books do you prefer? *

Mark only one oval.

⬭ Physical books

⬭ eBooks

⬭ PDFs

18.   Please explain your answer (why did you choose that):

_____

_____

_____

_____

_____

19.   If you are searching for something on a website and encounter a problem and   *
       need assistance, how would you like to get help and contact customer service?

Mark only one oval.

⬭ By chat

⬭ Email

⬭ Telephone

20.   Have you heard about accessibility on websites or mobile phones? *

Mark only one oval.

⬭ Yes

⬭ No

21. Please explain briefly what you know about accessibility:

_____

_____

_____

_____

_____

22. Do you use accessibility options on your mobile phone or computer? *

Mark only one oval.

◯ Yes

◯ No

◯ I don't use it, because I don't know where to find it.

23. If yes, which options do you usually use?

_____

_____

_____

_____

_____

Task scenario

Scenario 1:
You want to learn more about computers and smartphones. One of your friends has recommended the learning platform "www.digio.com" to you. You open the homepage of this website to see what kind of website it is. Take a moment to look at the home page without clicking on anything. Please scroll down to the bottom of the page.

Once you have seen the page, answer the following questions:

1. what type of courses are offered on this site?

2. do they offer online courses with a personal teacher?

1.   Please rate the following:

Check all that apply.

	Very Easy	Easy	Neither Easy nor Difficult	Somewhat Difficult	Very Difficult
Understanding the website was	☐	☐	☐	☐	☐

Scenario 2:
You have found a course on digio's website that you would like to learn, but you don't have an account yet, so you would like to create one. How would you do that?

2.   Please rate the following:

Check all that apply.

	Very Easy	Easy	Neither Easy nor Difficult	Somewhat Difficult	Very Difficult
Creating an account was	☐	☐	☐	☐	☐
Understanding the input fields was	☐	☐	☐	☐	☐

Scenario 3:

Your friends sometimes call you on WhatsApp, but you don't know how to add new contacts and how to call them back on WhatsApp using your smartphone. You check out the homepage of this website to find out if this website offers any course about this.

After you complete this scenario, let me know you are done.

3. Please rate the following:

Check all that apply.

	Very Easy	Easy	Neither Easy nor Difficult	Somewhat Difficult	Very Difficult
Fining the course was	☐	☐	☐	☐	☐

Scenario 4:

You have found the course "How to use WhatsApp". Take a moment and look at this page to get familiarize with it.

After you have familiarized yourself with the page, tell me what you see on the left side of the page (What options are there?)

4. Please rate the following:

Check all that apply.

	Very Easy	Easy	Neither Easy nor Difficult	Somewhat Difficult	Very Difficult
Understanding the "Content" is	☐	☐	☐	☐	☐
Understanding the "Notebook" is	☐	☐	☐	☐	☐
Understanding the "Q&A" is	☐	☐	☐	☐	☐

Scenario 5:

On this page you have seen the third video, "Set up WhatsApp profile". Now you want to read the course text below this video. The white background and font size bother you and you wonder if you can change the background color to a darker color and make the font size bigger so you can read the text better. See if there are ways to do this.

5.   Please rate the following:

Check all that apply.

	Very Easy	Easy	Neither Easy nor Difficult	Somewhat Difficult	Very Difficult
Changing the Background color was	☐	☐	☐	☐	☐
Changing the font size	☐	☐	☐	☐	☐

Scenario 6:

You prefer to read the course text on paper. On this page , find an option to print the text.

6.   Please rate the following:

Check all that apply.

	Very Easy	Easy	Neither Easy nor Difficult	Somewhat Difficult	Very Difficult
Printing the page was	☐	☐	☐	☐	☐

Scenario 02:

Participant	Comments
P01	"I don't like to join a website! They all have different policy and I don't like to read all their rules, because usually, I don't understand them. The texts are always complicated. If they show and explain how I can join the website in a video, and they explain in that video what terms of use they have, maybe I will be convinced and join their webpage. Now I prefer to learn new thing with YouTube, without an account."
P02	"The joining process is easy. I personally prefer to always register with my Facebook account. I find it great that you have placed this option here."
P03	"I don't know how to do it"
	"If I find nothing in the search bar, I will look in the frequently asked questions and if I still do not find it I will contact the customer service"
	"Join means I already have an account"
	"I know if I click here, I can sign in with an account, usually on sign in page, they write if you don't have an account click here. So I will click on this button."
	"I believe if I click here (on join free link), I can then create an account."
P04	"There is no sign-up button. How can I create an account?"
	"I can only click on sign in."
	"I believe you can remove the "me" on sign me in button."

Scenario 04:

Participant	Comments
P01	"On the right here, are the name of the courses. On the left, I'm not sure. Maybe this is the time that we need to learn the course."
	"We can click here, because the cursor turns into a hand."
	"I don't know what the Notebook does."
	"I prefer to write my notes on a piece of paper. I find writing with a pen much easier."
	"Under Q&A I will write my question if I have one."
P02	
P03	"Under the Q&A I can type my questions about the course or other questions, when I have a problem. "

Scenario 05:

Participant	Comments
P01	"I don't see any options to change the background."
	"Maybe if I click here (on style text), I can change the font size."
	"Aha! I can change the background also here under the style text tab."
	"I like the white background better."
P02	"I don't like the beige background. I prefer the white one."
P03	**"I can read easily with all the (background) colors."**
P04	**"There are not options to change the background."**
	"I don't understand what the style text (tab) means."
	"I don't know what the Read aloud button means."
P05	"I don't see any option for background, but maybe this button (Style text) will change it."

Scenario 06:

Participant	Comments
P01	"I know how to print with my web browser."
P02	"I use Ctrl+P, when I want to print something."

Interview:

Question 01:

Participant	Comments
P01	"This is a speaker. We can use it to turn the volume up and down."
P02	"It will read the text aloud."
P04	"I don't know what will happen if I click on the read aloud text, can I click on it?"

Question 02:

Participant	Comments
P01	"No, I just suggest changing the tabs, making them more understand-able."
P03	"No, I like the design."
P05	"It's better to separate the background and text style buttons. That way they are more understandable."

Question 03:

Participant	Comments
P04	"Why can't I click on this button?"
P05	"I like the design and it's completely clear and understandable."

Question 04:

Participant	Comments
P01	"Yes, I don't need to wear my glasses!"
P05	"Yes, I can read everything without my glasses. The small texts and large texts are easy to read."

Closing Interview:

Question 01:

Participant	Comments
P01	"I would add more videos instead of the texts. When I want to learn something, I prefer to watch it not read it."
P02	"Most of the pictures show old people with white hair. I don't like that. It would be better if you use younger people in pictures."

Question 02:

Participant	Comments
P01	"Yes, I had confidence. Your website it understandable, I just don't have the patient to read everything. If I want to learn something and I watch a video about it, I can see what the instructor is teaching, and I can be sure that I am doing the right thing. "
P02	"Yes, I did. Working with the website was easy."
P03	" Yes, except for when I wanted to create an account. It was hard for me to find the way."

Bibliography

Loranger , H. (2015, March 8). *Beyond Blue Links: Making Clickable Elements Recognizable.* Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/clickable-elements/

Alexiou, G. (2021, July 20). *Understanding The Specific Web Accessibility Requirements Of Older 'Silver Surfers'.* Retrieved from Forbes Website: https://www.forbes.com/sites/gusalexiou/2021/07/20/understanding-the-specific-web-accessibility-requirements-of-older-silver-surfers/

Alexiou, G. (2021, Juli 20). *Understanding The Specific Web Accessibility Requirements Of Older 'Silver Surfers'.* Retrieved from Forbes Website: https://www.forbes.com/sites/gusalexiou/2021/07/20/understanding-the-specific-web-accessibility-requirements-of-older-silver-surfers/

Ann Becker, S. (2004). *A Study of Web Usability for Older Adults.* Florida Institute of Technology.

Arch , A., & Abou-Zhara, S. (2004). *How Web Accessibility Guidelines Apply to Design for the Ageing Population.* Sophia Antipolis cedex: World Wide Web Consortium.

Arch, A., & Abou-Zahra, S. (n.d.). Retrieved from https://www.w3.org/WAI/older-users/developing/#p

Arch, A., & Abou-Zahra, S. (2018, January). *Developing Websites for Older People.* Retrieved from W3C: https://www.w3.org/WAI/older-users/developing/#p

Arch, A., & Abou-Zhara, S. (2004). *How Web Accessibility Guidelines Apply to Design for the Ageing Population.* France: World Wide Web Consortium.

Babich, N. (2020, March 12). *Best Practices for Form Design: Structure, Inputs, Labels and Actions.* Retrieved from Adobe Website: https://xd.adobe.com/ideas/principles/web-design/best-practices-form-design/

Barnum, C. M. (2011). *Usability Testing Essentials.* Massachusetts: Morgan Kaufmann.

Baumeister, M. (2020). Retrieved from UNSPLASH: https://unsplash.com/photos/uKdkh25_wc0

Beisch, N., & Schäfer, C. (2020). *Internetnutzung mit großer Dynamik: Medien, Kommunikation, Social Media.* Retrieved from ARD-Werbung SALES & SERVICES Website: https://www.ard-werbung.de/media-perspektiven/fachzeitschrift/2020/detailseite-2020/internetnutzung-mit-grosser-dynamik-medien-kommunikation-social-media/

Bradley, S. (2011, March 7). *What Designers Should Know About Visual Perception and Memory.* Retrieved from Vanseodesign Website: http://vanseodesign.com/web-design/visual-perception-memory/

Brown, T. (2009). *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation Introduction.* California: Harper Collins E-books.

Budiu, R. (2020, February 2). *Dark Mode vs. Light Mode: Which Is Better?* Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/dark-mode/

Budiu, R. (2022, July 31). *Fitts's Law and Its Applications in UX*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/fitts-law/

Bundesamt für Justiz. (2011). *Barrierefreie-Informationstechnik-Verordnung - BITV 2.0.* Retrieved from Gesetze im Internet: https://www.gesetze-im-internet.de/bitv_2_0/BJNR184300011.html

Carmien, S., & Garzo, A. (2014). *Elders Using Smartphones – A Set of Research Based Heuristic Guidelines for.* Greece: In: Proceedings of the 8th International Conference, UAHCI '14, Held as Part of the HCI International.

Center for Universal Design. (2011). *What is Universal Design*. Retrieved from Universaldesign Website: http://universaldesign.ie/what-is-universal-design/

d.school at Stanford University. (2018). *Design thinking bootleg.* California: Institute of Design at Stanford .

Deque. (n.d.). *Web Content Accessibility Guidelines (WCAG) Conformance*. Retrieved from Deque Website: https://www.deque.com/wcag/

Dickinson, A. A. (2007). *Methods for human – computer interaction research with older people. Behaviour & Information Technology 26 (4), 343–352.*

Digitales Dorf. (2020). *Digital fit im Alter.* Fraunhofer –Institut für Integrierte Schaltungen IIS.

Egelman, S. S. (2013). *Does my password go up to eleven? The impact of password meters on password selection.* ACM, New York, NY, USA, 2379-2388.: In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13).

Eisma, R., Goodman-Deane, J., Mival, O., & Jane Syme, A. (2003).

European Telecommunications Standards Institute. (2021). Accessibility requirements for ICT products and services. 45.

European Union. (2022). *Web accessibility initiative: ageing education and harmonisation*. Retrieved from CORDIS, European Commission Website: https://cordis.europa.eu/project/id/035015

Eurostat. (2021, 05 17). *How popular is internet use among older people?* Retrieved from Eurostat Website: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20210517-1

Fairweather, P. (2008). *How older and younger adults differ in their approach to problem solving on a complex website.* Nova Scotia.: Conference: the 10th international ACM SIGACCESS conference.

Gibbons, S. (2018, December 9). *Journey Mapping 101*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/journey-mapping-101/

Google . (2018). *Buttons*. Retrieved from Material Design Website: https://material.io/components/buttons#usage

Gordon, K. (2020, March 1). *5 Principles of Visual Design in UX*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/principles-visual-design/

Hawthorn, D. (2006, January). *Designing Effective Interfaces for Older Users.* Retrieved from Researchgate Website: https://www.researchgate.net/publication/33052467_Designing_Effective_Interfaces_for_Older_Users

IDEO. (2015). *The Field Guide to Human-Centered Design.* San Francisco: IDEO.org.

IDEO.org. (2015). *The Field Guide to Human-Centered Design.* San Francisco: IDEO.org.

Interaction Design Foundation . (2016). *A Mix Between Video-Based and Text-Based Lesson Content*. Retrieved from Interaction Design Foundation Webstei: https://www.interaction-design.org/literature/article/a-mix-between-video-based-and-text-based-lesson-content

Interaction Design Foundation. (2020). *Accessibility*. Retrieved from Interaction Design Foundation Website: https://www.interaction-design.org/literature/topics/accessibility

Interaction design foundation. (2020). *User Experience (UX) Design*. Retrieved from Interaction Design Foundation Website: https://www.interaction-design.org/literature/topics/ux-design

Interaction design foundation. (2022). *Design Thinking: The Beginner's Guide*. Retrieved from Interaction Design Foundation Website: https://www.interaction-design.org/courses/design-thinking-the-beginner-s-guide

Interaction design foundation. (n.d.). *Fitts' Law*. Retrieved from Interaction Design Foundation Website: https://www.interaction-design.org/literature/topics/fitts-law#:~:text=Fitts'%20law%20states%20that%20the,size%2C%20the%20longer%20it%20takes.

ISO. (2019). *Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems*. Retrieved from ISO Website: https://www.iso.org/obp/ui/#iso:std:iso:9241:-210:ed-2:v1:en

Jakob Nielson, T. K. (1993). *A mathematical model of the finding of usability problems.* Morristiwn, NJ.

Johnson, J. (2014). *Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules, second ed. .* Morgan Kaufmann Publishers, Waltham, MA.

Johnson, J., & Finn, K. (2017). *Designing User Interfaces for an Aging Population, Towards Universal Design.* Todd Green.

Jordan, B. (2020). Retrieved from UNSPLASH: https://unsplash.com/photos/xsszsCvIrw8

Kamiya, Y., Mun Sim Lai, N., & Schmid, K. (2020). *World Population Ageing 2020.* United Nations Department of Economic and Social Affairs, Population Division.

Kane, L. (2019, September 8). *Usability for Seniors: Challenges and Changes.* Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/usability-for-senior-citizens/

Keates, S. a. (2005). *Effect of age and Parkinson's disease on cursor positioning using a mouse. Proceedings of ASSETS 2005: 7th International ACM SIGACCESS Conference on Computers and Accessibility, Baltimore, MD, USA, pp 68-75. ACM Press .*

Keohane, S. (2017, June 6). *Accessible Design for an Aging Population.* Retrieved from IBM Website: https://www.ibm.com/blogs/age-and-ability/2017/06/06/accessible-design-aging-population/

Keohane, S. (2017). *Accessible Design for an Aging Population.* Retrieved from IBM Website: https://www.ibm.com/blogs/age-and-ability/2017/06/06/accessible-design-aging-population/

Krause, R. (2019, February 3). *How to Report Errors in Forms: 10 Design Guidelines.* Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/errors-forms-design-guidelines/

Laubheimer, P. (2018, December 23). *Breadcrumbs: 11 Design Guidelines for Desktop and Mobile.* Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/breadcrumbs/

liu, T. (2019). *5 Best Tips on How Using White Space in Design to Improve Better UX.* Retrieved from UXplanet Website: https://uxplanet.org/5-best-tips-on-how-using-white-space-in-design-to-improve-better-ux-6c5e6cdac7c4

Loranger, H. (2017, August 27). *Back-to-Top Button Design Guidelines.* Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/back-to-top/

Loranger, H. (2017, July 23). *Homepage Links Remain a Necessity.* Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/homepage-links/

Mariano, J., Marques, S., R. Ramos, M., Gerardo, F., & de Vries, H. (2020). *Too Old for Computers? The Longitudinal Relationship Between Stereotype Threat and Computer Use by Older Adults.*

Neilpatel. (2020). *Wie man die perfekte Handlungsaufforderung (Call-to-Action) erstellt.* Retrieved from Neilpatel Website: https://neilpatel.com/de/blog/wie-man-die-perfekte-handlungsaufforderung-call-to-action-kreiert/

Nielsen , J. (1994). *How to Conduct a Heuristic Evaluation*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/how-to-conduct-a-heuristic-evaluation/

Nielsen , J. (2008, March 30). *Middle-Aged Users' Declining Web Performance*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/middle-aged-web-users/

Nielsen Norman Group. (2021). *UX Design for Seniors (Ages 65 and older), 3rd Edition.* Nielsen Norman Group.

Nielsen, J. (1993). *Usability Engineering.* Morgan Kaufmann.

Nielsen, J. (2000, March 18). *Why You Only Need to Test with 5 Users*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/

Nielsen, J. (2001, May 12). *Search: Visible and Simple*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/search-visible-and-simple/

Nielsen, J. (2002, August 18). *Let Users Control Font Size*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/let-users-control-font-size/

Nielsen, J. (2013, May 28). *Usability for Senior Citizens: Improved, But Still Lacking*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/usability-seniors-improvements/

Nielsen, J. (2016, July 9). *Tabs, Used Right*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/tabs-used-right/

Nimrod, G. (2018). *Technophobia among older Internet users.* EducationalGerontology.

Owsley, C., Sekuler, R., & Siemsen, D. (1983). *Contrast sensitivity throughout adulthood. Vision Research 23 (7) 689–699.* Elsevier Ltd.

Pernice, K., & Nielsen, J. (2020). *senior-citizens-on-the-web*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/reports/senior-citizens-on-the-web/

Rae, M. (2020, June 12). *Designing States for Buttons & UI Interactions*. Retrieved from Adobe XD Website: https://xd.adobe.com/ideas/process/ui-design/designing-interactive-buttons-states/

Rubin, J., Chisnell, D., & Spool, J. (2008). *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests, Second Edition.* indianapolis: Wiley.

Shadeed, A. (2019). *Enhancing The Clickable Area Size*. Retrieved from Ishadeed Website: https://ishadeed.com/article/clickable-area/

Shankar, N. (2017, July 12). *Designing for accessibility, step 1: Color contrast*. Retrieved from Uxdesign Website: https://uxdesign.cc/the-easiest-part-about-designing-accessible-websites-76cd6b9a7ae4

Sherwin , K. (2014, April 27). *Beware Horizontal Scrolling and Mimicking Swipe on Desktop*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/horizontal-scrolling/

Sherwin, K. (2014, February 23). *The Magnifying-Glass Icon in Search Design: Pros and Cons*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/magnifying-glass-icon/

Sherwin, K. (2015, April 26). *Password Creation: 3 Ways To Make It Easier*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/password-creation/

Sherwin, K. (2018, Sep. 10). *Placeholders in Form Fields Are Harmful*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/form-design-placeholders/

Southern, L. (2020). Retrieved from UNSPLASH: https://unsplash.com/photos/9yCYGgPe5Kg

Statistisches Bundesamt. (2021). *Internetnutzung von Personen nach Altersgruppen in %*. Retrieved from Destatis Website: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Einkommen-Konsum-Lebensbedingungen/_Grafik/_Interaktiv/it-nutzung-alter.html;jsessionid=99AC59229B908FFBEA48D5B6EE2DC50D.live741

Trzepla, S. (2019, July 28). *UX accessibility for elderly — 12 principles*. Retrieved from Uxplanet Website: https://uxplanet.org/ux-accessibility-for-elderly-12-principles-9708289b6f78

United Nations. (2007). *Article 9 – Accessibility*. Retrieved from UN Website: https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities/article-9-accessibility.html

W3C. (2022). *Ensuring that the Web Page contains another CAPTCHA serving the same purpose using a different modality*. Retrieved from World Wide Web Consortium Website: https://www.w3.org/WAI/WCAG21/Techniques/general/G144.html

W3C. (2022). *G194: Providing spell checking and suggestions for text input*. Retrieved from World Wide Web Consortium Website: https://www.w3.org/TR/WCAG20-TECHS/G194

W3C. (2022). *Introduction to Understanding WCAG*. Retrieved from W3C Website: https://www.w3.org/WAI/WCAG21/Understanding/intro

W3C. (2022). *Providing a text alternative that describes the purpose of the CAPTCHA*. Retrieved from World Wide Web Consortium Website: https://www.w3.org/WAI/WCAG21/Techniques/general/G143.html

W3C. (2022). *Understanding Success Criterion 2.2.2: Pause, Stop, Hide*. Retrieved from World Wide Web Consortium Website: https://www.w3.org/WAI/WCAG21/Understanding/pause-stop-hide.html

W3C. (2022, June 30). *WCAG 2*. Retrieved from World Wide Web Consortium Website: https://www.w3.org/WAI/standards-guidelines/wcag/

WCAG. (2022). *Understanding Success Criterion 1.4.12: Text Spacing*. Retrieved from World Wide Web Consortium Website: https://www.w3.org/WAI/WCAG21/Understanding/text-spacing

Whitenton, K. (2016 a, July 10). *Centered Logos Hurt Website Navigation*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/centered-logos/

Whitenton, K. (2016 b, February 21). *Website Logo Placement for Maximum Brand Recall*. Retrieved from Nielsen Norman Group Website: https://www.nngroup.com/articles/logo-placement-brand-recall/

Wilhelm, S., Jakob, D., & Dietmeier, M. (2019). *Development of a senior-friendly training concept for imparting media literacy.* Bonn.

World Wide Web Consortium. (n.d.). *ACCESSIBILITY*. Retrieved from World Wide Web Consortium Website: https://www.w3.org/standards/webdesign/accessibility

Y. Tony Yang, B. K. (2015). *Web Accessibility for Older Adults: A Comparative Analysis of Disability Laws.* Advance Access publication.

YouGov, Texthelp. (2021, July 20). *Improving Online Accessibility for the older web user.* UK. Retrieved from www.forbes.com: https://www.forbes.com/sites/gusalexiou/2021/07/20/understanding-the-specific-web-accessibility-requirements-of-older-silver-surfers/

Zakharenkov, A. (2020, October 12). *Choosing the Right Font and Its Presentation: A Key to ADA Accessible Websites*. Retrieved from Pixelplex Website: https://pixelplex.io/blog/choosing-the-right-font-and-its-presentation/

Zheng, R. (2021). *Learn to Create Accessible Websites with the Principles of Universal Design*. Retrieved from Interaction Design Foundation Website: https://www.interaction-design.org/literature/article/learn-to-create-accessible-websites-with-the-principles-of-universal-design

Reference of the images used on the Digio website

Azabache, A. (n.d.). Retrieved from https://www.pexels.com/de-de/foto/foto-der-pyramide-wahrend-des-tages-3185480/

Baumeister, M. (2020). Retrieved from UNSPLASH: https://unsplash.com/photos/uKdkh25_wc0

benzoix. (n.d.). Retrieved from https://www.freepik.com/free-photo/ecommerce-concept-smiling-asian-senior-woman-showing-blank-laptop-screen-looking-happy-demonstra_19032937.htm#page=2&query=elderly%20computer%20happy&position=9&from_view=search

benzoix. (n.d.). Retrieved from https://www.freepik.com/free-photo/senior-asian-woman-working-freelance-using-laptop-smiling-standing-white-background_19032821.htm#page=2&query=elderly%20computer%20happy&position=7&from_view=search

DCStudio. (n.d.). Retrieved from https://www.freepik.com/free-photo/invalid-man-wife-saying-hello-their-family-disabled-senior-man-wheelchair-his-wife-having-video-conference-laptop-kitchen-paralyzed-old-man-his-wife-having-online-confere_17146680.htm#page=2&query=elderly%20computer%20ha

freepik. (n.d.). Retrieved from https://www.freepik.com/free-photo/top-view-man-checking-his-smartphone_9670192.htm#page=8&query=technology&position=26&from_view=search

freepik. (n.d.). Retrieved from https://www.freepik.com/free-photo/older-woman-talking-her-friends-through-video-call_14601089.htm#query=online%20call%20older%20people&position=26&from_view=search

freepik. (n.d.). Retrieved from https://www.freepik.com/free-photo/close-up-senior-person-while-learning_17666767.htm#page=3&query=online%20classes%20senior&position=6&from_view=search

gpointstudio. (n.d.). Retrieved from https://www.freepik.com/free-photo/happy-grandparents-using-their-digital-laptop_13188151.htm?query=elderly&collectionId=1666&&position=36&from_view=collections

Jordan, B. (2020). Retrieved from UNSPLASH: https://unsplash.com/photos/xsszsCvIrw8

Khongchum, C. (n.d.). Retrieved from https://www.pexels.com/de-de/foto/flachfokus-fotografie-des-mikroskops-2280547/

Pixabay. (n.d.). Retrieved from https://www.pexels.com/de-de/foto/sicherheitslogo-60504/

pressfoto. (n.d.). Retrieved from https://www.freepik.com/free-photo/modern-seniors-taking-picture-themselves_5399108.htm#query=gathering%20elderly&position=1&from_view=search

shurkin_son. (n.d.). Retrieved from https://www.freepik.com/free-photo/aged-people-electronic-gadgets-lifestyle-concept-portrait-excited-female-retirement-shopping-online-using-laptop-elderly-woman-having-happy-look-because-she-finally-paid-off-all-her-debts_11200023.htm#page=3&query=elderl

Southern, L. (2020). Retrieved from UNSPLASH: https://unsplash.com/photos/9yCYGgPe5Kg

UNSPLASH. (2021). Retrieved from https://unsplash.com/photos/31OdWLEQ-78

Ushakova, V. (n.d.). Retrieved from https://www.pexels.com/de-de/foto/frauenmalerei-3094218/

Affidavit

I hereby confirm that my thesis entitled Designing an accessible website for older adults with consideration of visual perception is the result of my own work. I did not receive any help or support from commercial consultants. All sources and materials applied are listed and specified in the thesis.

Place and date:
Berlin, 15.08.2022

Signature: