User Interface for e-learning Platform for Users with Disability

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Abstract. Persons with disabilities used to face discrimination and barriers that restricted them from participating in society on an equal basis with others. In recent years, there has been a revolutionary change in the approach to bridge the gap of discrimination and ensure that persons with disabilities enjoy the same standards of equality, rights and dignity as everyone else. This paper summarizes one attempt to improve the right of learning for the people with disabilities by offering them a way of learning how to improve their health. We put our focus on visual disability, hearing disability and cognitive or learning disabilities from a functional point of view. The research was performed in order to create a user-friendly working environment for each type of disability by establishing an e-learning platform for the users to broaden their knowledge on specific health issues. At the first stage, several topics were considered, such as high blood pressure, diabetes and good nutrition for a healthier life. The user interface for the e-learning platform is created using the principles of human-computer interaction (HCI) which encompasses computer science, human factors engineering and cognitive science as a broad multidisciplinary field, which overlaps with areas such as user-centered design (UCD), user interface (UI) design, and user experience (UX) design.

Keywords: user interface, e-Learning platform, human-computer interaction, people with disabilities, WCAG, e-Health, digital literacy, health literacy.

1. Introduction

One responsibility of every society is to create an environment that provides equal access to all aspects of life for everyone, including formal and informal education. The ambition to include people with disabilities in society is manifested in the UN-declaration of human rights and the international and national legislation [1].

Nowadays, the Web is an important resource in many aspects of life such as education, government, commerce, healthcare, entertainment and much

more domains. More specifically, the Web thoroughly has changed the process of gaining information, knowledge and the learning process. The Web must be accessible to provide equal access and equal opportunity to people with diverse abilities. The access to information and communications technologies is a basic human right in the UN CRPD (United Nations Convention on the Rights of Persons with Disabilities).

Web accessibility conjures the vision of designers, technologists and researchers valiantly making the World Wide Web (Web) open to disabled users. [2] Tim Berners-Lee, W3C Director and inventor of the World Wide Web has emphasized, "The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect."

The Web accessibility conducts to wider Web usability and universal accessibility. From the Web accessibility organizations, even people without disabilities can benefit, not just those with disabilities. Web accessibility encompasses all disabilities that affect access to the Web, including physical, auditory, visual, speech, intellectual, emotional, social, different age-related impairments etc. The web accessibility depends on several components working together, including Web technologies, Web browsers, websites and other tools.

The W3C Web Accessibility Initiative (WAI) develops technical specifications, guidelines, techniques, and supporting resources that describe accessibility solutions, access to information and knowledge through the Internet. These are considered international. The WCAG 2.0 standards with success criteria from Level AA and Level AAA are ISO standards.

To achieve Web accessibility, applications, Web sites and contents must be heterogenic, flexible and device independent. This is very difficult and challenging and needs a high level of experience and expertise from developers and organizations. Although, accessibility solutions are easy to understand and implement most of the accessibility solutions are more complex and take more knowledge to implement.

Cinquin et al. have shown that there is a lack of use of accessibility and special education references in the design process, particularly on specific neuropsychological disorders or syndromes [14].

Web accessibility encompasses many aspects such as legal, ethical, technical and social. Persons with disabilities encounter barriers when using the Web. The criteria for ensuring equal accessibility for disabled users should be that the individual is able to use (navigate and interact) the web content as the web site creator envisaged [13].

This paper gives an overview of several 'larger–scale' usability issues faced by every Web user and even solve some of them. Indeed, by understanding disabled–users' interaction, we enhance our understending of all users operating in constrained modalities where the user is disabled by both environment and

technology [2].

The rest of the paper is organized as follows: the second section depicts the background behind visual, hearing and cognitive or learning disabilities and the Web; in Section 3, we describe the components of Web Accessibility. The accessibility tools and techniques and the UI prototype for e-health platform according to the WCAG 2.0 standards are tabled in the consequent section; the last section provides concluding remarks about UI for the e-learning platform for specific health issues for the users with disability.

2. Disability categories

Tabakovska et al. have referenced to the Disability Services Act (1993) which emphasizes that disability is any continuing condition that restricts everyday activities [3, 4]. In this paper, we accept the disability classification given by the International Classification of Functioning, Disability and Health (ICF), which breaks down disability into several broad sub-categories, including the following 8 main types of disability: mobility and physical impairments, spinal cord disability, head injuries (TBI)-brain disability, vision disability, hearing disability, cognitive or learning disabilities, psychological disorders and invisible disabilities. Many people with disabilities have a combination of these impairments. The most common types of disabilities are physical disorders. The reported cases of neurological, cognitive and intellectual disabilities are on the rise.

In this paper, we will be focusing on visual disability, hearing disability and cognitive or learning disabilities from a functional point of view.

Visual disability. Bad eyesight is common, and it is so easy to correct with glasses. Other categories of visual disabilities are not so easily corrected as is the case with no vision at all or in other words blindness. Legal blindness is commonly defined as a condition in which the best-corrected visual acuity is 20/200, or less, or the person's visual field is 20 degrees or less [5]. Several assistive technologies available for blinded people can help them compensate for their lack of vision. Blind people use screen readers and keyboards to access web content. This category of visual disability will not be reviewed in this paper.

Another category of visual disability is low vision. Low vision is defined as a condition in which a person's vision cannot be fully corrected by glasses, thus interfering with daily activities such as reading and driving. Low vision is a common condition among the elderly, but younger individuals may also have this disability, whether due to genetics, traumatic injuries, or illnesses [5]. Some types of low vision disabilities are macular degeneration, glaucoma, diabetic retinopathy and cataract.

A lot of technology is applied to help people with this category of vision

disability. The most common technology that people with low vision use is the screen magnifier - software program that zooms in on a small area of the screen, allowing people with low vision to see it more clearly. High contrast is another mechanism for improving web accessibility. There is no hard rule as to how much contrast is enough, it just needs to be used to the best judgment. Some color combinations such as blue text on black backgrounds, red text on green backgrounds, or other combinations that are not easy to read, need to be avoided. They are inappropriate colour combinations especially for people with low vision. The operating systems and/or browser settings give an opportunity for increasing the contrast of the text regarding the background (for instance black background with white or yellow text; white or yellow background with black text). The general Web design rule, especially for people with low vision, is to make everything configurable. The text should allow users to enlarge it, change its colour, and change the background colour. If the layout is in percentages, the screen can be widened or narrowed to meet the user's needs.

One more category of visual disability is colour-blindness. People with colour-blindness disability cannot perceive the difference between certain colour combinations. Although there are, only a few true limitations it is important to consider them when designing web content. When Web content is designed for colour-blind people, it is good, but not necessary to convert all images to black and white, except in the case where colours are the only method of conveying important information.

Hearing disability. Hearing disabilities come in several different types. Tinnitus, one of the hearing disabilities, involves hearing noise in one or both ears that is not caused by an external sound. The noise may vary in pitch from a low roar to a high squeal. Conductive hearing loss occurs when the passage of sound is blocked either in the ear canal or in the middle ear. It may be hard to hear soft sounds and louder sounds may be muffled. Sensorineural hearing loss results from loss of or damage to the tiny hair cells in the inner ear. The tiny hair cells transmit sound from the inner ear through the hearing nerve to the brain. The people with sensorineural hearing loss hear voices with more difficulty in places with background noise (as at parties, restaurants, family gatherings, etc.). They have problems to hear soft or high sounds such as the clock ticking or the birds singing. People with auditory processing disorder (APD) have a hard time hearing small sound differences in words. APD does not mean the hearing is lost, only the brain does not "hear" sounds in the usual way. It does not pose a problem in understanding the meaning. The most common way of quantifying hearing loss is the degree of loss in decibels (dB) from mild loss (25 to 40 dB) to profound loss (90 dB or greater). Another distinction is between pre-lingual (before spoken language acquisition) and post-lingual deafness (after spoken language acquisition) [6].

Current research on Web accessibility for people with hearing loss is focused on providing alternatives for auditory information using visual information like captions, transcripts, or sign language synthesis. Captions provide accessible text versions of video and audio in real-time. Captioning provides an alternative channel of information that may make content more understandable also for people with learning disabilities. Adding text to video and audio content makes it more searchable and indexable, which allows more people to discover and access those materials [6]. Several captioning and real-time transcription services can help to convert audio to text. While with sign language synthesis of written or spoken languages are converted to video sign language using human-like graphics.

Some web accessibility solutions are good for one type of hearing loss, but not for others. Increasing the volume of audio and video content is helpful for people with conductive hearing loss, but not for people with sensorineural hearing loss. For people with auditory disabilities, sign language is the primary language, and they may not fluently read the written language. In addition, not all people with auditory disabilities know sign language [7].

Due to the aforementioned, accessibility requirements for people with hearing loss can be synthesized in four recommendations: Provide video content with captioning; Provide alternative video content in sign language; Provide textual transcripts of audio content; Simplified textual content [8]. The multimedia on the Web provides many opportunities for people with auditory disabilities and helps overcome challenges when content is not designed to be accessible.

Cognitive or Learning disabilities. Cognitive disabilities affect the act of processing information such as remembering or reasoning, making it more difficult to process information in a recognized, meaningful way for the individual [9, 4]. Cognitive disabilities include all conditions or impairments that inhibit a person's mental process [10, 4] According to the Siteimprove team, cognitive disabilities may be classified in two ways, functional that includes memory, attention, math comprehension, verbal comprehension, visual comprehension, problem-solving, and clinical, which includes autism, traumatic brain injury, dementia, developmental disability, dyslexia, dyscalculia and learning disabilities in general. Clinical cognitive disorders are not the subject of this paper. Instead, we will only be focusing on cognitive disorders from a functional standpoint.

According to the WCAG 2.0 success criteria from level AA and level AAA, Tabakovska et al., have listed recommendations for web and application developers, which develop contents for people with cognitive disabilities. These recommendations include:

- all live video content should have captions; visual content should also be represented in words;
- the user should be allowed to take extra time to complete a task if required;

- if the content is flashing, moving or refreshing the user should be able to pause, stop or hide that content;
- there should be a clear description of the title of a web page or app screen;
- links should be descriptive and meaningful, avoiding phrases like 'click here' or 'read more';
- providing more than one way for people to find content; the language should be clearly defined so that speech recognition software interprets the page correctly;
- if the language changes, that change should be indicated; words that are not common or considered jargon should be specifically defined such as in a glossary;
- abbreviations should be clearly defined.

The information should be readable at a lower secondary level. The correct pronunciation should be indicated for difficult words. Unexpected shall happen when an element receives focus. Users should be able to select an option and then confirm rather than immediately taking them to their choice. The navigation of the website should be predictable and consistent. Language should be used consistently, e.g. not interchanging a full name with an acronym. Moreover, the user should know that an error has occurred; it should be clear what you want the user to enter; guidance should be provided to the user as to how they can fix their error; guidance should be provided on what type of information needs to be entered in the form [4].

Although these recommendations are mainly aimed at people with cognitive disabilities, they might as well benefit everyone.

3. Components of Web Accessibility

People with disabilities are faced with many challenges when accessing information and knowledge through the Internet. The term web accessibility addresses web site or e-learning content accessibility, which means that people with all disabilities (visual, auditory, physical, speech, cognitive, and neurological disabilities) can access information and knowledge through the Internet.

Several components of the web site or e-learning platforms are responsible for the web to be accessible to people with disabilities. These components are significant interdependencies and they must work together for the web to be accessible.

The central component is **content**. Two groups of people have an impact on web accessibility: Web **developers** provide the content and appropriate alternative way of text representation and **users** get and interact with the alternative text. The web developers usually use **authoring tools** (enable, facilitate, and promote providing alternative text) and **evaluation tools** (help to check that alternative text

exists) to create web **content.** The **users** use web **browsers (**provide information on the World Wide Web)**, assistive technologies (**device, software, or equipment that provide a human interface to the alternative text in various modalities)**,** or **user agents** (software which provide the alternative text) to get and interact with the **content**.

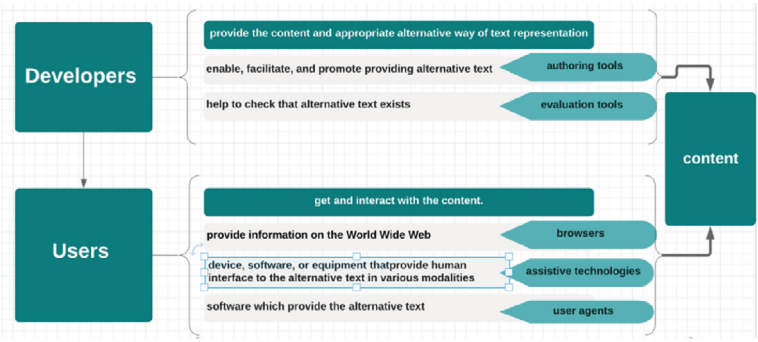

Figure 1. Components of Web accessibility.

If one component has poor accessibility support, other components need to compensate. This is hard and requires much more effort.

4. Accessibility tools and techniques

Nowadays, a lot of accessibility tools for developers are available. These tools automated the creation and editing of existing web pages to add accessibility content. Each tool targets different audiences/disability.

Three different tool sets can help improve web/app accessibility. The first two are developer oriented; they can assist the author in making the pages/app more accessible: evaluation tools and repair tools. The evaluation tools are used for automated testing, to perform automated analysis of pages and return a report or a rating. There are numerous automated accessibility-testing tools such as AChecker. WAVE, Tenor, aDesigner, CKEditor 4, aXe, audits, etc. [12]. Other two types of methods for web accessibility evaluation are manual inspection and user testing [12]. The third tool set is a filter and transformation tool, which assists Web users rather than authors to either modify a page or supplement an assistive technology or browser.

All of these testing tools can be employed in the process of accessibility improvement.

Traditionally accessibility has been most focused on the user interface and making that usable for people with impairments.

As one would accept, whenever a user interface is created, the principles

for user interface design need to be implemented. Galitz [16] emphasizes the most important principles for user interface design. Additionally, Bhaskar et all. in 2011 [15] derived a general principle as:

- **Aesthetic design** – a design composition is attractive to the eye;
- **Clarity** – the visual appearance of UI must be clear and elements should be understandable, relating to the user's real-world concepts and functions;
- **Consistency** – a system should look, act, and operate the same throughout (similar components should have a similar look and uses and operate similarly and that allows the user to develop general rules about how the interface works);
- **Comprehensibility** – a system should be understandable, flowing in a comprehensible and meaningful order;
- **Configurability** – easy personalization and customization through configuration and reconfiguration of a system enhances a sense of control, encourages an active role in understanding, and allows for personal preferences and differences in experience levels. It also leads to higher user satisfaction [16];
- **Responsiveness** – a user request must be responded quickly;
- **Simplicity** - provide as simple an interface as possible;
- **Groupings** – grouping screen elements aids in establishing structure, meaningful relationships and form;
- **Predictability** – predictability, reduces mistakes and enables tasks to be completed more quickly;
- **Forgiveness** – a system should tolerate mistakes that are common and unavoidable;
- **Flexibility** – the system is able to respond to individual people's needs;
- **Efficiency** – do the actions with minimum eye and hand movements;
- **Directness** – tasks should be performed directly;
- **Control –** a system gives feeling that it is responding to your actions.

In order to maximize the e-learning potential, the user interface should endeavor to satisfy the needs and concerns of all stakeholder groups as much as possible, so nowadays user interfaces implement much accessibility features. Some accessibility features will help people with cognitive impairments, but often the issues are about context, language, usability, and other more general factors that impact everyone to some degree.

Our research regarding creating a user-friendly working environment for each type of disability was conducted towards establishing an e-learning platform for the users to broaden their knowledge for specific health issues.

Creating the appropriate e-learning platform for the development of e-learning healthcare courses is a responsible and demanding job from two aspects. The challenge is to create a platform that is easy to use for the educational providers or

trainers and for the health care consumers (learners). The other challenge is that the platform supports different content representations (text, audio, and video). To accomplish an effective user experience, including users with disabilities and elderly people, it is important to consider basic factors that improve the user experience, productivity and accessibility/usability including user interface [17]

In the first stage of developing our e-learning platform, several topics, such as high blood pressure, diabetes and good nutrition for a healthier life, will be considered. The list is going to be broadened.

The starting point in creating an e-learning platform is to design information architecture. We have defined user requirements according to the WCAG 2.0 standards and our computer science experience. It is important to mention that all of the screens are meant to be flexible regarding orientation and size, and adaptable to different operating systems and browsers. The process of user interface design starts with creating a prototype for UI and its menu.

The menu will open giving the user a chance to see and / or to hear what appeared on the screen.

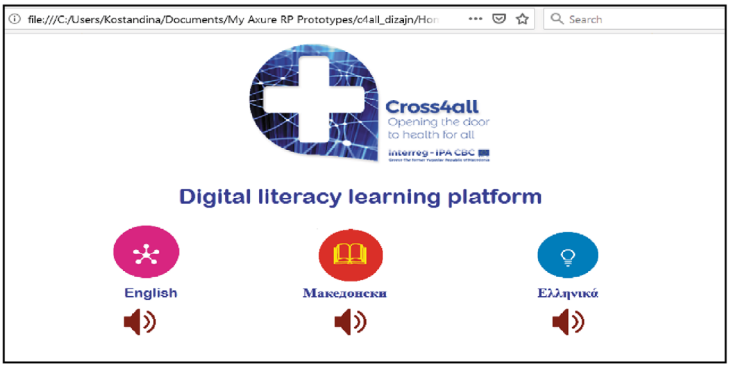

Figure 2. The main menu for language selection addressing visual and audio disability.

The idea is to offer a clean screen in order not to confuse the users that are with a disability or older what to read or what to click when a new screen appears in front of them.

The first step is to open the Digital literacy screen and to gather some knowledge regarding digital literacy in general.

The next step is to open Health literacy from the main menu to acquire knowledge for human health in general.

Figure 3. Health literacy information page.

When selecting "Courses" in the main menu, the courses will appear both on the submenu and the screen.

The first is the introduction and the user could select from the vertical menu on the left side whether to select Introduction, Digital literacy for the course, basic symptoms, prevention or actions to be taken in case of disease, or to take a quiz for that disease.

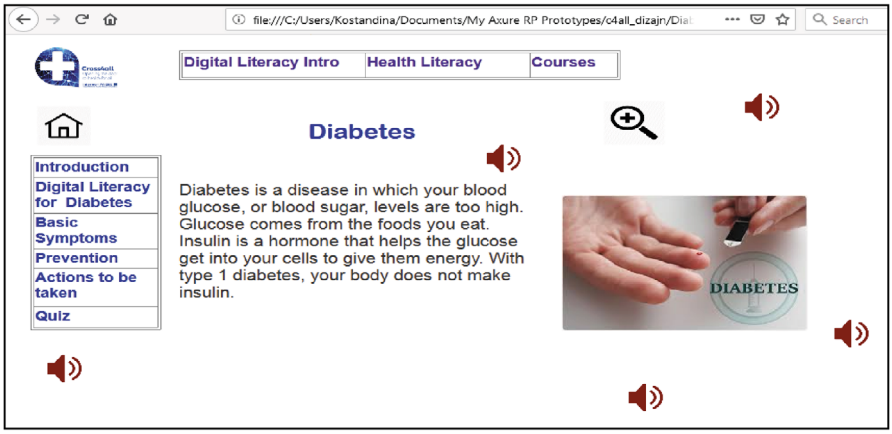

Figure 4. Diabetes information page.

E-learning platform offers possibilities to help people that are not able to see properly or to hear properly, i.e. people with disabilities to some extent and not completely disabled. Digital literacy for each type of disease is offered.

Basic symptoms for each disease are offered respectively.

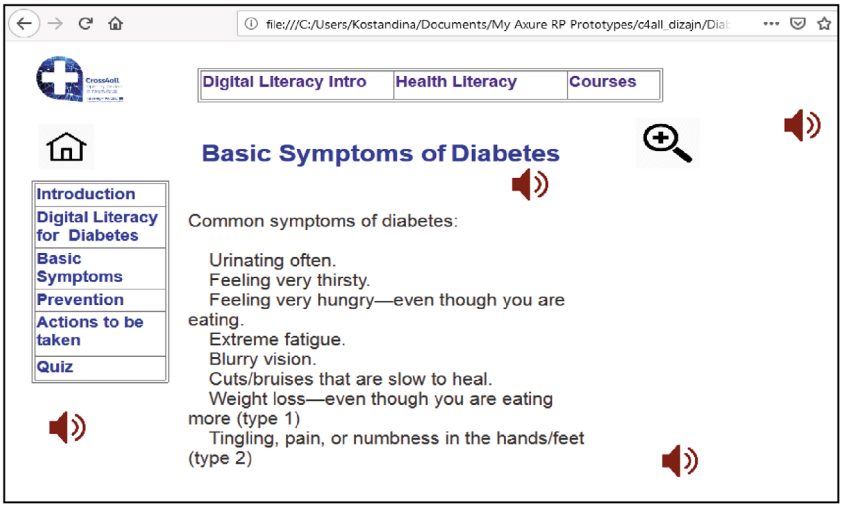

Figure 5. Basic symptoms page.

From the menu on the left-hand-side, the user could select to read about the prevention of diabetes or other diseases that would be offered in this e-learning platform.

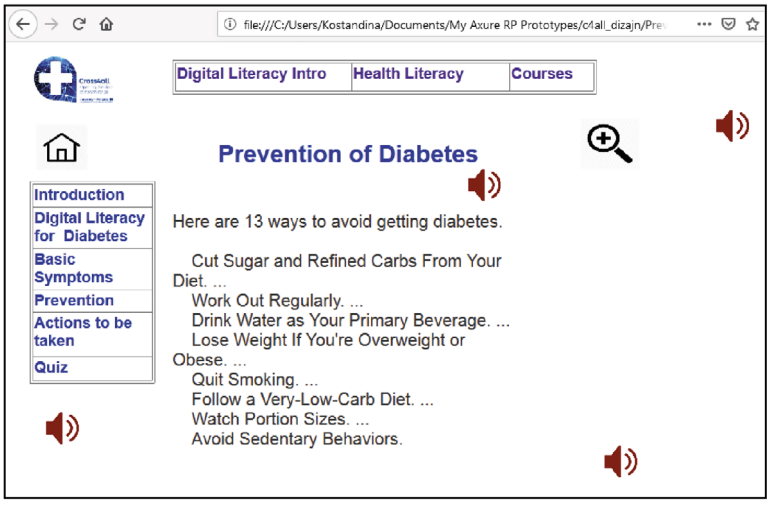

Figure 6. Prevention information page.

There is a very useful page in this e-learning platform, which enables the user to gather knowledge about actions to be taken in the case of some disease.

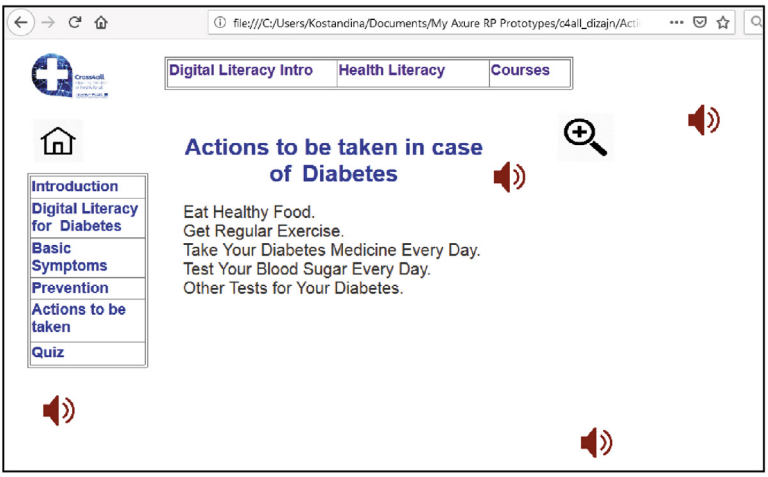

Figure 7. Actions to be taken page.

Taking the quiz for diabetes will give the user a sense of measuring the level of knowledge regarding that course. It is possible to answer the question by selecting an answer to each question simply clicking on the radio button next to each answer.

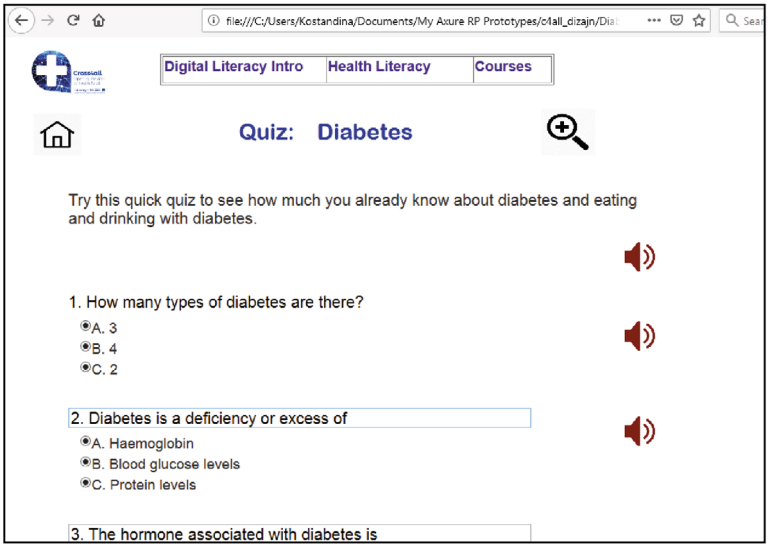

Figure 8. Quiz page.

Opening each window, the user has the opportunity to enlarge the content by clicking on the icon “enlarge”, and / or to hear the content, the title, and the menu

for that course by clicking on the icon “speaker”.

There is an opportunity to go back on the introduction page of each course by clicking on the icon “home”. In addition, there is a link to the first page on the icon of the project.

5. Conclusion and Directions for Further Work

The challenge is designing a site and software that will cover different users’ needs, preferences and situations. Web accessibility assists to make sure that people with all disabilities do not face these roadblocks when accessing the Web.

Many accessibility tools can help developers improve web/applications accessibility. Each tool targets different audiences/disability. Some accessibility features have a wider use and affect every type of impairment to some degree. UI is very important for everyone. The offer UI prototype and its menu according to the WCAG 2.0 standards include a clean screen. The screen, without a lot of objects and elements will be helpful not to confuse the users with a disability and to a great extent older user. This screen is not confusing for the user, and they can find the needed content, search and navigate the page with ease. The content of the page is either visible or audible according to the user’s needs. The platform in an easy way enables the user to gather knowledge about the basic symptoms for a disease, recommended actions, prevention information etc.

The next step of e-learning platform creation is to create a real web site where all the necessary information will find its place. One possibility for further research is to design an improved e-learning platform that will include intelligent user interface where artificial intelligence techniques [11] will be implemented to make the process of learning the health issues for persons with a disability even much easier.

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References

[1] Stefan Johansson, Jan Gulliksen, Ann Lantz, Cognitive accessibility for mentally disabled persons, 15th Human-Computer Interaction (INTERACT), Sep 2015, Bamberg, Germany. pp.418-435, 10.1007/978-3-319-22701-6 3. hal-01599467

[2] Yeliz Yesilada, Simon Harper, Web Accessibility: A Foundation for Research, Human–Computer Interaction Series, 2nd edition: © Springer-Verlag London Ltd., part of Springer Nature 2019, https://doi.org/10.1007/978-1-4471-7440-0

[3] Government of Western Australia, Department of Communities, Disability Services, http://www.disability.wa.gov.au/understanding-disability1/understanding-disability/what-is-disability/
[4] Natasha Blazheska-Tabakovska, Snezana Savoska, Blagoj Ristevski, Ilija Jolevski and Dragan Gruevski. Web Content Accessibility for People with Cognitive Disabilities, In Proceedings of International Conference on Applied Internet and Information Technologies (AIIT2019), Zrenjanin, October 2019.
[5] Visual disability, Web aim- web accessibility in mind, https://webaim.org/articles/visual/
[6] Anna Cavender and Richard E. Ladner, (2008) Hearing Impairments. In: Harper S., Yesilada Y. (eds) Web Accessibility. Human-Computer Interaction Series. Springer, London
[7] Accessibility Fundamentals, W3C-Web accessibility initiative
[8] Sandra Sanchez-Gordon and Sergio Luján-Mora, Web Accessibility Requirements for Massive Open Online Courses: Can MOOCs be really universal and open to anyone? Congreso Internacional sobre Calidad y Accesibilidad de la Formación Virtual (CAFVIR 2014), p. 529-534, Antigua Guatemala (Guatemala), May 14-16 2014. ISBN: 978-9929-40-497-7.
[9] Dr Scott Hollier, Cognitive Disability Digital Accessibility Guide, Media Access Australia-Inclusion through technology www.mediaaccess.org.au, 09.2019
[10] Siteimprove Cognitive Disabilities and Web Accessibility, 12.2014
(https://siteimprove.com/en/blog/cognitive-disabilities-and-web-accessibility/)
[11] Veljanovska, K. Analysis of Machine Learning Algorithms Performance for Real World Concept, International Journal of Advanced Research in Science and Engineering (IJARSE), Vol.06, No.12, 2017.
[12] Abascal J., Arrue M., Valencia X.Tools for Web Accessibility Evaluation. In: Yesilada Y., Harper S. (eds) Web Accessibility. Human–Computer Interaction Series. Springer, London, 2019
[13] Kurt, S. Moving toward a universally accessible web: Web accessibility and education. Assistive Technology, 31(4), 199-208, 2019
[14] Cinquin, P. A., Guitton, P., & Sauzéon, H., Online e-learning and cognitive disabilities: A systematic review. Computers & Education, 130, 152-167, 2019
[15] Bhaskar N U, Prathap Naidu P, Ravi Chandra Babu S R & Govindarajulu P , General Principles of User Interface Design and Websites International Journal of Software Engineering (IJSE), Volume (2) : Issue (3) : 2011
[16] Wilbert O. Galitz, “The Essential Guide to User Interface Design, Second Edition”, Wiley India Edition.
[17] Blazheska-Tabakovska N., Ristevski, B., Savoska S., Bocevska, A. (2019). Learning Management Systems as Platforms for Increasing the Digital and Health Literacy, In:The 3rd International Conference on E-Education, E- Business and E-Technology (ICEBT 2019), August 2019, Madrid, Spain,.