

ANALYSING ACCESSIBILITY, USABILITY AND READABILITY OF WEB-BASED LEARNING MATERIALS – CASE STUDY OF E-LEARNING PORTALS IN SLOVENIA

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In this article, by utilizing the guidelines available from literature, we attempted to compile a checklist that would identify the extent to which web-based learning materials in Slovenia properly address the needs of people with dyslexia. The focus of our research was the evaluation of the suitability of the design of web-based learning materials and not their pedagogical aspects, since design itself is one of the key factors that predominantly affect the accessibility of web-based learning materials for dyslexic learners. The results of our study showed that the developers of web-based learning materials were generally well aware of these criteria (accessibility, usability, readability); but some of the key ones remained overlooked. The study pinpoints accessibility as the weakest point of the examined web-based learning materials. The most plausible reasons for overlooking these criteria originate in the weak understanding of the needs of these particular users in addition to the weak comprehension of the established guidelines on the

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accessibility of web-based learning materials. As a potential solution, we suggested, apart from using the checklist as an indicator, increasing attention among the developers of web-based learning materials when considering accessibility issues as well as a wider integration of the concerned user population in the evaluation of web-based learning materials.

1 Introduction

Today's society perceives knowledge as a source and factor of a good-quality life. In the new social and technological settings, traditional educational concepts and methods no longer suffice, as they cannot cope with the increasing growth of knowledge, which also quickly becomes obsolete. The individual should have the opportunity to learn in all ages. Hence, traditional educational systems should become more open, flexible, adapted to individual learning objectives, individual needs, and interests. This is where e-learning comes very much to the foreground, because it supports new perspectives and possibilities of acquiring and creating knowledge (Agrusti, 2013; Dinevski & Radovan, 2013; Fee, 2009). One of its key characteristics is flexibility, which enables easier access to information for everyone. Not only people with dyslexia, but also all learning individuals can use these materials to gain better quality and friendlier access to educational content – as long as the materials are designed appropriately and allow for adaptation to individual needs.

Definitions vary mainly in how they perceive dyslexia (Camp & Aldridge, 2007; Doyle, 2002). Some authors emphasize its neurological factors, others educational characteristics, others still stress cognitive factors. Therefore, it is always important to take account of context when defining dyslexia, which will subsequently enable us to find the most suitable adaptations for the student's learning (Reid, 2009). The common ground all the theories share is the view of dyslexia as a developmental phenomenon, affecting the individual for life, with its main characteristic being difficulties in acquiring literacy skills. We should also highlight that there are numerous causes for dyslexia, including hereditary ones.

As for the learning of people with dyslexia, it is especially important to be aware that the consequences of dyslexia do not fit with the usual teaching methods. When tackling these people's different learning abilities, we can make great use of specific treatment, information and communications technology (ICT) and specific teaching adaptations (e.g. methods, techniques). Here, the suited approach of preparing learning materials is of great importance for learners' satisfaction and its use (Mažgon, Šebart, & Štefanc, 2015).

2 The use of ICT in education and dyslectic learners

ICT can be of great help to people with dyslexia, but we should realize

that it could not completely replace structured teaching and learning. This is also due to the constant appearance of new technologies and their relentless changes, which means that today technology is difficult to follow. Modern ICT is changing the educational process and educational content. This is not only true of teaching the content; it is providing learning individuals with a mass of resources, which are no longer only passive in form, as they include other media and interactive forms.

The wide variety of materials available on the market includes self-study online courses for individuals to learn as well as countless study notes accessible online (Smythe & Draffan, 2005). It is vital that these materials should be prepared in an effective, structured, organized manner and presented suitably, thus enabling users to acquire, understand, and process information as easily as possible. This is even more critical if users include people with dyslexia.

E-learning is not limited to merely multimedia materials and the Internet; it also involves assistive technology intended for users with special needs. For instance, when working with online materials, reading from the computer, listening to instructions or making notes, those with dyslexia frequently employ software such as text-to-speech software and digital voice recorders. Consequently, it is important for web-based learning materials to be developed to support the use of various software.

3 Guidelines for the development of web-based learning materials

As described previously (Radovan & Perdih, 2016), we attempted at developing a checklist to help us evaluate the adaptation of web-based learning materials to the needs of people with dyslexia. The checklist is based on three criteria: (1) **accessibility**, (2) **usability** and (3) **readability**. When drawing up the guidelines for each individual category, we relied on Rainger (2003), who puts forward practical recommendations for developing web-based learning materials for users with dyslexia, and on the book “Dyslexia in the Digital Age” by Smythe (2010), who is one of the leading authors in the field.

Our guidelines are therefore aimed at three sets of criteria that we think are essential for people with dyslexia:

- **Accessibility.** The accessibility of web-based learning materials is assessed according to whether a user with dyslexia can access information or not, regardless of how easy the materials are to use. They include: (1) enabling access to materials via assistive technology; (2) the use of illustrations, diagrams, flow-charts and photographs can enhance the accessibility of web-based learning materials; (3) enabling textual description of visual content etc.

- Usability. Learning content may be accessible, but if it is not embedded in a user-friendly environment, it will not lead to optimal educational/learning experience. As already stated, usability means how easily and how quickly we can learn from web-based learning materials. A possibility of assessing usability is counting the navigational errors that students make (their frequency and severity). The areas of usability we focus on are typography (typeface, font size, leading/line spacing, justification), text, background colour, and navigation.
- Readability. This is overlooked aspect of e-material design. It refers to the ease of understanding a text in terms of the vocabulary and grammar used. There are simple criteria for Internet material “readability”, which are also important for dyslexic users, such as: (1) sentence length should be between 15 and 20 words; (2) explicit information structure (e.g. at the beginning, the learning/educational objectives, expectations, etc. should be emphasized); (3) instructions should be given clearly and without lengthy explanations; (4) use of bullet points or numbering where appropriate, etc.

3.1 Purpose of the study

Our research problem addressed the question about how web-based learning materials were adapted to people with dyslexia and we attempted to provide recommendations on how to improve them. The research study included freely accessible web-based learning materials for adults’ independent learning in Slovenia. We selected a number of secondary school and higher education web-based learning materials and web-based learning materials for non-formal learning from various online portals offering online education.

Using a checklist, we evaluated how suitable the web-based learning materials were from the aspects of accessibility, usability, and readability. Therefore, our research questions referred to how web-based learning materials were adapted to people with dyslexia and to what degree they take account of the guidelines regarding each individual criterion. We focused on how the guidelines were applied in the areas of the accessibility, usability, and readability of web-based learning materials.

We asked the following research questions:

- Are the web-based learning materials suitable for use by people with dyslexia?
- How well applied are the guidelines in individual areas (i.e. accessibility, usability and readability)?

4 Methodology

Our sample consists of Slovenian online portals that publish web-based learning materials. The portals were searched for on Google, using the search string “web-based learning materials”. When selecting the web-based learning materials there occurred the problem of their accessibility as some portals offer their web-based learning materials commercially, which means they are not freely accessible. Consequently, we opted for six portals with freely accessible web-based learning materials that are designed for self-directed learning. In the next step, we randomly selected seven web-based learning materials from each web-portal, so we ended up with 49 web-based learning materials to evaluate.

Since we could find no adequate measuring instrument to assess the suitability of online materials for use by people with dyslexia, we attempted at developing a checklist to assist in answering the research questions. It is an evaluation checklist used to help assess the suitability of web-based learning materials regarding the needs of people with dyslexia (see Radovan & Perdih, 2016). The checklist covers 3 areas and 47 items. The first area is *accessibility*, containing 20 items, the second is *usability*, containing 18 items, and the third area is *readability*, containing 13 items. Each question had three possible replies: “Yes”, “No”, “Not possible to assess (NA)”. We evaluated the online portals with web-based learning materials according to the share of the recommendations they apply in each area.

5 Results and discussion

5.1 General suitability of web-based learning materials for people with dyslexia

The first research question examined whether the web-based learning materials were sufficiently adapted for use by people with dyslexia. Since scales are not comparable, we standardised them to a unified scale from zero to 100.

Table 1 shows the descriptive analysis of the summary scales, with the values ranging from zero to 100 points, and a total of $n = 49$ analysed web-based learning materials in the sample. The higher the scale value, the more the web-based learning materials adhered to the guidelines in our checklist. We selected the middle of the scale as the test value (i.e. $M = 50$), with the values above $M = 50$ denoting adequate suitability and the values below $M = 50$ suggesting poor suitability.

Table 1
 DESCRIPTIVE ANALYSIS OF THE SUMMARY SCALES AND THE UNIFIED SCALE

Accessibility Indicators	N	Nitems	Min	Max.	M	SD
Usability	49	20	60	93	84,21	10,51
Readability	49	18	50	100	76,36	12,42
Accessibility	49	13	25	70	51,53	12,79
Total	49	47	45	79	68,30	8,99

As the table above indicates, the web-based learning materials demonstrated different suitability according to different criteria. On average, they were the most suitable with regard to usability (M = 84.21 on the scale from zero to 100). On average, they were the least suitable with regard to accessibility (M = 51.53). The aspect of readability tended to be somewhere between the two (M = 76.36). It became apparent, that according to the unified scale, existing web-based learning materials reveal a generally satisfactory suitability for people with dyslexia, which means that their compilers largely take account of the criteria which are important to people with dyslexia.

A positive surprise was a good score in the area of usability, which mostly refers to the navigation, structure, and form of online contents. Usability may be a key factor in cognitive overload, which is likely to reduce learning effectiveness (Dunn, 2003). This is particularly significant for people with dyslexia, who sometimes have problems with short-term memory, which means that they may easily forget where in the material they find themselves, what they should click, and what sections of the material they have already studied.

Compared to the other two criteria in our sample, the criterion of accessibility scored slightly worse. On the one hand, accessibility requires enabling the user to access information in different formats (audio, video, pictures) and, on the other hand, it has to provide the user with more control over the representation of information (bigger font sizes, customising background colours, control over multimedia playing, etc.). Providing content in only one form and disabling customisation can have a considerable impact especially on people with dyslexia. It has been proven that these individuals can read more accurately if they are able to customize colours and font sizes (McCarthy & Swierenga, 2010), and they will remember the learning content more easily if it is supported by illustrations, diagrams, audio and video recordings (Burt, 2004), which they can see/hear several times.

In short, a general assessment suggests quite a positive result. However, in order to be able to interpret it we need to look into each individual criterion separately and establish what the guidelines with the lowest scores are and whether they are the ones with the strongest influence on people with dyslexia.

5.2 Applying the guidelines in the areas of the accessibility, usability and readability of online materials

5.2.1 Accessibility

The table below presents the shares of the application of each of the accessibility guidelines. The answers are given in descending order from the largest to the smallest share. Our analysis reveals that as many as nine guidelines on adapting web-based learning materials to people with dyslexia were ignored. In our view, this is troubling, since these are very important guidelines and they could contribute significantly to easier learning of people with dyslexia from the materials.

Table 2
APPLYING ACCESSIBILITY GUIDELINES

Accessibility Indicators	%
2. The material contains navigation	100.0
3. The navigation is clearly separated from the content	100.0
7. The material does not consist of text only	100.0
9. The content is supported with pictures, charts, illustrations	98.0
13. Pictures, illustrations, diagrams have their equivalents	83.7
19. Audio and video recordings and animations can be replayed by the user	79.6
18. Audio and video recordings and animations can be paused by the user.)	73.5
17. Audio and video recordings and animations can be started by the user	69.4
20. The material does not contain flashing elements that cannot be stopped	65.3
10. The content is supported with animations	63.3
16. Animations have their equivalents	51.0
12. The content is supported with video recordings	40.8
4. The material contains controllers to regulate font sizes	34.7
11. The content is supported with audio recordings	30.6
15. Video recordings have their equivalents	22.4
14. Audio recordings have their equivalents	18.4
1. The material enables access via assistive technology (text to speech)	0.0
5. The material contains controllers to regulate typefaces	0.0
6. The material contains controllers to regulate background and text colours	0.0
8. The material enables listening to the whole of material	0.0

Text is often a source of anxiety for people with dyslexia, and if it is presented in unsuitable or distracting size, typeface or colour, sharp contrasts between background and typeface colours, it makes it even more frustrating for them. Today's technology allows installing controllers, which enable the

customization of typefaces and font sizes as well as background/text colours. We established that text customisation is usually limited to font size, whereas typefaces and background/text colours cannot be set by the user. The possibility of modifying text appearance may be crucial to people with dyslexia and their learning. Thus, it is necessary that they offer such adjustments in web-based learning materials. Materials with audio options are a great help to many a person with dyslexia. Not even one of the examined web-based learning materials enabled, in its entirety, to be “listened to”. However, some web-based learning materials did permit listening to parts of their contents, which is certainly positive.

While images typically had their textual equivalents, we noticed that this was only rarely true of video and audio recordings. Relying on only visuals is more of a disadvantage than an advantage for people with dyslexia. In addition to visual/audio presentation, it is always better to add written explanation to support what is seen/heard. Ensuring equivalent descriptions is also important when considering access to the content via assistive technology (text-to-speech converters). The latter cannot read video or audio recordings, so the user who does not read the text cannot get the same information from such web-based learning materials as someone who reads the text.

5.2.2 Usability

We will now look into how the guidelines were applied in the area of usability.

Table 3
APPLYING USABILITY GUIDELINES

Usability Indicators	%
1. The material uses a sans serif typeface (Verdana, Arial, Georgia etc.)	100.0
4. The site map is hierarchical and it gives an overview of the complete material.	100.0
7. The material contains a progress indicator	100.0
8. When we want to return to the beginning or to a specific section, we do not have to go through all the sections.	100.0
9. The form and navigation of the material remain consistent throughout the material.	100.0
13. The content is provided on one screen with minimal vertical scrolling.	100.0
15. The material is divided into short paragraphs.	100.0
16. The text is in the middle or on the right side of the screen. It does not take up the whole screen.	98.0
14. There is no horizontal scrolling.	91.8
12. Hyperlinks are descriptive and we know where they will take us.	87.8
5. The material contains navigation forward/back buttons.	85.7

Usability Indicators	%
17. The material uses left text justification.	85.7
2. The font size is at least 12 pt.	59.2
18. The text is not crammed; it uses adequate line spacing (at least 1.5).	55.1
10. Textual hyperlinks are coloured when they have been clicked.	0.0

As we noticed when addressing the first research question, usability is the category that the developers of web-based learning materials take into account the most. The only serious problem we detected was the guideline related to hyperlinks, namely that textual hyperlinks should be coloured when they have been clicked. It means that no material with textual hyperlinks allows them to be coloured when they have been clicked. Since people with dyslexia may have memory problems and become lost quickly within web-based learning materials, consequently forgetting which link they have already clicked, a good and quick solution is allowing for the links that have been clicked to be coloured. This is the way for people with dyslexia to know which hyperlinks they have already visited. In addition, if returning to the same web-based learning materials they will have a good overview of what contents they have already studied.

5.2.3 Readability

Finally, we would like to consider how readability guidelines were applied.

Table 4
APPLYING READABILITY GUIDELINES

Readability Indicators	%
4. The text has clearly visible headings and subheadings.	100,0
8. Graphics are used better to illustrate and explain any complex text.	100,0
13. The material does not contain large chunks of underlined text, which is a not hyperlink.	100,0
12. The material uses the active voice, not the passive.	98,0
7. Bullet points are used for better clarity.	95,9
1. The average sentence length is between 15 and 20 words.	93,9
5. Important information is in bold or highlighted.	93,9
3. Instructions are given clearly and without lengthy explanations.	87,8
2. At the beginning, key information is emphasized (learning objectives, expectations...)	73,5
11. The material provides suggestions, additional explanations and links at the side or in drop-down menus or when moving the mouse over a text.	34,7
9. New concepts are explained in glossaries, icons in legends.	26,5
10. Boxes and mind maps are used to summarize important points.	12,2

Despite the relatively good result in this area, there remain three guidelines in the readability category with low scores. As the table shows, the smallest percentage was attained by the guideline *boxes and mind maps are used to summarise important points* (12.2%). As many people with dyslexia have problems with structure, summaries are a very welcome solution, making it easier for them to orient themselves and to revise what they have already learnt (Reid, 2009). Mind maps and boxes as a form of presenting summaries are especially emphasised, because visual support is particularly welcomed by such individuals.

Readability is also affected by the understanding of text. This is related to other two guidelines (11 and 9), that are both important to e-learning: if words or explanations are not understood in traditional learning in the classroom, we can ask the teacher to explain them again, but we cannot do so when learning from web-based learning materials. Therefore, it is important that web-based learning materials provide certain explanations that will function in a similar way as the teacher in the classroom. Because of reversing and inverting letters, people with dyslexia sometimes read words wrongly (especially more complex, longer or foreign words, etc.), so it is right to facilitate their reading by providing additional explanation in the form of a glossary or within the text itself (explanation at the side or when moving the mouse over a text, etc.). In web-based learning materials, such adaptations are extremely simple and should be applied as much as possible.

Conclusion

Although multimedia has become an important part of our knowledge-based society, the abilities to read and write remain crucial to understanding complex materials. They, furthermore, are preconditions for social and, especially, “digital” integration (Torrise & Piangerelli, 2010). Due to the struggles, they have to face when facing web-based learning materials, people with dyslexia remain a marginalised group. Although reading and writing difficulties can be compensated to a degree with the help of various technologies, the problems can persist if specific adaptations are not provided. Thus, it is vital that the developers of online services and, particularly, materials for online learning realise what problems this group of individuals’ faces, and avoid creating the so-called “exclusive digital environments” (Monteiro & Leite, 2016).

In its essence e-learning strives to ensure the suitability of the learning process for the individual’s needs, goals and wishes and to enable access to knowledge at the time, at the place and in the manner suitable for her/his needs. Although technological and learning support is undoubtedly one of the important factors in the success and effectiveness of any learning (Radovan

& Makovec, 2015), it is critical that we look for reasons deeper than that, too. Romiszowski (2000) lists as one of the most important reasons for failures in e-learning, also a failure to take account of participants' needs. According to the findings of our research study, we can conclude that a somewhat poorer application of certain guidelines important for dyslexic users may also be blamed on the lack of awareness among the developers of the needs of such users.

Such a result is also a consequence of the fact that dyslexia as a specific learning disability is only rarely addressed independently; rather, it is approached within the group of cognitive problems, without being dealt with separately. Literature and research on accessibility, also, primarily focus on physically disabled, blind and deaf individuals (Freire, Petrie, & Power, 2011), but dyslexia does not seem to figure appropriately in these contexts.

It often turns out that e-learning material developers are technologists and designers, who want to make the materials as visually attractive as possible, often neglecting these criteria. Moreover, the general accessibility criteria and guidelines developed by the Web Accessibility Initiative (WAI) are written in such a complex and incomprehensible way that even designers themselves find them hard to understand, let alone the teachers who set about compiling e-learning contents. Consequently, we should pay special attention to drawing up clear accessibility guidelines in order to make them readily comprehensible to everybody. More engagement from policymakers would certainly signify a step forward, promoting as they should a legally enforced right to these adaptations in e-learning. This would eventually have a positive influence not only on people with dyslexia but also on those who do not have dyslexia.

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