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Chapter

Improving Accessibility of e-Learning Templates for Students with Disabilities

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Abstract

Because of the effective development of contemporary technologies, also during the recent COVID-19 pandemic, students with disabilities have been increasingly integrated into the society, work, and academic environment. Accordingly, the question of how to provide accessible graphical design of e-learning materials for various categories of students with disabilities and how to comply with international accessibility standards is becoming more and more prominent. The purpose of the study was to propose recommendations for the design of e-learning materials to achieve the preparation of effective study materials for students with hearing and visual loss, as well as autism spectrum disorders. According to their needs and requirements, recommendations for the graphic design of accessible e-learning materials have been designed, developed, implemented, and evaluated. The findings revealed a higher level of acceptance of adapted material for all experimental groups and can be helpful for teachers and other professionals educating students with disabilities.

Keywords: e-learning, students with disabilities, accessibility, user interface design

1. Introduction

The spread of information and communication technology (ICT) in all parts of society and the increase of social awareness of the inclusion of persons with disabilities in the social, work, and pedagogical environment has enabled them to be more actively and effectively involved as equal actors in all areas of social activity [1].

Until recently, it was not a common practice for persons with disabilities (PWD) to publicly announce their forms of disability, but this has changed in recent years. For instance, in 2014, 27.1% of people in Europe declared having activity limitations [2]. Moreover, recent findings have revealed that over one billion people live with some form of disability [3]. Likewise, when students with disabilities (SWD) are in question, they are increasingly reporting on specific learning disabilities [4]. Over 10% of students have reported at least one special educational need (SEN), and over 5% have learning disabilities/disorders (LDs) (an overarching group of neurodevelopmental disorders that affect the development of primary and/or secondary academic abilities) [5].

The growing recognition of needs and requirements has also led to the adaptation of the accessibility of various contents, which was also recognized by UNESCO [6]. Assistive technology (AT) is deemed as 'any product whose primary purpose is to maintain or improve an individual's functioning and independence and thereby promote their wellbeing' [7]. Its implementation has the potential to improve functioning, reduce activity limitations, promote social inclusion, and increase participation in education, the labour market and civic life for PWD [8]. To be even more specific, in the study on the impact of AT use for SWD in higher education (HE), the use of AT was substantiated to increase social interactions, provide opportunities for learning support, promote active engagement with peers in course-related discussions, promote engagement in clubs or groups, and encourage the creation of a social group of AT users [8]. Moreover, the gap between assistive and general use technologies in internet tools, software, and hardware has been overcome and has allowed SWD access to a wide range of technologies [9].

Speaking about the learning process for SWD and the use of AT, the concept of e-learning must be considered. The definition of e-learning has changed through the years. Once a new type of training, can nowadays be deemed a web-based learning system for dissemination of information, communication, and knowledge for education and training [10]. E-learning, as a concept, covers a wide range of applications, learning methods, processes, and tools [5] and can be seen as an appropriate tool for SWD. The categorization of e-learning for SWD can be divided into two major groups. The first group refers to the use of AT (hardware or software, used to increase, improve or maintain capabilities of students with disabilities aimed to support and/or increase learning) [11]. The second group of e-learning, which is in the focus of this chapter, refers to a system of procedures, processes, and instructional materials that support learning [5, 12].

Today, computer-based learning management systems are the most used learning systems [13]. The reason is in its very nature. As Moore et al. [14] highlighted, all forms of e-learning could provide learning opportunities for individuals, and the incorporation of technology in education has undoubtedly improved learning for SWD [15]. Therefore, advances in computer-based education are seen as an effective way of remedying this situation by providing assistance and compensation for SWD [16].

The number of SWD attending universities is increasing [17]. Regardless of this fact, many HE institutions do not pay attention to disability, so students continue to face various barriers [9]. These include inaccessible digital course materials and websites, lack of training on how to use needed AT, poor compatibility between software used by the HE institution and students' AT, libraries that do not stock accessible digital textbooks or coursepacks, professors who do not allow students with disabilities to use their mobile technologies in class; procurement of inaccessible HE technologies that will affect teaching and learning for years, the high cost of some AT, and restricted access to computer labs [1]. SWD often report that learning and studying with ICT and related e-learning can help them [18]. It is also generally accepted that through the ICT they can overcome barriers to more successful education [19]. It cannot be overlooked that during recent COVID-19 pandemics, e-learning has been increasingly used to support students' learning processes, especially for SWD [5, 12].

Despite rich guidance and methods for the appropriate design of e-learning materials, which should enable successful accessibility for all, regardless of the type of disability [20, 21], the question arises as to how good graphic design of e-learning is. Do materials also consider the requirements and needs of SWD? The question is

also whether there is an effective standardized e-learning course template for SWD. The final question that arises is how the graphic image or template of e-learning material affects the acceptance and effectiveness of the given content according to the type of disability of SWD. While general design guidelines are available [22, 23], there is, to our knowledge, a lack of studies and specific guidelines for the preparation of e-learning templates for SWD concerning different types of disabilities.

In the literature, the studies addressing the requirements of professors, disability service providers, post-secondary graduates, and assistive technologists prevail. At the same time, the problems of designing graphical user interfaces for SWD have still not been sufficiently covered [1]. In their systematic review of papers dealing with the impact of AT on educational and psychosocial outcomes for SWD in higher education, McNicholl et al. [8] found only one article dealing with autism and three with hearing impairments. A few studies have examined some dimensions of e-learning, for instance, learning mathematics [24] and distance learning during COVID-19 [5, 15, 25]. Likewise, Debevc [26] addressed the needs of students with hearing loss where the graphical image of the user interface for a website was developed. It provided the possibility of using a video sign language interpreter in the fixed and pop-up form on the website. However, in this study, there was no research on the acceptance and effectiveness of the user interface template and besides, it was designed for only one SWD category.

According to the literature, no specific standards and guidelines for graphical design of user interfaces for e-learning materials for SWD, in general, could be found, but only general rules for using additional utilities such as captions/subtitles, including an audio description of graphics, providing text-only versions and similar. These general guidelines are also set out in guidelines, such as the web content accessibility guidelines (WCAG), which are also linked to standards such as ETSI EN 301549 "Accessibility requirements for ICT products and services" [27] and other accessibility standards [28].

In the present study, which was part of a larger European Erasmus+ project Trans2Work [29] on transferring students to work environment, we examined whether the graphical design of e-learning course templates affects the acceptance of the given content according to the type of disability of SWD. We focused on the three groups of SWD, which are (1) blind and partially sighted (B&VI), (2) deaf and hard-of-hearing (D/HH), and (3) students with autism (only high functional autists with Asperger's syndrome – ASD). We designed, developed, implemented, and evaluated the effectiveness of our customized e-learning template. The study was conducted with the assistance of various national civil associations, NGO representatives, educational institutions, and medical institutions for PWD and SWD.

Based on the findings, we proposed an e-learning template to prepare appropriate e-learning materials adapted for individual types of disabilities in post-secondary education. The primary purpose was to identify the most suitable template for SWD, to design proposals of e-learning materials and to evaluate their efficiency.

2. Barriers and solutions in e-learning for students with disabilities

When preparing e-learning materials for SWD, first and foremost materials should be made accessible. Cooper [30] and Khazanchi [31] point out that e-learning materials should be designed without additional barriers for SWD, and the path to

knowledge should be made easier for them. Every person, regardless of their disability, should have access to information through technology. Through the literature review, we first identified the problems that SWD encounter in the learning process and then sought appropriate solutions.

2.1 E-learning for blind or visually impaired students

Vision is the primary sense that is necessary for successful learning and development [32]. One of the main problems associated with low vision is access to information, which is only exacerbated using advanced technologies [33]. B&VI students are faced with barriers in daily life, and in their studies, they frequently require the use of assistive tools and technologies [34].

The barriers for B&VI students are different from those perceived by other people. Most e-learning environments are designed for students without vision problems. They are based on the use of visual images and interactive functions, which, however, cannot be used by students with acute visual impairments. As a result, they need to rely on applications that allow the translation of screen content and documents into more accessible formats [35].

The most common barriers for students with acute visual impairment are unavailability of websites, unavailability of learning materials, and special learning requirements related to their needs. To ensure an understanding of the concepts of teaching for B&VI students, additional learning resources created specifically for their needs are, therefore, needed [35]. In their work, Kesič et al. [36] emphasized the main barriers for B&VI students in the classical teaching approach. Based on the mentioned literature review, in **Table 1** we summarized essential e-learning solutions for B&VI, primarily relying on technology assistance.

Barriers in classical teaching	Solutions in e-learning for blind and visually impaired students
Fonts are too small.	Enlargement of the text in e-learning material.
Students need to sit close to a lecturer and in front of the blackboard to see clearly on blackboard.	Reading the e-learning material on a computer display and enlarging it accordingly.
Audible communication cannot be recorded.	Use of the dictaphone or other personal audio recorder.
Handouts are too small.	Enlargement of electronic handouts on the computer display.
Evaluation in a classical way by writing tests is difficult or even impossible.	Performing testing on a computer display.
Reading the written text is difficult or even impossible.	Use of audiobooks on different digital devices.
The lecturer must have a clear and strong voice without turning around so that the student can clearly listen to him.	Adjusting the speaking volume on a digital device accordingly.
Students cannot see clearly what is on the blackboard or the wall with the movie presentation.	Using audio description for figures or video in e-learning material.

Table 1.
Basic e-learning solutions for educating B&VI students.

2.2 E-learning for deaf or hard-of-hearing students

We defined four forms of support upon which an e-learning material could be designed for D/HH students [37, 38]: (1) sign language interpreting, (2) real-time speech-to-text transcription, (3) note taker's notes, and (4) printed or electronic saved copy of the text that was transcribed in the class. Some studies researched learning approaches for D/HH students, for instance, perspectives of AT [39], use of mobile technology, [40] and the use of AT for D/HH [38], where the SWD retained more lecture information with speech-to-text service in comparison to sign language inter-preter support or studying note-taker notes or a hard copy of the text after the lecture.

When teaching D/HH students, the use of visual elements is strongly advised [36] as their problems in the learning process are defined by their disability. Therefore, photos, videos, charts, histograms, posters, sketches, etc., can be easily displayed in the e-learning material. Solutions for e-learning of D/HH are listed in **Table 2**.

2.3 E-learning for students with Asperger's syndrome

Children with ASD typically attend a regular school program because most of them do not have cognitive deficits. However, they need adjustment of lessons and help due to their other specific needs. They become very disturbed by noise, classroom, and schedule changes, so it is necessary to remove stimuli from the environment to which they are particularly compassionate, and to avoid surprises and unannounced changes [41]. With the help of e-learning, children with ASD can avoid disturbing stimuli in the classroom and learn at a distance. According to Žagar [41], computer learning is

Barriers in classical teaching	Solutions in e-learning for deaf and hard-of-hearing students
Students who use sign language as their first language need a sign language interpreter in class.	E-learning material uses pre-recorded sign language interpreter videos together with captions/subtitles.
The lecturer needs to be always facing the student so that he can read from his lips.	The student is always facing the computer display to see and read e-learning material.
The lecturer needs to have a clear and robust voice without turning around so that the student with a hearing aid can clearly listen to him.	Accordingly, adjusting the speaking volume on a digital device in case of direct connection to the hearing aid.
The student needs to sit close to the lecturer and in front of the blackboard to see clearly on the blackboard.	Reading the e-learning material on a computer display and enlarging it accordingly.
Students need mainly visual demonstration, which, however, is challenging to show in class on the blackboard alone.	E-learning material contains various graphic illustrations (photos, charts, etc.) or multimedia media (video, animation, etc.) together with captions/subtitles.
Disturbing sounds, background chatter and noises can occur in the classroom, causing problems for students who use hearing aids.	E-learning material on the computer can be listened directly using audio adapters connected to hearing aids. In this way, students do not hear noise and chatting in the background.
Students overhear important information during spoken lectures.	Audio description in the e-learning material. Important ones can be written at the end of each learning unit.

Table 2.
Basic e-learning solutions for teaching deaf and hard-of-hearing students through e-learning.

appropriate for people with ASD and among the advantages are the adjustment of difficulty and speed of progress according to the performance in solving tasks.

People with ASD are not interested in the whole subject matter provided for in the annual curriculum, but only in part. When a lecturer comes up with exactly this material, students with ASD ask a lot, which can be distracting for the rest of the students in the class. Also, time is limited by lecturers as they must stick to the curriculum and do not have time to address their questions fully. In the relevant literature, [42, 43] there is a solution to this problem. It can be solved with an avatar in e-learning material. A person with ASD can ask whatever he is interested in and for how long he wants because, according to the mentioned research, people with ASD sympathize very well and communicate with avatars. Another problem in education, which can be solved with the help of an avatar, is that it is difficult or impossible to predict in advance anything that a person with ASD will show a strong interest in. Therefore, we cannot predict which parts of e-learning materials will be interesting for them and consequently describe them in more detail. Thus, a person with ASD can ask the avatar only what interests him and avoid the learning material that does not interest him.

Based on the literature review and according to the detected barriers in classical teaching of ASD [36], we provide some essential solutions in e-learning as technology may assist these students to grasp the learning topics (**Table 3**).

It is possible to overcome frequent barriers in the classical teaching approach of SWD by using appropriate technology and applying a thoughtful approach tailored by the special needs of each SWD group. The key in the e-learning process is, therefore, the preparation of appropriate e-learning materials. Although e-learning materials are at first glance like printed ones, different solutions are needed in terms of design, development, and implementation procedures.

3. E-learning materials for students with disabilities

When dealing with e-learning materials, we do not only prepare the content (text), but we must include graphic and multimedia elements to ensure greater interactivity

Barriers in classical teaching	Solutions in e-learning for students with Asperger's syndrome
Students have difficulty in understanding the terminology or the meaning of words.	For harder-to-understand words, a hyperlink to a page that explains a particular word or phrase is included.
Students need mainly visual demonstration, which is challenging to show only on a blackboard.	E-learning material contains various graphic illustrations (photos, charts, etc.) or multimedia media (video, animation, etc.) together with captions/subtitles.
Students are confused by several instructions at once.	E-learning material contains each instruction as a visible list on handouts.
Students do not like social and/or eye contact.	Using a computer-based communication eye and social contact can be avoided.
Students do not know how to imagine alternative outcomes of situations and find it difficult to predict what will happen.	E-learning material contains a description of what was in progress before the chapter and what will follow it.
Students need a clear structure of the content.	At the beginning of the e-learning material, a clearly visible structure of the study material (index of chapters) is provided.

Table 3.
Basic e-learning solutions for teaching students with Asperger's syndrome.

and interest. E-learning materials must provide SWD with good orientation, sovereign use, transparency, accessibility, and encourage motivation to learn. E-learning material contains several types of media and comprises all the advantages provided by ICT. Namely, in addition to the text part, it can also include audio recordings, videos, animations, and simulations. A significant advantage is an interactivity allowing easy and quick feedback on exercises and tests. According to Lombardi et al. [44], professors often make online materials available on a course website, course management system or online education platform, which allows students to interact with learning materials outside the classroom. Interactivity can also be reached through interactive whiteboards (e.g., SMARTboard), study pods or via mobile technologies, which provides a wide range of learning tools, for instance, digital books with interactive elements [9].

Clark and Mayer [45] highlight two problems in designing e-learning materials. The first one is the fact that the potential of graphics in e-learning materials as visual media is underused. On the other hand, we encounter materials that authors overdecorate and overdesign because they try to achieve greater motivation. Such a design of materials can lead to inhibition of the learning process. When designing and adding graphics to teaching materials, it is fundamental that these graphics are relevant to the content.

Much of the printed learning material is unattractive to look at, does not hold an individual's attention, and does not arouse interest in reading further [46]. Therefore, Lockwood [46] believes that an essential goal in preparing materials should be to use as many resources as possible to create an environment that motivates the student. Apart from the topic, the writing process itself and the appropriate levels of difficulty, typography are also vital, which must bring high readability and make reading a pleasure. Of great importance are the design of entire pages, the placement of objects, and the application of rules. Graphic design is a vital component of texts, as it can significantly raise a student's level of motivation [46]. For instance, using a graphic organizer for students with learning disabilities [47] or students with ASD in teaching mathematics [48].

When using graphics, integration of text is very important, as a poor connection of these elements can lead to student confusion. A study has shown that poor integration of text and graphics can lead to distraction because visual elements take on attention that would otherwise be focused on important information [49].

3.1 Prototyping e-learning material for students with disabilities

Preparing e-learning material for SWD demands different preparation and design of e-learning materials. Accordingly, in the following subsections, we provide recommendations for B&VI, D/HH, and students with ASD. Recommendations are provided individually for each group of students, as their needs and requirements differ.

When providing recommendations for the accessibility of e-learning materials to SWD, we followed the recommendations on online accessibility and guidelines WCAG, as both e-learning materials and websites for SWD are accessed through the same user interface. WCAG defines [50] the following principles when designing e-learning materials for SWD: (1) perceivable, (2) operable, (3) understandable, (4) and robust. Each principle includes guidelines with success criteria. Standard ETSI EN 301549 [27], for example, specifies requirements for ICT to be accessible for people with disabilities, emphasizing that ICT must enable SWD to search for, identify and implement ICT and access the provided information, regardless of physical, cognitive, or sensory abilities. European standard ETSI EN 301549 was updated to adopt WCAG for information and communications technology (ICT), including web content, electronic documents, and non-web software, such as native mobile apps.

According to Cooper [30], it is recommended to all educators to include at least the following guidelines in the design of web or software course components:

• Allow for user customisation.

• Provide equivalent visual and auditory content and interface elements.

• Provide compatibility with assistive technologies.

• Allow access to all functionalities from the keyboard alone.

• Provide context and orientation information.

The above-listed recommendations were used as the main foundation in our prototyping for e-learning materials for SWD.

3.1.1 E-learning material for blind or visually impaired students

When preparing e-learning material for B&VI, we must pay attention to those who use screen readers and/or screen magnifiers. As to the use of screen readers, we must be careful to write all the information. We also need to write what we see in the pictorial material. It allows screen readers to pass on the information about what is in the image to blind people, as the computer program cannot describe the image material at this time.

Regarding those who use screen magnifiers, however, we need to pay attention to appearance and shape. It should not be taken for granted that all the information that is written and the pictorial material will be seen without difficulty. Instead, we must consider the following layout of the e-learning material:

• High contrast: Between the background and the foreground elements, such as text and graphic elements, there must be a high contrast for visually impaired people to distinguish the elements from each other. The most commonly used high contrast is black on white. The Iris Center recommends the use of the highest possible color contrast [51].

• Capital letters: Text must be larger than usual. The Iris Center recommends a font size of at least 18 pixels [51].

• Non-serif font: Letters must be easy to read, so a non-serif font is recommended, as it does not add ornaments on the letters, and the text is easier to read. The Iris Center recommends the Arial and Tahoma fonts [51].

In accordance with the recommendations for e-education of B&VI students, the following elements of e-learning material should be used (**Figure 1**):

1. Title (title of the lecture or chapter).

2. Text (we need to make the text visible, so we need capital letters and non-serif font).

3. Audio-audio recording of all information (all information recorded must also be available in audio form, despite the possibility that the person is using a screen reader).
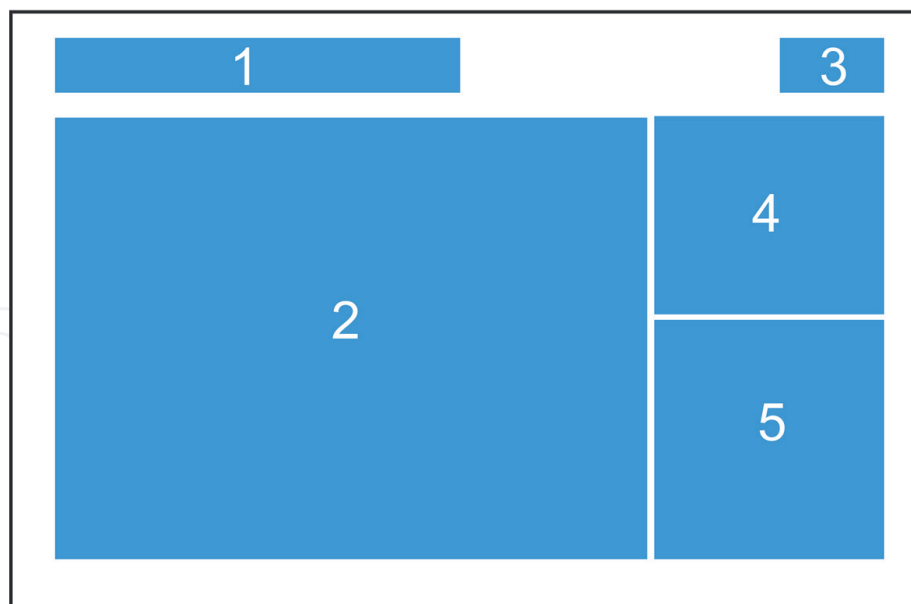
Figure 1.
Prototype of e-learning template for blind or visually impaired students.

4. Graphic element (if necessary, the text can be enriched with a graphic element).

5. Annotation to the graphic element (if we use a graphic element, we must describe in the caption what we see in the picture).

3.1.2 E-learning material for deaf or hard-of-hearing students

In the literature, two appropriate examples of e-learning materials for the D/HH were examined, and we followed the initial design. We immediately noticed that the examples of e-materials differ from other conventional e-materials, due to the video with the sign language interpreter and captions/subtitles. This is essential for e-materials for the D/HH, as we do not need it for the B&VI and people with ASD. Both examples also contain the title, text, and pictorial material, which are highly recommended for e-materials for the D/HH. Another example includes a video with a lecturer that D/HH can read from his lips, the possibility of multilingualism, which is needed only for international e-materials, and the possibility of sound, which is more important for the B&VI than for the D/HH persons.

Based on the recommendations for e-learning of D/HH described in the previous chapter and judging by two good examples of the proposal of e-learning material for D/HH (**Figure 2**), we can understand that we need to use the following elements of e-learning material (**Figure 3**):

1. Title (title of the lecture or chapter).

2. Text (all information must be written).

3. Graphic elements (it is recommended to support the text with pictorial material, as visual demonstration is recommended for D/HH).

4. Video of the lecturer (if possible, in addition to the text and pictorial material, include a video with a lecturer so that both D/HH can see his gestures and thus read from their lips).
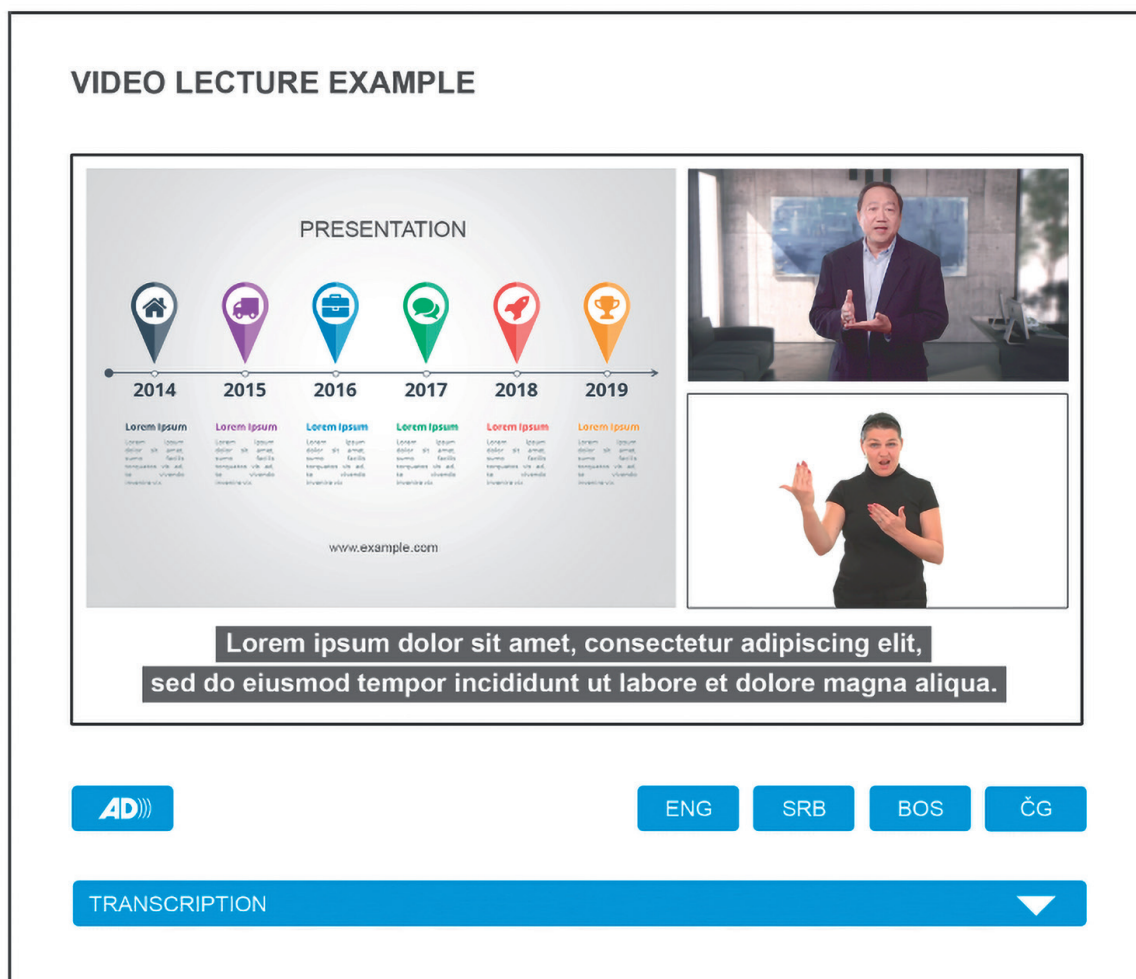
Figure 2.
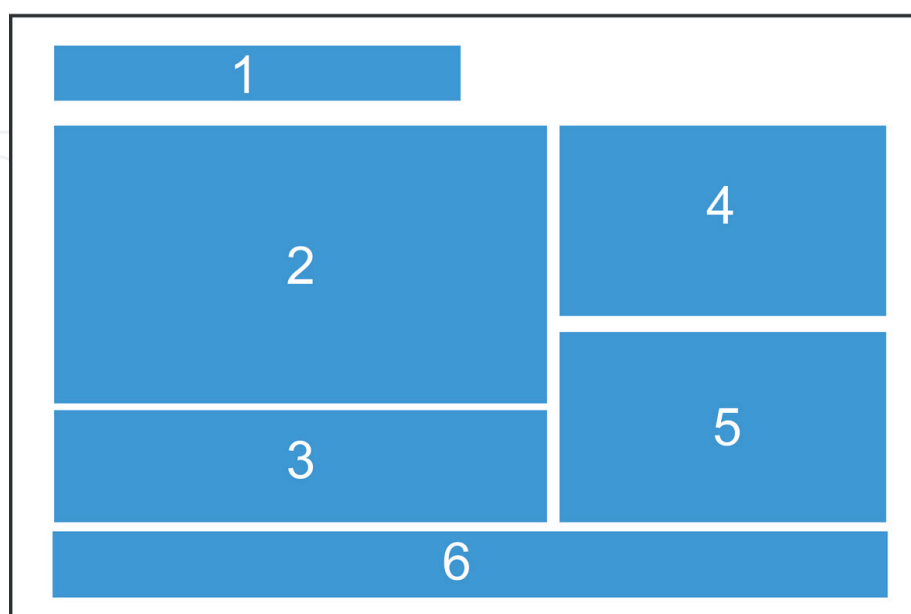*Example of an e-learning template for deaf or hard-of-hearing students.*

Figure 3.
Prototype of e-learning template for deaf or hard-of-hearing students.

5. Video with sign language interpreter (if possible, including sign language interpreter video, as some D/HH use sign language as their first language).

6. Captions/subtitles (under the video with a lecturer or with a sign language interpreter, we must add captions/subtitles so that D/HH can read what a lecturer or sign language interpreter is saying).

3.1.3 E-learning material for students with Asperger's syndrome

Persons with ASD are the most unpredictable of our three groups of SWD. Hearing problems are common to D/HH students, vision problems are common to B&VI students, and students with ASD have very different needs. Therefore, it is difficult for these people to make universal recommendations that would apply to everyone. Some are attracted to the blue color. Others would immediately close the e-learning material when looking at it. Even the pictorial material can be liked by someone, but someone else associates the motive in the picture with a bad experience and panics. Nevertheless, based on the literature some recommendations should be used for all people with ASD. It is advisable to stick to them when preparing e-learning material:

• At the beginning of the e-learning material, we prepare an index and present the structure of the learning material to acquaint the person with ASD what the course will be like so that there will be no surprises.

• Each page of the e-learning material must have navigation showing the previous and following chapters so that the person with ASD is not confused and knows what to expect.

• We use plenty of pictorial material, as people with ASD have a visual way of thinking and mostly describe their thoughts with pictures.

• Difficult words (terminology) and phrases need to be described in more detail. It is best to use a hyperlink for these words or, if this is not possible, at least a note where we write a word's meaning (definition). The same applies to phrases or proverbs, as people with ASD take them literally.

• For possible questions regarding a specific subject, we use an avatar, which, in addition to the presentation on the topic on the learning e-learning material, can also answer their questions.

The prototype website (WordPress) for people with ASD was created in 2015 as part of the European project Autism&Uni [52] and is intended for research, design, production, and evaluation of tools to help people with ASD during their studies (**Figure 4**). As we can see from our list of recommendations, it contains only a few graphic elements and content navigation. We can conclude that the prototype is poorly designed, does not solve the problems that people with ASD have online, and does not attract them.

From the recommendations for e-learning for students with ASD, we can understand that we need to use the following elements in e-learning material (**Figure 5**):
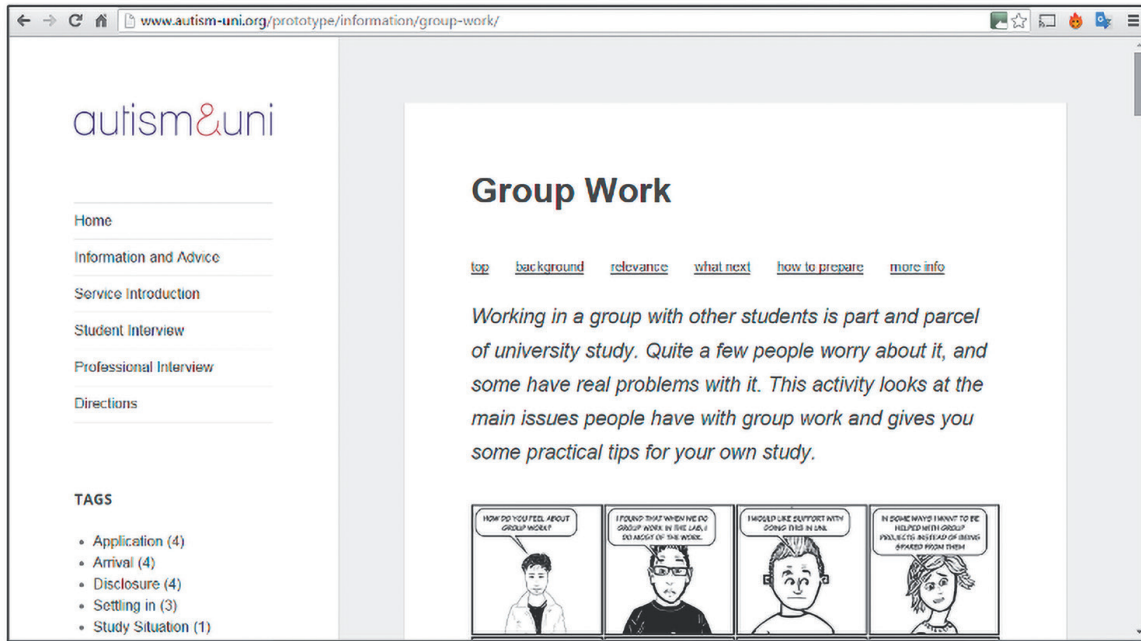
Figure 4.
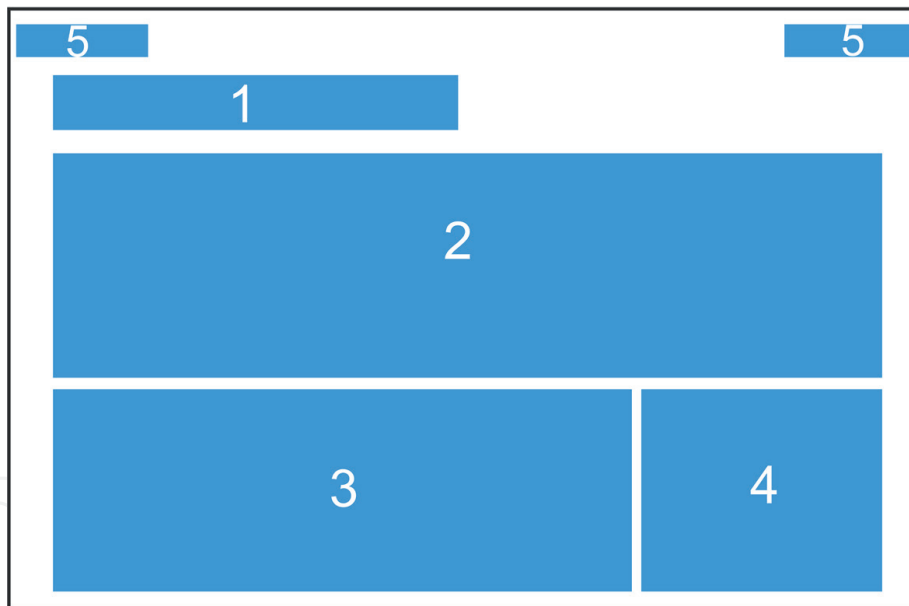*Example of a website for students with Asperger's syndrome [52].*

Figure 5.
Prototype of e-learning template for students with Asperger's syndrome.

1. Title (title of the lecture or chapter).

2. Lots of graphic elements (they need a lot of graphic elements as they visually memorize the material).

3. Text (we need to write clear and concise sentences that are complemented by graphic elements).

4. Avatar (use it so that people with ASD can ask what they are interested in. In addition to answering the questions, they can also describe the material on the

learning e-learning material and so people with ASD gain information through reading, visual demonstration, and sound, which dramatically affects the memorization of the given information).

5. Navigate with information about the previous and next chapters.

3.2 Evaluating prototypes: a case study

Our study was mainly intended to assess the approval of e-learning templates based on literature recommendations and prototypes. We created several examples of a PowerPoint presentation handout, namely one non-adapted disability (neutral handout), only based on the text, which we compared with a customized handout for an individual studied group of SWD. This was presented in the questionnaires only in the form of a captured image. Along with each handout, the survey also contained an attribution of the content elements represented on the handout.

3.2.1 The case

To explore the possibilities of e-learning materials, we have conducted a pre-survey of frequently used methods in the field of study. A review of several studies [53, 54] dealing with similar questions about SWD showed that a survey experiment method was used to investigate such questions. As a result, we also decided to collect data using the survey process, so that we would use the survey questionnaire as a measuring instrument.

Our study focused on three groups of SWD, namely (1) blind and visually impaired (B&VI), (2) deaf and hard-of-hearing (D/HH), and (3) people with ASD (only highly functional autistic people with Asperger's syndrome participated in the study). In connection with the latter, we aimed to find participants for each of the groups who met the following criteria: the person is computer literate, the person knows the education process, and the person has prior experience in using electronic material.

3.2.2 Research content design

In preparing the unadjusted disability handout, we followed the recommendations [55]. The neutral handout contained only the title and text with the recommended shape and font size. In contrast, the customized handouts were designed according to the recommendations and prototypes to produce e-learning material for SWD. The planned scheme of e-learning materials for individual observed groups is defined in **Table 4**.

As shown in **Table 4**, each experimental group of persons first evaluated the neutral and then the adapted e-material. According to the specific needs of each group, we prepared a separate customized handout for each of the groups, specific to them or their needs. The production of these e-learning materials is presented in the following sections.

We designed the text on the handout as simple, neutral, and understandable as possible. We followed the presentation at the annual Microsoft event, held on 26 October 2016. At the event, a fig tree was presented as an example of a presentation. In our case, we used the Slovenian symbol—a linden leaf. The material for the e-learning material was taken from the website [56]. An example of an unadjusted disability handout is shown in **Figure 6**.

Deaf and hard of hearing	Blind and visually impaired	Asperger's syndrome SD
E-learning material with written information.	E-learning material with written information.	E-learning material with written information.
E-learning material with video sign language interpretation.	Verbal-auditory conversion of visual communication e-learning materials.	E-learning material with content presented by multimedia media.

Table 4.
Planned scheme of e-learning materials for individual observed groups of persons with disabilities.

Linden leaf

- Linden leaves are arranged alternately.
- They are 7 to 17 centimetres long.
- They are upside down, heart shaped.
- They are pointed and finely sawn.
- The stalk is hairy and 5 centimetres long.
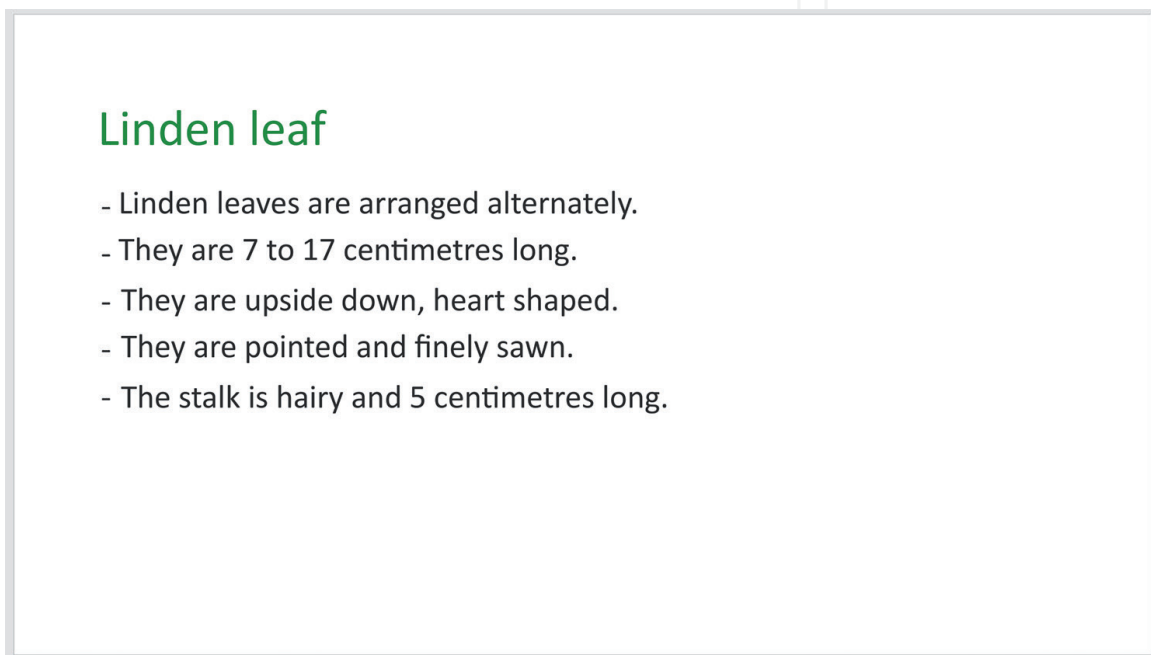
Figure 6.
Neutral handout.

3.2.3 E-learning material for blind or visually impaired students

According to the recommendations, it was necessary for visually impaired (VI) people to make the text visible, to enable audio-audio recording of information, and to add a graphic element, which also has a description of the content of the graphic. Based on these recommendations, we produced the handout shown in **Figure** 7.

In addition to basic information (title and text), the presented handout also contains a button—an audio recording (above right), which enables voice playback of recorded content, an image, and a caption to the image, which describes what we see in the image. The text differs from the text on the neutral handout, where only keywords are written, as whole sentences are written here for the case of a visually impaired person using a screen reader.

When creating the handout, we also followed the recommendations to produce materials for the visually impaired [51] and thus increased the font, and accordingly, used non-serif font and increased line spacing.

Figure 7.
Handout for blind or visually impaired students.

3.2.4 E-learning material for deaf or hard-of-hearing students

When preparing e-learning material for the deaf and hard of hearing, we wrote down all the information, added graphic elements and a video with a sign language interpreter on the handout, according to the recommendations. In doing so, we also included the video with the sign language interpreter and captions/subtitles so that

Figure 8.
Handout for deaf or hard-of-hearing students.

people can also read the content. Based on the mentioned recommendations, we designed the handout shown in figure (**Figure 8**).

It can be seen from **Figure 8** that the handout contains the entire text as presented by the lecturer. In addition to the text, it also contains visualizations with an image (bottom left), a sign language interpreter on the right who interprets the provided text in national sign language together with captions/subtitles.

3.2.5 E-learning material for students with Asperger's syndrome

The last experimental group in our study were people with ASD or Asperger's syndrome. Based on the recommendations, it is necessary, when teaching this group of SWD, to include as many graphic elements as possible, the text must be clear and concise, the handbook must contain straightforward navigation, and it must have an avatar, which allows students to access additional information on the selected topic. Based on the mentioned recommendations, we designed the handout shown in **Figure 9**.

According to the recommendations, our handout contains various visualizations with outlines of the information available in the text. The upper part provides additional information on navigation in the e-learning material, and the handbook also contains an avatar that allows accessing additional information whenever needed.

3.3 Participant recruitment

We found the respondents with the help of associations that connect PWD and organized meetings with them. Both paper-based and online surveys were applied. Although the survey was anonymous, anyone wishing to participate in the live survey signed a consent form to participate in the survey. If the participant was aged 18 or lower, the consent was signed by the parents or guardians. All participants in the survey process had the opportunity to withdraw from the survey process at any time or terminate their cooperation.
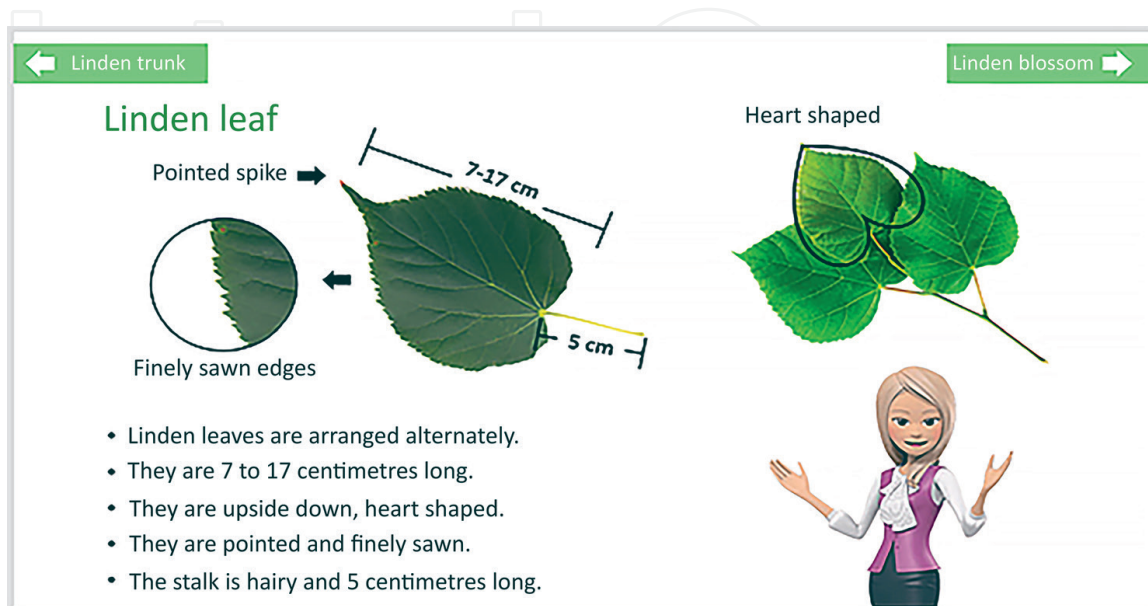

Figure 9.
Handout for a student with Asperger's syndrome.

The study was designed and implemented in line with the Declaration of Helsinki by the World Medical Association [57] and the Ethical Principles released by the American Psychological Association [58].

3.4 Measuring instrument

We prepared a questionnaire for each of the three experimental groups of SWD, as the adapted handouts of e-learning material differ from each other. The exception was a group of blind people, as they cannot see the handouts of the e-learning material. For this group, we removed the handouts from the survey questionnaire and left only questions that did not contain pictorial material. Because of the removal of handouts, we adjusted the survey a bit so that, despite the different forms of the questionnaire, we obtained enough information about their opinion on e-learning materials. The design of the survey was adjusted to the needs and requirements of B&VI [51].

The questionnaire contained two sets, namely the capture of demographic data and the evaluation of e-learning materials. The survey questionnaire consisted of explaining its intentions, one open-ended question, and six to nine closed-ended questions (depending on the type of questionnaire). We used closed questions with answer choices between the given answers and open-ended questions (age – a year of birth). For some close-ended questions, we used the Likert scale to answer questions, which is one of the most used instruments for measuring variables, such as motivation and self-efficacy [59].

The second part of the questionnaire was intended to evaluate e-learning materials, which was conducted so that the respondents (blind people were excluded here) evaluated the two handouts of e-learning materials presented in the previous subchapter. We had a problem in determining evaluation questions on elimination, as most of the evaluation questionnaires (user interface satisfaction questionnaire – QUIS, perceived usability and ease of use – PUEU, attributes of Nielsen usability – NAU, Questionnaire on computer system usability – CSUQ, Practical Heuristics usability – PHUE, and similar according to Edutechwiki [60]) are composed of assessing the actual performance of either a website, program, mobile application, or PowerPoint presentation. We used only the PowerPoint presentation handout for evaluation. As a result, we had to use questions that related only to our handouts and were not standard (the information on the handout is understandable, the handout is transparent, etc.).

To evaluate the given handouts, we identified nine five-point Likert type [61, 62] statements, based on which the respondents expressed their chosen level of agreement, namely:

1. The information on the handout is comprehensible,

2. The handout is transparent,

3. The handout provides sufficient information,

4. The handout is attractive

5. Nothing bothers me on the handout

6. The information is reasonably organized

7. With the help of a handout, I quickly learn something new

8. The handout is boring (reversed question)

9. The information is arranged in a meaningful way.

3.5 Procedure

The survey was conducted so that the respondents first assessed the handout that was not adapted to their disability. Then, in the same way, they assessed the handout of the adapted e-learning material. The questions, claims, and grading scales were identical on both handouts, which allowed us to compare respondents' agreement with the claims on the two given handouts. This answered the research question: Does the form of the e-learning template affect the acceptance of the given content of e-learning materials and the understanding of this content among people with special needs?

To verify with certainty whether the form of the e-learning template influences the acceptance of the given content of e-learning materials and the understanding of this content among people with special needs, we prepared an additional closed-ended question on the previous two questions. We wanted to get the opinion from the respondents on the importance of certain elements in the e-learning material. For each experimental group of SWD, we used statements with different elements in the e-learning material, which the respondents then rated with the Likert agreement scale.

B&VI respondents were asked about the importance of the contrast between the text and the background, the enlarged text, the use of images and graphs, and the captions to images describing the image in the e-material. We asked blind respondents about the importance of the audio recording in the e-learning material, the caption to the pictures with the audio description of the pictures, and the recording of the whole text as it would be read by the lecturer and not just keywords. Respondents with ASD were asked about the importance of using images and graphs, additional information, navigation, and a dictionary in the e-learning material. D/HH participants were asked about the importance of writing the entire text, images and graphs, sign language interpreters, video, and captions/subtitles in e-learning material.

3.6 Results

The D/HH survey results showed that, on average, respondents expressed neutral agreement with the unadjusted disability handout (3.0). In contrast, the adapted handout showed a higher acceptance rate, by as much as one level (1,1) to 4.1, which according to the five-point rating scale means that, on average, respondents from the group agree with the adapted template. An even significant difference was found in the handout boredom analysis, where the rate of agreement with the statement decreased from 3.7 to 2.0, representing a difference of 1.7 degrees. In this way, we substantiated that the adapted template for the D/HH group is much more interesting, which can affect the concentration and interest in the presented content (**Figure 10**).

When analyzing the importance of the participation of elements in e-learning materials, we also substantiated that all the proposed elements in e-learning materials are desirable, as at least 68% of respondents agreed with the presence of the given elements (use of whole sentences and captions/subtitles when using video), followed by using a video with an interpreter (84%) and the graphic elements (92%).

The next studied group were B&VI respondents. Because of the different abilities to perceive content (the difference between poor eyesight and blindness), we prepared two different questionnaires for this group. We did not include visual aids
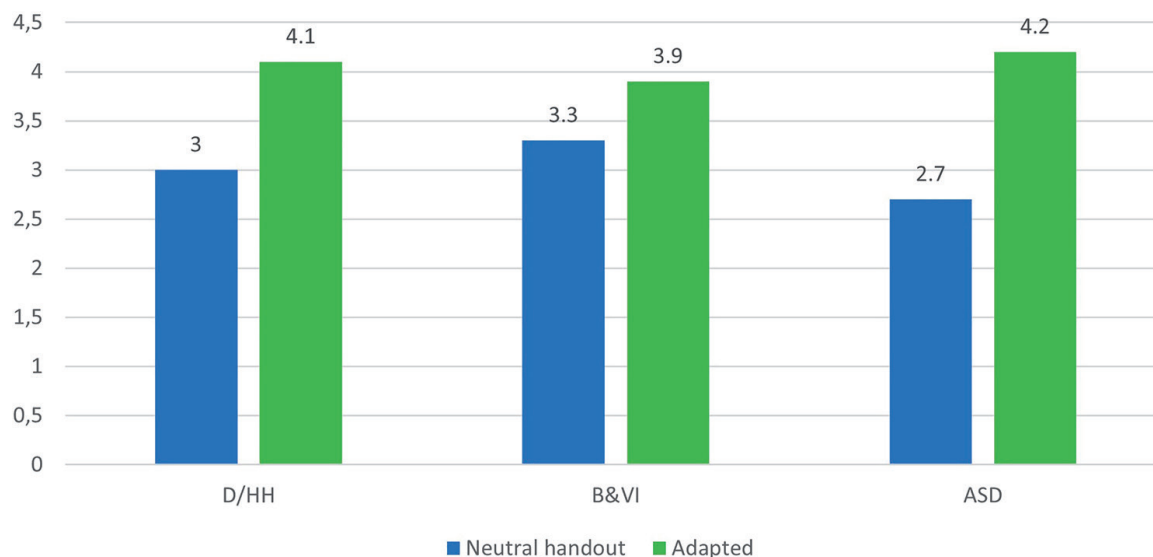
Figure 10.
Summary data of adapted handout assessment.

for the blind. The results for the visually impaired are described first, followed by the results for the blind.

In the visually impaired group of respondents, the results showed that the studied group agreed with the statements related to the unadjusted handicap of disability on average with a value of 3.3, which expresses neutrality. Compared to the neutral, the agreement with the adjusted handout increased on average by only 0.6 points to 3.9. We proved that the adapted proposal seems better to the mentioned group, but we did not achieve a significant difference.

The same applies to the claim related to the monotonous nature of the proposal, where the rate fell from 3.4 to 2.6, which also showed that although the adjusted yield was less tedious, it did not prove to be to a lesser extent reduce the boredom of the handout.

A minor degree of improvement can also be attributed to the results of claims related to the presence of elements in the e-learning material, where it was shown that for certain respondents some elements in the e-learning material were even undesirable. This was significantly evident in connection with the added visual materials, where 13% of respondents found it irrelevant to include graphic elements in the e-learning material, which can consequently be attributed to differences in the level of visual impairment, as it also depends on the ability to perceive such content. Despite the above, most respondents agreed with the given elements, namely 63% using images and graphs, 69% attributing information to them, and 86% with high contrast between text and background and increased text in e-learning material.

In the questionnaire, blind respondents assessed only the importance of the elements in the e-learning material. The results showed that the most important thing for this group is that the e-learning material contains a textual description and the pictorial material (76%), followed by the fact that the e-learning material contains the entire text and not just keywords (63%). However, a more significant difference is observed in the participation of the audio recording, where it turns out that 28% consider this option necessary. This result can be attributed to data on the use of screen readers, where the use of it was confirmed by 88% of blind people. As a result, we can conclude that they do not need audio content in e-learning materials, as they have already overcome this barrier by using a screen reader.

The last of the groups studied were respondents with ASD. Of all the groups studied, this group showed the most significant difference between the assessment of unadjusted and adjusted disability benefits. Respondents rated the unadjusted handout with an average level of 2.7, while they rated the adjusted handout with a grade of 4.2, representing a difference higher than 1.5 grade. This can also be attributed to the importance of visual elements in the materials for the mentioned group.

A similarly high difference was also shown in the analysis of the statement "Handout is boring," where the rate between handouts decreased from 4.2 by 2.5 to 1.7. It can be concluded that for respondents with ASD the adjusted handout proved to be much more appropriate than neutral.

ASD respondents also confirmed with a high degree the presence of the proposed building blocks in the e-learning material, namely two of the options (the use of graphic elements and the presence of definitions and a dictionary of words used) were 100% selected as an essential element. The possibility of asking for additional information seemed vital to 91% of respondents. The discrepancy was shown only in the case of the presence of navigation in the e-material, where this element was chosen as necessary by only 58% of respondents. We can conclude that of all the proposed elements, this one seems to be the least important.

3.7 Discussion and guidelines

In our study, we found that SWD face several problems when using e-learning materials, although they provide access to information and more opportunities to interact. There are quite some accessibility-related barriers in printed educational materials, which can be overcome by using e-learning materials. It is essential that e-learning materials can be understood by everyone, so they can navigate, interact, and co-create.

We expected the results of our study would show that the form of the e-learning template affects the acceptance of the given e-learning material content also on understanding the content among selected groups of SWD. The results of the analysis of the experimental groups showed that the form of the proposal in the case of all groups affects the acceptance of e-learning materials, where the biggest difference was shown in the case of ASD and the smallest in the case of B&VI.

Regarding the D/HH group, we expected that the template, which contains a written form of providing information or video interpretation with sign language, would affect the acceptance and understanding of the content. Our expectations were justified, as D/HH respondents confirmed that the form of the e-learning materials template influenced their acceptance of the given content of the e-learning materials and their understanding of the content. The information on the adapted handout was more understandable, sensibly organized, and distributed to D/HH than the non-adapted handicap. Also, the adapted handout was more transparent, interesting, and provided them with more information. In the survey questionnaire, D/HH respondents also confirmed that the video with sign language interpretation and the sharing of captions/subtitles are vital in the e-learning materials. Also important is the inclusion of graphic elements and entire sentences as if read by the lecturer and not just the keywords.

In the group of B&VI, we checked whether the written form of providing information or verbal-auditory transformation of visual communication of e-learning materials affects the acceptance of the given content and its understanding. The survey results confirmed the research question, as the B&VI confirmed that the form of e-learning

templates influenced the acceptance of the given content and the understanding. Although the difference between the two handouts in this group was the most minor (0.6 degrees), (VI) respondents rated the adapted handout of e-learning material with a higher grade than the unadjusted handout of disability. The adapted handout was, in their view, more transparent, attractive, and provided them with more information. The information on the adapted handout was more understandable to them, sensibly organized, and arranged. With its help, we would also learn new things faster. In the survey questionnaire, 86% of VI confirmed the importance of text size and high contrast between text and background, 63% confirmed the importance of including graphic elements and 69% of their descriptions in e-learning material. The results indicate that the inclusion of graphic elements is not so important for the studied group. However, if they are present, it is vital that they contain an additional description.

Like the previous groups, in the group of ASD, we expected that the form of a template with a written form of providing information or visual communication with the help of multimedia media would affect the acceptance of the given content of e-learning materials and their understanding. Here, too, our expectations were justified, as the respondents with ASD confirmed that the form of the e-learning template influenced their acceptance of the given content of e-learning materials, as well as their understanding of this content. According to respondents with ASD, the adjusted handout was 1.5 degrees better than the unadjusted one in terms of transparency, interest, provision of information, number of interfering elements, meaningful layout, speed of memory, and comprehensibility and organization of information. Absolutely all respondents with ASD confirmed that the presence of definitions, vocabulary, and graphic elements in the e-learning material is essential. A total of 91% of respondents thought that they could ask for additional information at any time in the learning process, which indicates a tendency to use an avatar in e-learning material. However, just over half of them believe that navigation should be included in e-learning material.

4. Conclusion

When conducting the study, we found no standardized e-learning templates for SWD, except a few e-learning templates and quite a few recommendations [9, 30, 51]. However, it is very important to adhere to the provisions of the ETSI standard when creating e-learning materials and to consider that a multidisciplinary approach is then needed in designing, developing, and providing learning environments, learning materials and in the use of tools and devices if the aim is to consider all specific requirements in SWD e-learning [5].

The legislation also does not define how e-learning materials for SWD should be conceptualized and designed. We have found in the legislation only directives for the accessibility of PWD to the Internet. On 3 December 2012, on the International Day of Persons with Disabilities, the European Union adopted a Directive on the accessibility of websites of public sector bodies that provide essential information and services to citizens. The Directive stipulates that the Member States must take the necessary measures to ensure that public sector websites for PWD are accessible. In creating the accessibility of e-learning materials for SWD, we should also follow the recommendations and guidelines for the accessibility of websites, as both fall under ICT (recommendations such as text size, use of colors, etc., are the same for both online and e-learning materials).

The findings and recommendations presented in this study can help a variety of people who are actively involved in the implementation of the education process, particularly those who encounter PWD. In addition, the findings can also be a vital resource for e-learning content creators, as the technology has great potential for bringing information and knowledge closer to PWD. Because of this potential, it is essential that, in the future, the technology is even more adapted to SWD and facilitates or even overcomes barriers to access e-learning materials, e-learning and other electronic environments. A vivid example was given by Lynch [63] who foresees that in the future, professors may transform learning into an interactive experience using personal artificial intelligence tutors, helping SWD access lectures at their own pace with personalized artificial intelligence help.

In conducting the research, we found that the elements used in the case of electronic materials do not differ from the elements on the website, as the way of accessing information is the same, for example, computer. For this reason, the results of our analysis can also serve as recommendations for designers of websites aimed at SWD.

We suggest replicating the study for other SWD, for example, students with intellectual disabilities, speech and language disorders, mobility impairments, etc. Our study can be upgraded, and e-learning material, not only selected handouts, can be produced (with authentic video material of sign language interpreters, audio material of written text…). Based on these findings, an experiment could be performed, where, in addition to the acceptance of e-learning material, a difference in the effectiveness of e-learning material based on acquired new knowledge could be observed.

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References

[1] Fichten CS, Ferraro V, Asuncion JV, Chwojka C, Barile M, Nguyen MN, et al. Disabilities and e-learning problems and solutions: An exploratory study. Educational Technology & Society. 2009;**12**(4):241-256

[2] Grammenos S. European comparative data on Europe 2020 & People with disabilities, Final Report, Academic Network of European Disability Experts; 2013. Available from: https://hdl.handle.net/1813/76816 [Accessed: December 1, 2021]

[3] World Health Organization (WHO). Disability and Health. 2021. Available from: https://www.who.int/news-room/fact-sheets/detail/disability-and-health [Accessed: December 1, 2021]

[4] Schelly CL, Davies PL, Spooner CL. Student perceptions of faculty implementation of Universal design for learning. Journal of Postsecondary Education and Disability. 2011;**24**(1):17-30

[5] Petretto DR, Carta SM, Cataudella S, Masala I, Mascia ML, Penna MP, et al. The use of distance learning and e-learning in students with learning disabilities: A review on the effects and some hint of analysis on the use during COVID-19 outbreak. Clinical Practice and Epidemiology in Mental Health: CP & EMH. 2021;**17**:92. DOI: 10.2174/1745017902117010092

[6] UNESCO. Guidelines for Accessible Information in Learning. 2015. Available from: https://www.european-agency.org/sites/default/files/Guidelines%20for%20Accessible%20Information_EN.pdf [Accessed: December 1, 2021]

[7] Khasnabis C, Mirza Z, MacLachlan M. Opening the GATE to inclusion for people with disabilities. The Lancet. 2015;**386**:2229-2230. DOI: 10.1016/s0140-6736(15)01093-4

[8] McNicholl A, Casey H, Desmond D, Gallagher P. The impact of assistive technology use for students with disabilities in higher education: A systematic review. Disability and Rehabilitation: Assistive Technology. 2021;**16**(2):130-143. DOI: 10.1080/17483107.2019.1642395

[9] Fichten C, Olenik-Shemesh D, Asuncion J, Jorgensen M, Colwell C. Higher Education, information and communication technologies, and students with disabilities: The good and the bad. In: Seale J, editor. Improving Accessible Digital Practices in Higher Education – Challenges and New Practices for Inclusion. Cham: Palgrave Pivot; 2020. pp. 21-44. DOI: 10.1007/978-3-030-37125-8

[10] Cidral WA, Oliveira T, Di Felice M, Aparicio M. E-learning success determinants: Brazilian empirical study. Computers & Education. 2018;**122**:273-290. DOI: 10.1016/j.compedu.2017.12.001

[11] Simsik D, Galajdova A, Onofrejova D. Some aspects in e-learning for persons with disabilities. In: Proceedings of the 15th International Conference on Emerging eLearning Technologies and Applications. New York: IEEE; 2017. pp. 1-7. DOI: 10.1109/ICETA.2017.8102527

[12] Cataudella S, Carta S, Mascia ML, Masala C, Petretto DR, Penna MP. Psychological Aspects of Students With Learning Disabilities in E-Environments: A Mini Review and Future Research Directions. Frontiers in Psychology. 2020;**11**:611818. DOI: 10.3389/fpsyg.2020.611818

[13] Kraleva R, Sabani M, Kralev V. An analysis of some learning management systems. International Journal on Advanced Science, Engineering and Information Technology. 2019;**9**(4):1190-1198. DOI: 10.18517/ijaseit.9.4.9437

[14] Moore JL, Dickson-Deane C, Galyen K. e-Learning, online learning, and distance learning environments: Are they the same? The Internet and higher education. 2011;**14**(2):129-135. DOI: 10.1016/j.iheduc.2010.10.001

[15] Alkahtani MA. E-learning for Students with Disabilities During COVID-19: Faculty Attitude and Perception. SAGE Open. 2021;**11**(4). DOI: 10.1177/21582440211054494

[16] Cinquin PA, Guitton P, Sauzéon H. Online e-learning and cognitive disabilities: A systematic review. Computers & Education. 2019;**130**:152-167. DOI: 10.1016/j. compedu.2018.12.004

[17] Calle-Jimenez T, Sanchez-Gordon S, Arias-Flores H. Profiling of e-learning users with accessibility needs. In: International Conference on Applied Human Factors and Ergonomics 2021. Cham: Springer; 2021. pp. 477-485. DOI: 10.1007/978-3-030-80091-8_56

[18] Seale J, Georgeson J, Mamas C, Swain J. Not the right kind of 'digital capital'? An examination of the complex relationship between disabled students, their technologies and higher education institutions. Computers & Education. 2015;**82**:118-128. DOI: 10.1016/j. compedu.2014.11.007

[19] Kajee L. Disability, social inclusion and technological positioning in a South African higher education institution: Carmen's story. Language Learning Journal. 2010;**38**(3):379-392. DOI: 10.1080/09571736.2010.511783

[20] Keeler CG, Horney M. Online course designs: Are special needs being met? The American Journal of Distance Education. 2007;**21**(2):61-75. DOI: 10.1080/08923640701298985

[21] Fresen JW, Hill RK, Geng F. A collection of suggested electronic course templates for use in higher education. Research in Learning Technology. 2014;**22**. DOI: 10.3402/rlt.v22.21669

[22] Hatipoglu N, Tosun N. The design of renewable and interactive e-book template for e-learning environments. Online Journal of Communication and Media Technologies. 2012;**2**(2):126. DOI: 10.29333/ojcmt/2382

[23] Savidis A, Grammenos D, Stephanidis C. Developing inclusive e-learning systems. Universal Access in the Information Society. 2006;**5**(1):51-72. DOI: 10.1007/s10209-006-0024-1

[24] Wen ZA, Silverstein E, Zhao Y, Amog AL, Garnett K, Azenkot S. Teacher views of math e-learning tools for students with specific learning disabilities. In: The 22nd International ACM SIGACCESS Conference on Computers and Accessibility. New York: ACM; 2020. pp. 1-13. DOI: 10.1145/3373625.3417029

[25] Smith C. Challenges and opportunities for teaching students with disabilities during the COVID-19 pandemic. International Journal of Multidisciplinary Perspectives in Higher Education. 2020;**5**(1):167-173

[26] Debevc M, Stjepanovič Z, Holzinger A. Development and evaluation of an e-learning course for deaf and hard of hearing based on the advanced Adapted Pedagogical Index method. Interactive learning environments. 2014;**22**(1):35-50. DOI: 10.1080/10494820.2011.641673

[27] European Telecommunications Standards Institute (ETS). Accessibility requirements suitable for public procurement of ICT products and services in Europe – EN 301 549 v.2.1.2. 2018. Available from: https://www.etsi.org/deliver/etsi_en/301500_301599/301549/02.01.02_60/en_301549v020102p.pdf [Accessed: December 1, 2021]

[28] Persson H, Åhman H, Yngling AA, Gulliksen J. Universal design, inclusive design, accessible design, design for all: different concepts—one goal? On the concept of accessibility—historical, methodological and philosophical aspects. Universal Access in the Information Society. 2015;**14**(4):505-526. DOI: 10.1007/s10209-014-0358-z

[29] Debevc M, Kožuh I, Raspopovic M, Kaplarski K, Ljubojevic D, Kartasidou L, et al. E-learning approaches for supporting higher education (HE) students with disabilities on transition planning. In: Ćirić T, Jovanović SM, editors. Proceedings of the Seventh International Conference on eLearnin. Belgrade, Serbia: Belgrade Metropolitan University; 2016. pp. 110-115

[30] Cooper M. Making online learning accessible to disabled students: an institutional case study. ALT-J. 2006;**14**(1):103-115. DOI: 10.1080/09687760500479779

[31] Khazanchi P, Khazanchi R. Pedagogical practices in teaching students with disabilities in inclusive education. In: Handbook of Research on Critical Issues in Special Education for School Rehabilitation Practices. Hershey, Pennsylvania: IGI Global; 2021. pp. 66-86. DOI: 10.4018/978-1-7998-7630-4.ch004

[32] Kelley P, Sanspree M, Davidson R. Vision impairment in children and youth. In: The Lighthouse Handbook of Vision Impairment and Vision Rehabilitation.

Vol. 2. New York: Oxford University Press; 2000. pp. 1111-1128

[33] Permvattana R, Armstrong H, Murray I. Web-based learning environments for the vision impaired. In: Kommers P, Issa T, Isaias P, editors. Proceedings of the IADIS International Conference: Internet Technologies and Society. Perth: IADIS press; 2010. pp. 277-281

[34] Creed C. Assistive tools for disability arts: Collaborative experiences in working with disabled artists and stakeholders. Journal of Assistive Technologies. 2016;**10**(2):121-129. DOI: 10.1108/JAT-12-2015-0034

[35] Permvattana R, Armstrong H, Murray I. E-learning for the vision impaired: A holistic perspective. International Journal of Cyber Society and Education. 2013;**6**(1):15-30. DOI: 10.7903/ijcse.1029

[36] Kesič DM, Blažič M, Kavkler M. Vsi učenci so lahko uspešni: napotki za delo z učenci s posebnimi potrebami [All students can be successful: Guidelines for working with students with special needs.]. Ljubljana: Rokus Klett; 2010

[37] Stinson MS, Eisenberg S, Horn C, Larson J, Levitt H, Stuckless R. Real-time speech-to-text services. In: Stuckless R, editor. Reports of the National Task Force on Quality Services in Postsecondary Education of Deaf and Hard of Hearing Students. Rochester, New York: Northeast Technical Assistance Center, Rochester Institute of Technology; 1999. pp. 1-22

[38] Stinson MS, Elliot LB, Kelly RR, Liu Y. Deaf and hard-of-hearing students' memory of lectures with speech-to-text and interpreting/note taking services. The Journal of Special Education. 2009;**43**(1):52-64. DOI: 10.1177/0022466907313453

[39] Lartz MN, Stoner JB, Stout LJ. Perspectives of assistive technology from deaf students at a hearing university. Assistive Technology Outcomes and Benefits. 2008;**5**(1):72-91

[40] Kuzu A. The factors that motivate and hinder the students with hearing impairment to use mobile technology. The Turkish Online Journal of Educational Technology-TOJET. 2011;**10**(4):336-348

[41] Žagar D. Drugačni študenti [Different Students]. 1st ed. Ljubljana: Znanstvena založba Filozofske fakultete; 2012

[42] Ceranoglu TA. Autism spectrum disodrers and electronic media use: Empathy with avatars. Journal of the American Academy of Child & Adolescent Psychiatry. 2016;**10**(55):S70. DOI: 10.1016/j.jaac.2016.07.714

[43] Mantziou O, Vrellis I, Mikropoulos TA. Do children in the spectrum of autism interact with real-time emotionally expressive human controlled avatars? Procedia Computer Science. 2015;**67**:241-251. DOI: 10.1016/j.procs.2015.09.268

[44] Lombardi AR, Murray C, Gerdes H. College faculty and inclusive instruction: Self-reported attitudes and actions pertaining to Universal Design. Journal of Diversity in Higher Education. 2011;**4**(4):250. DOI: 10.1037/a0024961

[45] Clark RC, Mayer RE. E-Learning and the science of instruction: proven guidelines for consumers and designers of multimedia learning. San Francisco: John Wiley & Sons; 2016

[46] Lockwood F, editor. Open and Distance Learning Today. Routledge Studies in Distance Education. London: Routledge; 2013

[47] Dexter DD, Hughes CA. Graphic organizers and students with learning disabilities: A meta-analysis. Learning Disability Quarterly. 2011;**34**(1):51-72. DOI: 10.1177/073194871103400104

[48] Delisio LA, Bukaty CA, Taylor M. Effects of a graphic organizer intervention package on the mathematics word problem solving abilities of students with autism spectrum disorders. Journal of Special Education Apprenticeship. 2018;**7**(2):n2

[49] Wiebe EN, Annetta LA. Animation and narration: Using eye tracking to understand visual attention distribution. In: Annual meeting of the Americal Educational Research Association. Chicago: Department of Mathematics, Science and Technology Education; 2007

[50] Caldwell B, Cooper M, Reid LG, Vanderheiden G, Chisholm W, Slatin J, et al. Web content accessibility guidelines (WCAG) 2.0. WWW Consortium (W3C). 2008;**290**:1-34

[51] Center IRIS. Priporočila za oblikovanje besedila za tisk za populacijo slabovidnih oseb [Recommendations for drafting a print text for the visually impaired people]. 2017. Available from: http://center-iris.si/pomoc-inkluziji/pripomocki/priporocila-za-oblikovanje-besedila-za-tisk-za-populacijo-slabovidnih-oseb/ [Accessed: December 1, 2021]

[52] Fabri M, Andrews P. Evaluation of Course Scenario Prototypes with Representative Students and Autism Professionals. Leeds Beckett University. Report D3.2 autism&uni, 2015. Available from: https://www.autism-uni.org/wp-content/uploads/2015/10/D3.2-AutismUni-Evaluation-of-Prototype-Scenarios.pdf [Accessed: December 1, 2021]

[53] Riddell S, Weedon E. Disabled students in higher education: Discourses

of disability and the negotiation of identity. International Journal of Educational Research. 2014;**63**:38-46. DOI: 10.1016/j.ijer.2013.02.008

[54] Debevc M, Milošević D, Kožuh I. A comparison of comprehension processes in sign language interpreter videos with or without captions. PLoS One. 2015;**10**(5):e0127577. DOI: 10.1371/journal.pone.0127577

[55] Ministry of Public Administration of Republic of Slovenia – Administrative Academy. Navodila za izvajalce usposabljanj na upravni akademiji [Instructions for trainers at the Administrative Academy]. 2016. Available from: http://www.mju.gov.si/fileadmin/mju.gov.si/pageuploads/JAVNA_UPRAVA/Upravna_akademija/UA/Za_izvajalce/Navodila_za_izvajalce_usposabljanj_UA_okt2016__002_.pdf [Accessed: December 1, 2021]

[56] Gozd in gozdarstvo. Lipa [Linden]. 2017. Available from: https://www.gozd-les.com/slovenski-gozdovi/drevesa/lipa. [Accessed: December 1, 2021]

[57] World Medical Association. World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. Bulletin of the World Health Organization. 2001;**79**(4):373

[58] American Psychological Association. Ethical Principles of Psychologists and Code of Conduct. 2017. Available from: https://www.apa.org/ethics/code/ [Accessed: December 1, 2021]

[59] Nemoto T, Beglar D. Likert-scale questionnaires. In: Sonda N, Krause A, editors. JALT 2013 Conference Proceedings. Tokyo: JALT; 2014. pp. 1-8

[60] Edutechwiki. Usability and User Experience Surveys. 2017. Available from: http://edutechwiki.unige.ch/en/Usability_and_user_experience_surveys [Accessed: December 1, 2021]

[61] Friedman HH, Herskovitz PJ, Pollack S. The biasing effects of scale-checking styles on response to a Likert scale. In: Proceedings of the American Statistical Association Annual Conference: Survey Research Methods. Vol. 792. 1994. pp. 792-795

[62] Brown S. Likert Scale Examples for Surveys. ANR Program Evaluation, Iowa State University, USA. 2010. Available from: https://www.extension.iastate.edu/Documents/ANR/LikertScaleExamplesforSurveys.pdf [Accessed: December 1, 2021]

[63] Lynch M. My Vision for the Future of the Assistive Technology in Education. Resource Document. The Edvocate. 2018. Available from: https://www.theedadvocate.org/vision-future-assistive-technology-education/ [Accessed: December 1, 2021]