Inclusive Higher Education during the Covid-19 Pandemic

K. Zdravkova* and V. Krasniqi **
* University Ss. Cyril and Methodius, Faculty of Computer Science and Engineering, Skopje, N. Macedonia
** PhD Student, Kosovo
katerina.zdravkova@finki.ukim.mk

Abstract - **The Covid-19 pandemic caused a sudden shift towards online teaching, learning and assessment, which was troublesome for both teachers and students. The most affected were the students with various disabilities, whose inclusive options provided in the classroom were no longer available at home. Many socially responsible universities managed to support the education for differently abled students enabling various forms of alternative activities that partially or completely bypass their problems. This paper reviews the accessibility options of operating systems, learning management systems and especially assistive technologies that facilitate the education of impaired students. They cover the add-ons and tools for vision and hearing impairment. Teaching, learning and assessment are carefully examined for both disabilities. Particular attention is paid to practical work, which is a compulsory part of many higher education courses. The paper concludes with the major barriers of online higher education, which should during Covid-19 pandemic enable an equal right to all the students, regardless of their physical and mental disabilities.**

Keywords - accessibility, assistive technologies, inclusive hgher education

I. INTRODUCTION

According to Article 26 of the Universal Declaration of Human Rights, education is one of the main human rights [1]. Moreover, "higher education shall be equally accessible to all on the basis of merit". The outbreak of Covid-19 impacted education worldwide, demanding an instant closedown of schools. UNESCO estimated that in the beginning of April 2020, 84.8% of total enrolled learners in all forms of education were not attending school [2].

To enable education for all, particularly for university students, most countries have instantly shifted towards online learning, discriminating the university students and the schools with inadequate social, economic and infrastructural conditions, as well as the staff and students with lower information technology competence. Without a doubt, the most affected were the students with various disabilities, whose inclusive options provided in the classroom were no longer available at home. It had seriously worsened the fact that very few students with disabilities will ever get a college degree [3]. Many responsible universities, which have had a capacity to make reasonable adjustments, managed to provide accessibility options for differently abled students [4], [5], [6], [7]. They typically include magnification and navigation of the content by speech, listening of the content using a screen reader; the opportunity to change colors, contrast levels and fonts for vision impaired students; accessible applications based on sign language for hearing impaired; and a variety of tools for students with communication or cognitive disorder.

All these accessibility applications are offered for students who attend the lectures within university premises. Most of the afore mentioned assistive technologies can also be used at home, allowing the impaired students to successfully continue their higher education in spite of the extraordinary conditions the pandemic brought.

Assistive technologies incorporate personal aids, assistive products and assistive medical devices that have a potential to reduce the growing exclusion of students with disabilities [8]. They have facilitated students with various impairments to have better learning opportunities, to gain greater independence in achieving their educational goals and to become more self-confident [9].

Regrettably, only 10% of the people who need assistive technologies can access those [8]. Does this estimation imply that the majority of higher education students were sacrificed due to Covid-19 pandemic? Probably not, because all the frequently used operating systems have accessibility options [10], most learning management systems (LMS) support accessibility too [11], and a wide range of Web based and mobile assistive applications are offered free of charge or for a reasonable fee [12]. These allow for abundant usage to avoid the discrimination on the basis of disability.

The major prerequisites to achieve this goal is students' previous experience with accessibility products, the awareness of universities to suggest the best options, and the teachers' competence to get the best out of them.

The paper continues with Section 2, which presents common accessibility suites of operating systems and accessibility features of learning management systems. Sections 3 introduces the assistive technologies for hearing and vision impairment, where teaching, learning and assessment have been carefully examined. Section 4 introduces the opportunity to support practical work. The paper concludes with the major barriers of online higher education, which should during Covid-19 pandemic enable an equal right to all the students, regardless of their physical and mental disabilities.

II. ACCESSIBILITY OF OPERATING SYSTEMS AND LEARNING MANAGEMENT SYSTEMS

The most popular operating systems (OS): Android, Mac OS, Microsoft Windows and Ubuntu have many embedded accessibility options. Android offers accessibility applications and services, like Accessibility Menu, Select to Speak, Switch Access, TalkBack and TalkBack Braille keyboard [13]. Mac, on the other hand, provides accessibility shortcuts with a keyboard or assistive devices enabling voice control, audio description of presented content, and access to magnifiers and screen readers, as well as support for physical and motor impairment [14]. Moreover, Windows offers magnification and modification of the screen content, which can be presented verbally or with Braille display using Narrator [15]. These are available on all Office applications. Additionally, they provide access to people with learning, mobility, and cognitive impairment. And finally, Ubuntu provides the screen reader Orca, keyboard modifier for mobility disabled, and voice recognition [16]. OS accessibility options successfully bypass many problems of handicapped students, particularly the ones with vision and hearing incapacities, helping them use the equipment and to access LMSs.

LMS accessibility was examined for Blackboard Learn [17], D2L Brightspace, formerly Desire2Learn [18], Canvas [19] and Moodle [20]. The selection of these LMSs was done referring PCMag's systematic review of various technical journals [21], marketplaces [22], and knowledge sharing platforms [23], which are endorsed by scholar references [24]. Their basic audio, vision and motor impairment add-ons are presented in Table I.

All the LMSs have embedded accessibility add-ons that support teaching and learning of students with vision or with hearing impairments. Screen magnification is part of them all. Deaf-blind students can attend online classes only if they use Blackboard Ally, which has a refreshable Braille display (RBD). Screen readers are part of testing plugins, enabling the assessment of blind students as well. Moreover, all examined LMSs have navigation keyboards that are crucial to facilitate education of motor impaired.

Unlike teaching and learning, which is facilitates by the LMSs that were assessed, the assessment is explicitly mentioned only for D2L [18]. D2L embeds third-party accessibility testing services, such as Axe, Lighthouse, WAVE, HTML CodeSniffer and Bookmarklets. They are accessed via a cloud-based platform.

In parallel with the self-created tools that support assistive education, learning management systems usually embed standalone accessibility applications, which are compatible for different OS (Table I). They will be presented in more details in the following sections of this paper.

III. ASSISTIVE TECHNOLOGIES FOR VISION IMPAIRED STUDENTS

The assessment of online learning accessibility of selected applications mentioned in Section 2, is examined using the recommendations that are most suitable for higher education. They were suggested in Web Content Accessibility Guidelines (WCAG) 2.1 [25]. WCAG is a referenceable technical standard that was approved as an ISO standard ISO/IEC 40500:2012 [26], with a new version 2.2 announced for 2021. WCAG 2.1 covers four major accessibility principles, based on examining whether the content is perceivable, operable, understandable and robust. The requirements are divided into three levels of conformance: A (lowest), AA and AAA (highest). They define the testable success criteria necessary for design specifications.

Captions are intended for hearing impaired, while label in name for vision impaired only. Prerecorded media alternative and live audio are the high-level criteria belonging to level AAA and they are intended for deaf and hard of hearing. The conformance of the most frequently used applications with these success criteria for hearing impaired is presented in Table III.

Non-text content enables presentation of the written content with text or with Braille alphabet. Audio-only and video-only provides an alternative to listen, see or touch the pre-recorded content. Captions are intended for hearing impaired, who can access prerecorded auditory information of the content presented on the screen. Label in name activates control that briefly explains the content appearing on the screen. These four success criteria belong to level WCAG 2.1 recommendations belonging to level A, the first two are intended for both vision and hearing impaired.

TABLE I. COMPARISON OF LMS ACCESSIBILITY FEATURES

LMS	Accessibility features			
	Blackboard Learn	*Brightspace D2L*	*Canvas LMS*	*Moodle*
LMS name	Blackboard Ally	Brightspace CORE	Canvas LMS	Moodle
Screen magnif. tools	Partially supported	Zoomtext	Supported with own tools	Supported with own tools
Screen reader tools	Chrome JAWS	JAWS NVDA VoiceOver Talkback	JAWS VoiceOver	JAWS NVDA Chromevox ORCA
Audio descript. tools	Ultra	Partially supported	Not applicable	Not applicable
Speech recognit. tools	Read Speaker	Dragon Inspection	Not applicable	Not applicable
Braille display	RBD	Partially supported	Not applicable	Not applicable

TABLE II. APPLICATIONS FOR VISION IMPAIRED AND WCAG

Success criterion	WCAG 2.1 compatibility		
	JAWS	*VoiceOver*	*ZoomText*
Non-text Content	Supported	Supported	Supported
Audio only	Supported	Supported	Supported
Label in name	Supported	Supported	Supported
Media alternative	Partially supported	Partially supported	Partially supported
Audio only (live)	Partially supported	Partially supported	Partially supported

TABLE III. APPLICATIONS FOR HEARING IMPAIRED AND WCAG

Success criterion	WCAG 2.1 compatibility		
	AVA	*RogerVoice*	*VoxSci*
Captions	Supported	Supported	Supported
Video only	Supported	Supported	Supported
Sign language	Not applicable	Partially supported (English, French)	Partially supported (British English)
Audio control	Partially supported	Partially supported	Partially supported
Text alternatives	Supported	Supported	Partially supported
Images of Text	Partially supported	Not applicable	Not applicable

JAWS [27] and VoiceOver [28] are screen readers for Windows and macOS users correspondingly. JAWS was recently powered with the text magnifier Zoomtext [29], making Vision. Vision is available in English, Spanish, German, French and Dutch for an annual fee of 160 US$. VoiceOver's advanced version VoiceOver with Braille offers better support to vision impaired and deaf-blind students. It currently supports only those students who are familiar with English and Spanish. Compared with these screen readers, NVDA for Windows [30] offers around 50 languages, which also provide Braille display. VoiceOver and NVDA are free.

IV. ASSISTIVE TECHNOLOGIES FOR HEARING IMPAIRED STUDENTS

By choosing the option for screen reading, vision impaired and blind students can study at home, do self-assessments and successfully participate in the quizzes and examinations [31]. They are more convenient than Braille's displays, which can be used by only 10% of all the students who are familiar with the Braille alphabet.

Table III presents the conformance of the popular assistive technologies for hearing impaired: AVA [32], Roger Voice [33] and VoxSci [34] with the WCAG 2.1 success criteria. They predominantly include the time-based media, which were introduced in Section III. AVA enables speech recognition, lip reading and live transcription of lectures, helping hard of hearing and deaf students have an access to spoken lectures and to quizzes. Intended for mobile phone use, Roger Voice for Android and iOS successfully supports collaboration among students, enabling them to communicate with colleagues who have no disabilities. VoxSci is a British sign language translator, which is converting voice messages into text. It is not embedded in LMSs.

V. ASSISTIVE TECHNOLOGIES SUPPORTING PRACTICAL WORK

Practical laboratory work and experiments improve the practical skills of students in various courses, from STEM to medicine and arts [35]. Implementation of different techniques like virtual labs, simulations and hands-on exercises in online learning environments proved their usefulness and effectiveness gaining students' appreciation [36].

Recently, LMS Moodle was redesigned and fed with engineering related content adapted for blind, deaf and deaf-blind students [37]. The assessment was done using multiple choice questions presented visually for the deaf, and auditory for the blind.

VI. FINAL REMARKS

Students with different disabilities should have an equal right to education as all their colleagues. Unfortunately, as a consequence of full closedown of schools caused by the Covid-19 pandemic, in average two thirds of previous academic was lost [38]. The only solution for higher education to continue the school year was to shift to online education. This was not painless, particularly not for the differently abled students. They seem to be "at great risk of losing connection both academically and emotionally" [39].

One school year usually makes a difference in life. With the new pandemic peaks, it is obvious that the online education will remain the only alternative at least by autumn semester 2021, making the discrimination due to disabilities more profound. Regardless of many available software tools supporting inclusive education, only the privileged students have the opportunity to actively attend the lectures, study at home and pass their exams. There are several major obstacles they face. The first problem is the digital divide, i.e. the disability of many students worldwide to connect to the Internet. At the moment, if affects in average 40% of all the population, predominantly in the economically underdeveloped countries [40]. The second barrier is the lack of LMS experience among many teachers and students, affecting the quality of teaching and the accuracy of assessment. Unavailability of most software tools supporting disabled students in languages different from English and Spanish is a drawback for vision and hearing impaired who are not confident in using them. Cost can also be a restriction, particularly during learning at home, because universities provide only the school access for teaching and examination. With determined activities of governments and considerable investments in education, the situation can improve, reducing the discrimination on the basis of poverty and disability.

VII. CONCLUSION

Despite all the efforts to support inclusive education, the greatest challenge will always remain unsolved. Online teaching and learning drastically decrease social interaction during education. It is important for all students, especially for those who need additional care due to their specific needs. No digitally supported activity can substitute the established friendly relationship between teachers and students, professors' readiness to find the most appropriate hints to demystify the incomprehensible subjects, their ability to make analogies with everyday activities, and capacity to bridge most problems. For ages, good teachers have been role models students were inspired of and trying to mimic. This human dimension of education is missing today. If all students do not return back to traditional education soon, and especially the differently abled, their emotional stability, mental health, motivation and well-being will be endangered.

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