Assessment of the Need in ICT-Based Accommodations for Higher Education Students

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Abstract

The purpose of the study is to assess the health-related needs in special learning environments (including e-learning) for students of mathematical and information technology specialties. The study was carried out in April 2021 on the Faculty of Mathematics and Computer Science of the V.I. Vernadsky Crimean Federal University. A representative sample of 182 students was obtained by the method of an anonymous voluntary online survey. The questionnaire was developed based on the methodology of the World Health Organization Model Disability Survey and contained 64 single-choice questions and 17 multiple-choice questions. The survey results were processed employing IBM SPSS Statistics 23.0. It was revealed that a significant number of respondents have health disorders, believe that the choice of learning format (distance/blended/full-time) may allow them to overcome their health-related problems, need easy access to online courses due to health reasons. Among factors that might significantly simplify learning, the respondents indicated: captions and transcripts in video lectures, audio descriptions in video lectures, synopses of video lectures, the ability to customize a webpage, the ability to control any page only with the keyboard, and other web accessibility success criteria. Results of the survey show an urgent need for specialized learning conditions for a substantial part of students. This need could be minimized, among other things, with the help of e-learning resources that conform to WCAG 2.1 web accessibility requirements.

Keywords 1

Health Disorders, Special Needs in Education, ICT, Accommodations, Web Accessibility, Higher Education Students, E-learning

1. Introduction

According to the Convention on the Rights of Persons with Disabilities (2006) [1], education should become inclusive at all levels, including higher education in particular. The inclusiveness of education is achieved by providing "reasonable accommodation", which is understood as making "necessary and appropriate modifications and adjustments" (special conditions and services) for people with special needs. It is known that students with disabilities have difficulties in inclusion into educational processes because of unsatisfied demands on reasonable accommodations [2]. On the other hand, there is a positive correlation between the use of reasonable accommodations, including assistive technologies, and quality of education, including academic progress, participation in learning activities, and perception of higher education institution as a friendly environment [3].

Reasonable accommodations in learning broadly mean any changes in the learning process, which allow reducing the negative impact of health disorders on adapting access to educational programs [4]. Reasonable accommodations determine the ways of presenting and delivering learning content; assessing knowledge and receiving feedback from students; adapting the time of educational activities and learning schedule; suitable placing the students and teachers [4]. The information and

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Proceedings of VI International Scientific and Practical Conference Distance Learning Technologies (DLT-2021), September 20-22, 2021, Yalta, Crimea

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CEUR Workshop Proceedings (CEUR-WS.org)

communication technologies (ICT) based assistive tools are essential components of reasonable accommodations in learning. Authors of the review [5] concluded that assistive hardware and software make learning tasks easier and more efficient, lead to positive psychological changes as well as increase the learning activity and academic progress of students with disabilities. In this way, students identified as persons with special educational needs and provided with reasonable accommodations (including ICT-based ones) are more likely to be integrated into the learning environment and receive high-grade education.

At the same time, recent studies show that a significant number of university students with health disorders and disabilities are not identified, and as a result, they are not covered by special learning conditions [2]. The lack of real data about the health and disability status of university undergraduates is because students keep silent about their disabilities or cannot on their own identify health disorders demanding special conditions in education [6]. Students at large universities and students with higher achievement levels are less likely to report their need for accommodations and services in learning [7]. Fear of discrimination, stereotypes, pity, exclusion from a student society, deviation from the "norm" of a typical student is also indicated among the reasons that stop students from disclosing their disabilities and health problems [5, 8-10]. The refusal of self-identification or unwillingness to use accommodations in learning can negatively affect the academic success of students with special needs [9].

It is more difficult to identify a student with an "invisible" disability or latent health impairments. The "invisibility" of disability is a predictor of students' adaptation difficulties in higher education [11]. In e-learning using Internet technologies, all students with disabilities become "invisible" and that can lead to the marginalization of the target group if the design of educational web resources is not focused on accessibility and inclusion [12, 13].

The identification of persons with special needs is a health issue. The Model Disability Survey (MDS) of the World Health Organization [14] has been developed to collect complete, comprehensive, and relevant information on health disorders and disabilities in the adult population. The MDS methodology aims to obtain data on the actual health state of people who were not previously identified in terms of disability. The accuracy and flexibility of MDS questionnaires allow applying this methodology to obtain precise data concerning the depth and characteristics of health-related problems in various fields of human activity including education and learning.

The purpose of our study is to assess with the help of MDS toolkit the health-related needs in special learning environments (including e-learning) among students of mathematical and information technology specialties.

2. Material and Methods

The study was carried out in April 2021 on the Faculty of Mathematics and Computer Science of V.I. Vernadsky Crimean Federal University. According to official data [15], a total of 547 persons study at the faculty including 359 males (65.6%), 188 females (34.4%); 448 bachelors (81.9%), 99 masters (18.1%). 11 students (2%) are formally registered as disabled persons. Other students with special health needs are not identified and special education tools (accommodations) for such persons are not established.

The questionnaire is based on the MDS methodology [14], it contains 64 single-choice and 17 multiple-choice questions. To control the representativeness of the sample, the questionnaire includes items "sex" and "education level".

A representative sample of 182 students (confidence interval 90%; 113 males (62.1%), 69 females (37.9%); 150 bachelors (82.4%), 32 masters (17.6%)) was obtained by the method of anonymous voluntary online survey using the Google Forms tool (Google LLC, USA). The survey results were processed using IBM SPSS Statistics 23.0 (IBM Corporation, USA) using descriptive statistics methods.

3. Results

The results of our study are divided into two parts. The first part examines the health state of students and health-related educational problems. The second part studies contextual factors affecting learning and usage of ICT-based accommodations in learning.

3.1. A Faculty Health State and Educational Problems **3.1.1.** Health Status and Health Disorders

108 respondents (59.3%) identified their health as good or very good. Moderate health condition was reported by 56 students (30.8%). 15 persons (8.2%) complained of their poor health, 3 persons (1.6%) rated their health status as very poor.

136 persons (74.7%) reported that they are diseased or have health problems at the time of the interviewing. From the proposed list of health disorders, the respondents identified following ones: visual inadequacy - 71 (39.0%), hearing deficiency - 14 (7.7%), impaired motor functions - 6 (3.3%), high blood pressure - 10 (5.5%), heart disease - 12 (6.6%), chronic bronchitis or emphysema - 5 (2.7%), asthma, allergic respiratory disease - 8 (4.4%), back or joint pain - 56 (30.8%), depression - 23 (12.6%), anxiety - 41 (22.5%), trauma - 5 (2.7%), mental or behavioral disorders - 13 (7.1%). Gastrointestinal diseases, neuralgia, eating disorders, epilepsy, impaired renal function, chronic tonsillitis, hypotension, and other disorders were indicated in isolated cases. Thereby, the three most common health problems are visual impairment, back or joint pain, and anxiety.

23 respondents (12.6%) take medication on regular basis.

3.1.2. Health-related Difficulties in Activities

The respondents were asked to rate the degree of difficulties that they experience because of their health state. The evaluation was performed with the help of a five-point scale, where 1 means no difficulty and 5 means extreme or insurmountable difficulties.

It was found that the respondents have the least difficulties with the viewing nearby (no problems - 162 (89.0%) persons, serious and insurmountable difficulties - 2 (1.1%) persons), with the hearing another person in a quiet room (158 (86.8%) and 1 (0.5%), respectively), with the support of conversation during "live" communication (157 (86.3%) and 2 (1.1%), respectively). The greatest difficulties are related to the mental sphere and feeling fatigued. 29 (15.9%) respondents indicated that their perception of fatigue and lack of energy is an extreme, often insurmountable problem for them. 30 (16.5%) persons experience serious difficulties with feelings of concern, nervousness, or anxiety, 27 (14.8%) - with feelings of sadness, gloom, or depression.

More than a half of the respondents told about health-related difficulties with seeing far off, remembering and concentration, forgetfulness, controlling important things in life, solving all preplanned tasks.

A significant result of this study is the fact that none of the respondents indicated sitting at the computer as an insurmountable health problem. An example of table styling. It is recommended to add cross-references to tables, i.e., please, check Table 1. The style should be switched to Normal.

3.1.3. Health-related Critical Situations in Learning

Survey results show that the majority of respondents have managed to avoid health-related critical situations in learning. At the same time, 110 persons (60.4%) reported on situations when their health conditions negatively affected their academic results, 35 persons (19.2%) at least once thought about being sent down from the university for health reasons, 71 respondents (39.0%) indicated that their state of health caused the anxiety due to possible decline in academic results and supposed expulsion from the university. 40 students (22.0%) have found themselves in situations when, due to health problems,

they could not complete tasks in the proposed way, 17 persons (9.3%) reported that their health conditions formerly did not allow them to use electronic educational resources.

It was found that 38 respondents (20.9%) for health reasons needed assistance in education but did not know whom to ask for help at the university. 18 persons (9.9%) asked for help but did not receive it. The crosstabs analysis for variables "presence and characteristics of health disorders" and "assistance in the education for health reasons" showed that the group of respondents who never asked for help in learning mainly (68.0%) consists of persons with health disorders.

33 students (18.1%) reported that they received help with their learning at home or the university due to health problems.

3.2. Contextual Factors and ICT-based Accommodations **3.2.1.** Contextual Factors Affecting Learning

A total of 128 persons (70.3%) answered the question about the need for reasonable accommodation in learning. The choice of learning format (distant/blended/full-time) was found to be the most chosen factor leading to overcoming health-related learning problems; the use of assistive equipment and software was the least likely to be chosen (Figure 1). At least every fifth respondent chose to change the learning and exam schedules and access to electronic educational resources in all subjects as a reasonable accommodation. About one-third of the respondents told that they need to extend the deadlines for completing control tasks and tests.



Figure 1: Distribution of answers to the question "Indicate factors which, in your opinion, would help you overcome learning difficulties related to your health (you can choose more than one answer or choose none)"

In the next question, each factor of the learning environment was assessed using a five-point scale, where 1 - "makes it very difficult", 5 - "makes it very easy". In total, 22 factors were assessed in four blocks: workplace equipment, classroom environment, training format, web accessibility of electronic educational resources. Web accessibility factors were determined according to the WCAG 2.1 Web Accessibility Guidelines [16].

The distribution of answers at the extreme points of the scale (for all factors) showed that the greatest learning difficulties are connected with the noise and overcrowding in an office or classroom (49; 26.9%). A quiet and calm environment, on the contrary, greatly simplifies learning (95; 52.2%).

In general, the respondents were satisfied with the user's workplace equipment both at home and at the university - 68 (37.4%) and 37 (20.3%), respectively, choosing the most popular option "very easy".

According to the respondents, distance learning works more often as an accelerator (58; 31.9%) than as a barrier (25; 13.7%). The blended learning (distance lectures, face-to-face practical lessons) rather complicates learning (37; 20.3%) than simplifies it (28; 15.4%) The full-time learning was considered as a barrier and accelerator in approximately equal shares: 24 (13.2%) and 23 (12.6%), respectively. The obtained data, on the one hand, confirm the advantage of distance learning from the standpoint of health, on the other hand, they indicate the need for giving students the choice. Besides, 63 respondents (34.6%) prefer a pair/group format of work on practical tasks. 35 students (19.2%) consider learning through online courses as a very good solution for themselves.

The group of factors related to web accessibility stands out among other learning accelerators. The respondents stated the following characteristics of electronic educational resources which greatly simplify learning:

- video lectures have captions and/or transcripts 34 persons (18.7%);
- audio description of video lectures corresponds to the video 41 (22.5%);
- the web page provides the customization (choice of font size, contrast, and color scheme) 36 (19.8%);
- media player provides adjustable video speed and audio volume 67 (36.8%);
- web page structure is not distorted by changing screen resolution or size of the browser window and by usage in a mobile device 59 (32.4%);
- any hyperlink corresponds to a specific link purpose, there are no links like "Click here", "Forward" 54 (29.7%);
- lecture synopsis corresponds to video lecture 84 (46.2%);
- the web page can be controlled with a keyboard without a mouse 36 (19.8%).

3.2.2. Assistive Technologies and Adaptive Strategies in Learning

With the view to analyze actual, prospective, and retrospective inclusion of assistive technologies and adaptive strategies in learning, the respondents were asked to assess each technology or strategy in three time periods: A - I use it now; B - I think I need it; C - I used it earlier. Five blocks of dysfunctions were considered: visual impairment; hearing and speech impairment; disorders of orientation, memory, and attention; cognitive impairment and learning disabilities; disorders of the musculoskeletal system. For each block, a list of technologies and strategies was prepared. The distribution of respondents' answers is presented in Table 1.

Table 1

Application of assistive technologies and adaptive strategies in learning

Technology or strategy	A – I use it	B – I think	C – I used	
	now,	l need it,	it earlier,	
	n (%)	n (%)	n (%)	
Visual impairment				
Eyeglasses, contact lenses	60 (33.0)	52 (28.6)	58 (31.9)	
Portable digital magnifiers	3 (1.6)	2 (1.1)	3 (1.6)	
Portable optical magnifiers	0 (0.0)	0 (0.0)	1 (0.5)	
Screen magnifiers	2 (1.1)	1 (0.5)	9 (4.9)	
Screen readers	2 (1.1)	0 (0.0)	4 (2.2)	
Braille displays and keyboards	0 (0.0)	0 (0.0)	1 (0.5)	
Dictation software	3 (1.6)	2 (1.1)	4 (2.2)	
Dictaphones and other recording equipment	6 (3.3)	5 (2.7)	5 (2.7)	
Audiobooks, audio lectures	13 (7.1)	6 (3.3)	9 (4.9)	
Human support (eg, an assistant who reads aloud, explains	5 (2.7)	6 (3.3)	5 (2.7)	
a program code or illustrations)				

Hearing and speech impairment					
Hearing aids	0 (0.0)	1 (0.5)	0 (0.0)		
Inductance loop	0 (0.0)	1 (0.5)	0 (0.0)		
FM systems	0 (0.0)	2 (1.1)	0 (0.0)		
Light / sound / vibration alarms	1 (0.5)	0 (0.0)	0 (0.0)		
Video captions	5 (2.7)	6 (3.3)	7 (3.8)		
Video transcripts	1 (0.5)	1 (0.5)	1 (0.5)		
Sign language in video	0 (0.0)	0 (0.0)	0 (0.0)		
Communication programs	0 (0.0)	0 (0.0)	1 (0.5)		
Communication pad	2 (1.1)	2 (1.1)	1 (0.5)		
Human support (eg, an assistant who translates speech into	2 (1.1)	2 (1.1)	1 (0.5)		
sign language)					
Disorders of orientation, memory, a	nd attention				
Global Positioning System (GPS) locators	17 (9.3)	9 (4.9)	12 (6.6)		
Voice assistant (Siri [®] , Alice [®] , and similar)	12 (6.6)	5 (2.7)	16 (8.8)		
Organizer app, diary, calendar with reminder system	40 (22.0)	23 (12.6)	31 (17.0)		
Pill organizer	8 (4.4)	7 (3.8)	6 (3.3)		
Human support (eg, an assistant who reminds you of	16 (8.8)	9 (4.9)	9 (4.9)		
deadlines and upcoming events)					
Other (neurostimulator to prevent epileptic seizure)	1 (0.5)	0 (0.0)	0 (0.0)		
Cognitive impairment and learning	disabilities				
Spelling checkers	31 (17.0)	12 (6.6)	17 (9.3)		
Word prediction programs (T9 and analogs)	33 (18.1)	9 (4.9)	17 (9.3)		
Audiobooks, audio lectures (if you find it difficult to read	10 (5.5)	4 (2.2)	4 (2.2)		
and understand the meaning of the text)					
Text-to-speech software (if you find it difficult to read and	4 (2.2)	2 (1.1)	2 (1.1)		
understand the meaning of the text)					
Dictation software (if you find it difficult to type)	2 (1.1)	3 (1.6)	3 (1.6)		
Text editors (if you find it difficult to write)	19 (10.4)	9 (4.9)	8 (4.4)		
Dictaphones and other recording equipment	9 (4.9)	3 (1.6)	6 (3.3)		
Human support (eg, an assistant who reads aloud or	4 (2.2)	3 (1.6)	3 (1.6)		
corrects spelling errors)					
Disorders of the musculoskeleta	lsystem	- (
Dictation software	3 (1.6)	2 (1.1)	1 (0.5)		
Dictaphones and other recording equipment	2 (1.1)	3 (1.6)	1 (0.5)		
Audiobooks, audio lectures	3 (1.6)	2 (1.1)	4 (2.2)		
Specialized input and control devices	6 (3.3)	5 (2.7)	3 (1.6)		
Modified or ergonomic workstation	0 (0.0)	3 (1.6)	0 (0.0)		
Corset, spine bandage	3 (1.6)	10 (5.5)	7 (3.8)		
Human support (eg, an assistant who reads aloud, prints	1 (0.5)	3 (1.6)	2 (1.1)		
and brings study materials, write from dictation)		- /			
Other (neurostimulator, orthopedic pillow)	2 (1.1)	0 (0.0)	0 (0.0)		

It was revealed that the main adaptive strategy in cases of visual impairment is to use corrective glasses or contact lenses, the second one is to listen to audio lectures and audiobooks. In addition, some students are already using or considering the use of analog and digital magnifiers, speech-to-text software, sound recording equipment, and human help. In total, 94 persons (51.6%) reported that they already use aids for vision, 99 (54.4%) have used them before, 74 (40.7%) think they need them.

The priority adaptive strategy in cases of hearing impairment is to use captions in video materials. The rest of the aids (human support, communication pad, sensory alarms, transcripts, hearing aids, induction loops, FM systems) were indicated in isolated cases. In total, 11 respondents (6.0%) have used and are using now adaptive hearing aids, 15 (8.2%) understand they need them.

Students actively use (94; 51.6%), have used (74; 40.7%), and are going to use (53; 29.1%) assistive technologies and adaptive strategies to support orientation, memory, and attention. The most popular ones are organizer apps, GPS locators, human support, and voice assistants.

112 respondents (61.5%) reported the usage of hardware and software in learning to reduce cognitive impairments and specific learning disabilities. 60 persons (33.0%) have used these technologies earlier, 45 (24.7%) believe they need them. Word prediction programs, spell checkers, and word processing programs are most requested by students with learning disabilities. Moreover, the students often indicated as helpful tools the recorders and audio materials, in some cases - text-to-speech software, dictation software, and human support.

20 students (11.0%) use adaptive strategies and assistive technologies to improve their musculoskeletal system, 28 persons (15.4%) are going to use them, 18 (9.9%) have used them in the past. Among devices and technologies, the specialized input and control devices, as well as spine corsets were most often indicated. Dictation software, audio recording equipment, audio materials, ergonomic workstation, and human support were noted less often, but at least twice.

4. Discussion

According to our knowledge, this study is the first in the former USSR states analysis of the need for reasonable accommodations (including ICT-oriented ones) for students who were not previously identified in terms of their health status. Results of this study show that three-quarters of the students reported various health disorders, sometimes persistent or chronic. More than 70% of them need some reasonable accommodation. At the same time, the university's official data declare that students with disabilities (except 11 students (2%) registered as the acknowledged invalids) are absent (not recorded) at the faculty and, therefore allegedly, there is no formal reason to spread assistive technologies and adaptive strategies in learning to a more wide audience. Thus, there is a discrepancy between the actual results and formal data on the health and educational needs of the questioned students.

The three most common health problems of students are visual impairment, back or joint pain, and anxiety. The anxiety disorders apparently may accompany the underlying disease. The greatest difficulties that learners experience during usual activities are also connected with mental health disorders. It is known that students with disabilities and special needs show higher levels of anxiety and stress than their healthy peers [8, 17]. They adapt to a higher education environment with difficulty and may think about the abandonment of their higher education due to problems arising in the integration process [11]. The latter fact is confirmed by the survey results. About 50% of the respondents reported situations when their health condition negatively affected academic efficiency or caused their anxiety concerning possible decline in academic performance. One-fifth of all respondents thought about being sent down from the university because of their poor health.

Almost 70% of students who never asked for help in education because of health reasons have diseases and health impairments. It is possible that students with health problems need psychological, medical, and pedagogical support, but do not understand this. It was shown [6, 18] that students do not report openly their health problems because they do not admit they have such problems. This is especially true for people with "invisible disabilities" [6, 19].

It was found that one-tenth of the respondents at least once got into a situation when electronic educational resources (including online courses) were inaccessible for them due to their health state. The assessment of contextual factors shows that compliance with web accessibility requirements of electronic educational resources is one of the most important learning accelerators. The problem of E-learning accessibility is widely discussed in the literature. According to [20], the number of publications on web accessibility in open education is constantly growing. A series of studies recorded multiple disruptions in the accessibility of open education platforms and massive open online courses (MOOCs) [21-25]. According to some findings [26], e-learning environments need to be designed in compliance with principles of universal design for inclusion and equal access to education.

The survey revealed that the choice of learning format (distance / blended/full-time) is a significant learning accelerator, and students with disabilities are more likely to prefer the online format. Indeed,

the Internet removes barriers peculiar to the physical environment [27] and more freely provides people with special tools [28]. Online resources could be easier aligned with accessibility requirements than similar non-electronic materials [13]. However, the total introduction of distance learning should be treated with caution due to the "invisibility" of students. Roberts et al. (2011) found out that students who study merely online less often disclose their health problems and ask for support [29].

Among reasonable accommodations in learning, the option "use of assistive equipment and software" was indicated by the respondents more seldom than others. At the same time, in the questions containing lists of specific devices and software, the respondents chose quite a variety of different technologies serving to cope with health problems. Perhaps, the word "assistive" in the first question was erroneously associated by students with highly specialized aids designed exclusively for persons with severe disabilities. Nevertheless, most of the selected technologies mentioned in the subsequent questions (audio lectures, video captions, organizers, voice assistants, GPS locators, spell checkers, word predictors, word processors) are universal (designed for everyone). Authors of [5] concluded that higher education should be focused on universal design and must use the potential of general-purpose technologies as assistive tools for people with disabilities. Universal assistive technologies can be useful as well for teachers and students without disabilities and will help create a truly inclusive environment.

Summarizing the above, we can offer solutions to problems specified as a result of the survey (Figure 2).



Figure 2: The problems identified as a result of the survey and proposed solutions (icons in the figure made by Eucalyp: https://www.flaticon.com/authors/eucalyp)

Problem 1. Lack of objective data on health status. Solution: carrying out annual preventive medical examination of all students to identify their diseases and other health disorders.

Problem 2. High levels of anxiety and stress due to health-related learning difficulties. Solution: the creation of psychological service for students to provide the targeted psychological assistance (consultations) and to conduct seminars and training on self-identification and self-affirmation.

Problem 3. A variety of health disorders requiring different learning approaches. Solutions: (a) providing students with the personal opportunity to choose suitable training format; (b) application of universal design principles in the learning environment and option to use universal learning tools; (c) development of e-learning resources following the web accessibility guidelines based on WCAG 2.1 [16].

5. Conclusion

The university environment should be prepared to deal with and support students having health problems. These problems include disabilities, temporary and invisible health disorders, physical and mental impairments, etc. In case of proper regular medical examination, any student must be sure that he or she will be provided with reasonable accommodation in learning.

Lack of objective data on the health state of students at the faculty can be in particular related to students' ignorance of their rights, their fear of being marginalized, the inadequacy of formal and material basis to do health assessment among all students, and lack of appropriate motivation of university managers. The discovered problem requires further discussion and research.

The quantitative and qualitative indicators of health disorders can change for the same population group and the same individuals over time. Therefore, the identification of students' health disorders should be systematic.

Results of the survey show an urgent need for specialized learning conditions and techniques for a substantial part of students. This need could be minimized, among other things, by providing universal design principles in learning and the use of e-learning resources that conform to web accessibility requirements.

The study has some limitations. The data about health-state and health-related problems in learning were obtained based on the subjective opinion of students and may differ from the data of an objective medical examination.

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