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Assessment of the Availability of Educational Resources for Persons with Disabilities on the Basis of Existing Quality Assessment Standards Software

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Abstract

The article provides a review of literary sources on the problems of evaluating the quality of software systems. The concept of accessibility is considered. Attributes that are most important for building an architecture Web-oriented educational systems Attributes are available based on the international standard WCAG 2.0-2.1 and are classified by types of psycho-physiological human disorders. This model is based on a three-level model of accessibility, which can be used to make an informed choice of the optimal resource in accordance with the individual needs of the student.

Keywords: accessibility, HIA, software, quality assessment standards.

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Оценка доступности образовательных ресурсов для лиц с ограниченными возможностями на основе существующих стандартов оценки качества программного обеспечения

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Аннотация

В статье представлен обзор литературных источников по проблемам оценки качества программных систем. Рассматривается понятие доступности. Атрибуты, наиболее важные для построения архитектуры Web-ориентированных образовательных систем, доступны на основе международного стандарта WCAG 2.0-2.1 и классифицируются по типам психофизиологических расстройств человека. Данная модель базируется на трехуровневой модели доступности, которая может быть использована для обоснованного выбора оптимального ресурса в соответствии с индивидуальными потребностями учащегося.

Ключевые слова: доступность, ОВЗ, программное обеспечение, стандарты оценки качества.

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The existence of barriers to human perception of information as a result of its existing disorders is a serious obstacle to the use of information systems in education of people with disabilities. We need to consider the availability of the software as one of the basic characteristics of its consumer qualities.

The concept of software quality

We can consider the quality of the software I have in two ways: as a certain system, and as a control object [1]. Modern quality management is focused not only on product quality control, but also on the quality control of its development process. It is a complex technology and funds that are closely related to international standards [2].
In the context of international standards, the concept of quality software (Software Quality) can be defined as follows [3]:

1. software quality is the degree to which software has the desired combination of properties (1061-1998 IEEE Standard for Software Quality Metrics Methodology, [4]);
2. It is the fullness of the quality properties and characteristics of the product, process or services that provide the ability to meet the requirements stated or implied (International Standard ISO 9001 [5]).

In [6] quality is defined as "conformity to user requirements", and in [7] as "the achievement of a great level of fitness for use."
Summarizing these concepts, we can say that the Software Quality System has the ability to meet the needs of the user when used under specified conditions.
Quality requirements can be expressed in a structured system characteristic, attributes, the criteria that form the so-called quality model [8].

Standard ISO 9126

One of the most common is the multi-level model of quality, presented in a set of standards ISO 9126 [9]. In this model, the quality assessment software is considered at three levels [10]:

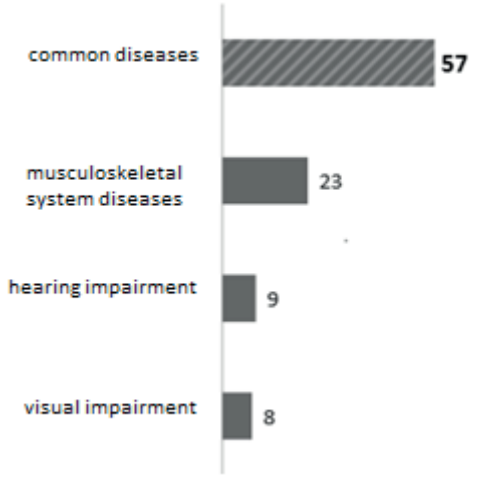
- level goal - articulated needs of the user;
- level attributes - property software necessary to achieve the objective;
- level metrics - quantitative characteristics degree presence attributes.

In the model 6 allocated purposes, subdivided into 21 quality attribute: functionality, reliability, practicality, efficiency, maintainability, portability.

Standard ISO 25010

Standard ISO 25010 [11], adopted in 2011, it is the most relevant and best reflects the current trends in the IT- sector. ISO 25010 complements the set of characteristics and quality attributes ISO 9126. It adds, for example, characteristics such asperformance and Compatibility of that is the ability to integrate and interact.
It first examines the quality characteristics such as the availability of which is the ability of a software system to support the work of people with disabilities.
National Standard GOST R 52872-2012

Ensuring the availability of the category is the subject of a number of documents. National standard of the Russian Federation, which regulates the accessibility requirements of Internet resource is entered into force in 2012, the GOST R 52872-2012 "Online Resources. accessibility to the visually impaired Requirements "[12]. This standard applies to Russian-language electronic resources of the Internet. It establishes general accessibility requirements for the visually impaired, using the computer as a technical means of rehabilitation. On the basis of GOST R 52872-2012 formed version requirements for the visually impaired, which are required to have the sites of all state bodies and local government agencies, including educational institutions [13].
GOST R 52872-2012 contains about 150 claims covering reporting options for the visually impaired. In this case, it is absolutely not take into account the complexity of information access for persons with other psycho-physiological disturbances, which according to statistics there are more than 90% of students with disabilities in the Russian Federation [14] (Figure 1).



F i g. 1. Distribution of students with disabilities Statistics on nosological groups (according to the Comprehensive nationwide monitoring of availability of higher education for disabled persons and persons with disabilities, in February 2017 [15])

International standard Web Content Accessibility WCAG 2.0

International experience is built on the use of standards to ensure the availability of Web-content (Web Content Accessibility Guidelines - WCAG 2.0)[1]. The second version of this standard was developed by W3C consortium in 2009 In 2013 it was officially translated into Russian. In June 2018 it adopted a version of WCAG 2.1[2], complements and specifies the requirements of web accessibility of the previous version, including the users of alternative SMART - devices.
Web-accessibility [16-19] involves the development of the Internet - the resource, taking into account all the possible problems that can confront people when it is used. Specialists determine the factors Web resources available to a wide range of users with special

[1] Web Content Accessibility Guidelines (WCAG) Overview [Electronic resource]. Available at: https://www.w3.org/WAI/standards-guidelines/wcag (accessed 01.02.2020). (In Eng.)

[2] Web Content Accessibility Guidelines (WCAG) 2.1 [Electronic resource]. Available at: https://www.w3.org/TR/WCAG/ (accessed 01.02.2020). (In Eng.)

needs, such as visual impairment (blind and visually impaired), hearing impaired (deaf), disorders of the musculoskeletal system, impaired speech, impaired mental sphere, as well as various combinations multiple and associated disorders.

Most of these factors can be used to analyze web-accessibility of educational platforms and individual e-courses, used in training people with disabilities [20- 21]. However, their use in practice, requires systematization and classification in accordance with the existing students' disabilities.

To meet the needs of different user groups in different situations [22] defines three levels of compliance: A (lowest), AA (low) and AAA (highest).

Four availability principle correspond to these levels [23].

1) Perceptibility

Information and user interface components must be presented only in a form that can be perceived by the user. In particular, due to insufficient communication of certain physiological disorders must be compensated to acquire information using alternative sources of perception.

T a b l e 1. **Classification of availability requirements for species disorders respective principle perceptibility WCAG 2.0-2.1** [24-25]

number	**criteria**	**infringement**				
		of view	hearing	musculoskeletal system	cognitive	**Note**
1.1	**Non-text content:** All non-text (graphic) content must have a text version					Special programs -skrinridery can read the text aloud, convert to Braille.
1.2	**media content:**					
1.2.1	Text version of the pre-recorded audio and video content					Deaf-blind can read the text in braille.
1.2.2	Subtitles for media (audio, video) of content					
1.2.3	Audio description or alternative mediaversiya (recording)					
1.3	**Adaptability**					
1.3.1	Information and relationships visually displayed, may be determined by software or available in text version					For people who are blind, deaf-blind using braille display is updated, it becomes available for the information transmitted through the color
1.3.2	Significant sequence of reading the content defined programmatically					When using assistive technologies that read aloud content
1.3.3	Text alternative sensory characteristics: shape, size, orientation, sound.					
1.4	**Selectivity easier viewing and listening to content, the important part is separated from the secondary**					
1.4.1	Using color should not be the only means of visual notation action request for feedback or isolation of the visual element					People who have problems with color vision can watch or listen to text signals, and the use of tactile interfaces to discover their touch
1.4.2	To record longer than three seconds should be a mechanism to pause or stop it, or to control volume					This is especially important for those who use screen reader technology, and thus can not hear
1.4.3	The contrast (minimum): Contrast ratio> = 4.5: 1					It is especially important for people with impaired color vision
1.4.4	Changing text size (except for titles and text images) in the range up to 200%					
1.4.5	It preferred to use the text for transmission of information, but not the text in the image					

2) Controllability
User interface components and navigation must be controlled, providing a comfortable experience for users, regardless of their physiological characteristics.

T a b l e 2. **Classification availability requirements for species disorders respective principle controllability WCAG 2.0-2.1** [24-25]

number	criteria	infringement				Note
		of view	hearing	musculoskeletal system	Cognetive	
2.1	**Accessibility keyboard control**					
2.1.1	All the functionality of the content can be controlled by keyboard	■		■		For users with Noda using a mouse difficult
2.1.2	Using the keyboard, the focus can be moved	■		■		
2.1.4	The ability to disable or reconfigure shortcuts key characters that consist of one character key or symbol keys			■		By using speech input
2.2	**Sufficient time. The users should be given sufficient time to study and work with content**					
2.2.1	Time Setup: The user can disable and set time limits	■	■	■	■	When using an interpreter in sign language is important to monitor timelines
2.2.2	For any auto-updated information should be able to pause, stop, hide, or change the refresh rate				■	Using content that blinks may be a problem for people with cognitive impairment
2.3	**The ban on the use of known hazardous design elements**					
2.3.1	Web pages do not contain elements of flare more than 3 times per second, with a few exceptions				■	People with photosensitive epilepsy and other disorders
2.4	**Navigation. Users are given help and support in the navigation, content search, and in identifying their current position on site**					
2.4.1	It provided a mechanism for passing blocks of content that are repeated on multiple web pages	■				
2.4.2	Web pages have titles that describe the theme or purpose of their	■		■	■	
2.4.3	The focus must be moved in a sequence that preserves both the meaning and the ability to control	■		■		People with impaired mobility who use a keyboard
2.4.4	Target of the link (in the context) must be clear from the text links	■		■	■	It helps avoid unnecessary keystrokes
2.5	**Input Options: All functions must be accessed via the input device pointer, for example, with the mouse pointer finger interacting with the touch screen, the electronic pen / stylus or laser pointer**					
2.5.1	Gestures Index: possibility to use the content to a wide range of pointing devices			■		cephalic index, belief system, or mouse emulation controlled speech
2.5.2	Cancel pointer: it reduces the likelihood of accidental activation control	■		■	■	
2.5.3	Visible text labels controls match their names available			■	■	Users can activate the voice input controls
2.5.4	Users who are unable to perform certain movements guaranteed control touch or voice input			■		
2.5.5	target size: the size of the target for the index entries of at least 44 by 44 pixel CSS	■		■		

3) Clarity
Information and operation of the user interface must be comprehensible for all users.

T a b l e 3. **Classification availability requirements of types of violations corresponding principle intelligibility WCAG 2.0-2.1** [24-25]

number	**criteria**	**infringement**				
		of view	hearing	musculoskeletal system	Cognetive	**Note**
3.1	**Readability**					
3.1.1	The main language of each Web page can be programmatically determined	■			■	It is important in synthesizing speech
3.2	**Predictability. Web pages should appear and function in a predictable way**					
3.2.1	Sets focus to the other component does not cause changes of context	■		■	■	
3.2.2	Changing the settings of any interface component does not automatically change the context	■			■	Unexpected changes disorientate users
3.3	**Help as you type. Prevention and correction of errors**					
3.3.1	Identifying typing errors automatically, the error is described to the user in text form	■			■	
3.3.2	When you enter information provided notes and instructions	■		■	■	Increases clique Area Control
3.3.3	Error Prevention (Legal, Financial, Data entry errors)	■		■	■	

4) Reliability
Content must be reliable to the extent that is required to play back a wide range of different user applications, including assistive technology (hardware and software).

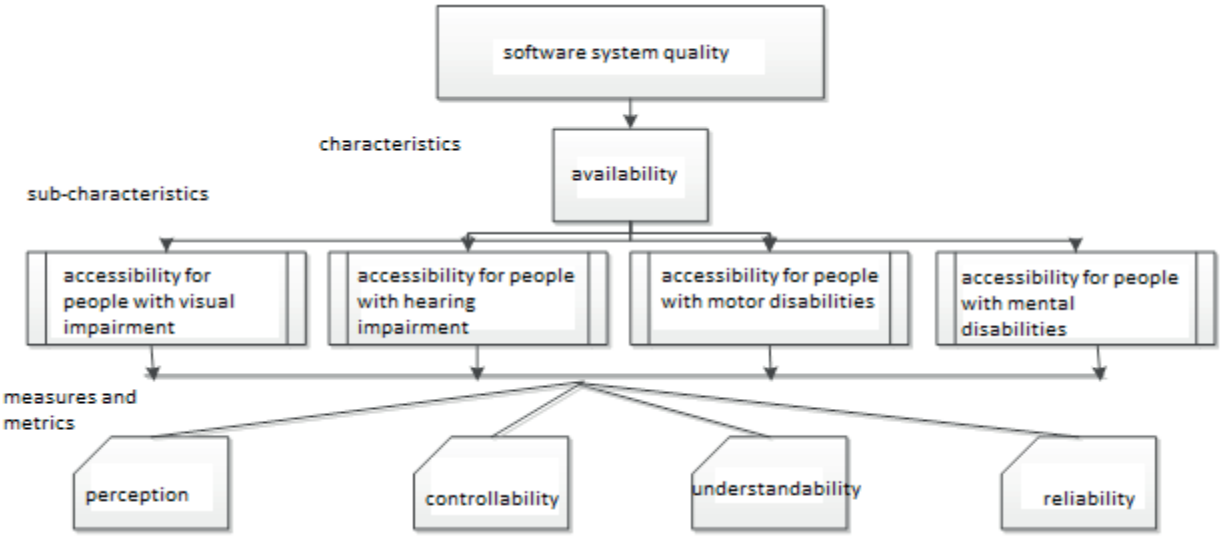
T a b l e 4. **Classification availability requirements for species disorders respective principle reliability WCAG 2.x** [24-25]

number	**criteria**	**infringement**				**Note**
		of view	hearing	musculoskeletal system	Cogne-tive	
4.1	Maximizing Content compatibility with user applications, including assistive technologies					
4.1.1	Syntax: Using markup syntax competent	■	■	■	■	
4.1.2	The name, role, value defined software interface for all components	■	■			This enables compatibility with assistive devices and software

The integrated model of evaluation of availability of educational content

We built a three-level model available web-based educational content, based on multilevel model of ISO quality standards [7-11], as well as accessibility criteria, constructed and classified based on the WCAG 2.0-2.1 [15, 16] (Fig. 2).

In this model, the top level is represented by the quality of the considered characteristic (target). It is the availability of a software system which consists of four basic sub-characteristic determining accessibility for people with various disorders. The criteria for access to determine the level attributes that are required to achieve the goal (availability), and their quantitative characteristics - level metrics.



F i g. 2. Model availability Web-based educational resource

Considered in model accessibility criteria are inadequate, that is, can have different effects on the possibility of full access to the information depending on the severity of the violation. The degree of importance of each measure in the process of integrated assessment of resource availability can be taken into account, using weights.

Thus, to obtain the integral characteristic availability we must make a choice of the weight coefficients depending on the significance of each measure for a particular characteristic (a characteristic). Thereafter, the value of sub-features, characteristics and integral quality evaluation can be prepared according to the formula proposed in IEC 28195-99. [26-27]

Integral assessment of the j-th sub-characteristics of the i-th quality characteristic S_{ij} is:

$$S_{ij} = \sum_{k=1}^{m}(M_{jk}V_{jk}^{M}) \quad (1)$$

where M_{jk} is the value of the k-th measure the j-th sub-characteristics, V_{jk}^{M} is the weighting coefficient measures.

Integral assessment of the i-th quality characteristics calculated by the formula:

$$C_i = \sum_{j=1}^{n}(S_{ij}V_{ij}^{S}) \quad (2)$$

Where V_{ij}^{S} - weighting value of each sub-characteristics.

Then the integral evaluation of the quality of Web-based resource in terms of its availability is determined by the formula:

$$Q = \sum_{i=1}^{q}(C_iV_i^{C}) \quad (3)$$

Where V_i^{C} - the weights of each characteristic.

Weighting factors must be determined in such a way that,.

$\sum_{k=1}^{m}V_{jk}^{M} = 1 \sum_{j=1}^{n}V_{ij}^{S} = 1 \sum_{i=1}^{q}V_i^{C} = 1$

The proposed model can obviously be generalized to an arbitrary number of characteristics, sub-characteristics and measures.

Conclusion

This article gives an overview of the literature on the problems of an estimation of quality of software systems. The concept of accessibility as the audio quality characteristics. The most important for building architecture Web-based educational systems availability attributes are formulated on the basis of international standard WCAG 2.0-2.1 [15, 16] and are classified by type of psycho-physiological disorders of man. On their three-level model is constructed based on availability, which can be used to justify the choice of optimal resource in accordance with individual needs of the student.

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