Science and education for sustainable development

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1.3. DIGITAL VISUAL FATIGUE: METHODS FOR DIAGNOSING MONITORING, AND EFFECTIVELY PREVENTING DEVELOPMENT

The number of mobile device users is growing rapidly, which requires high quality software. This is driving the rapid growth of mobile software development technologies. Although new technologies accompany people at all stages of human evolution, they have become the subject of special theoretical studies relatively recently. From the standpoint of socio-philosophical discourse, the phenomenon of technology has become more conceptually considered since the middle of the 20th century. The constructive understanding of technology is provided by an active communication approach, focused on the interaction between people and technology. These approaches allow us to consider the emerging socio-technical systems in their entirety in order to accept the dominant beginning of the activity arising in the form of communication.

The relevance of the study is determined by the fact that its assessment is associated not only with a person's working capacity, but also with such physiological concepts as fatigue, overwork and recovery of the body, as well as professional burnout, which is increasingly occurring among specialists in technological industries, and the stress associated with it. The studies of many sociologists, psychologists, doctors and diagnosticians are devoted to the study of this topic. Many studies are known in the field of diagnostics of the functional state; there are a significant number of patents and copyright certificates of researchers who show great interest in this issue. The tasks of determining the functional state were carried out by scientists R. M. Baevsky, A. P. Berseneva, L. K. Garkavi, V. V. Parin, I. B. Ushakov, G. G. Ivanov, S. P. Morozov, I. I. Dedov, A. A. Kashitsyna, E. E. Godik, I. V. Gulyaev.

A number of methods for determining the functional state and fatigue of a person are discussed in the literature, but the process of adaptation to stress has not been fully studied taking into account the individual characteristics of a particular organism, there is no simple and obvious way to determine the onset of fatigue and overwork.[10] There is no method for the individual selection of diagnostic procedures for each subject, and the correction for learning during the experiment is also little taken into account. Analysis of the literature has shown that this method can be called the method of the critical flicker fusion frequency (CFFF). In connection with the choice to determine the functional state of the CFFF method, the development of computer technology devices for measuring the CFFF, providing the necessary accuracy and reliability of measurements, remains relevant.[11] The aim of the work is to analyze and develop, on the basis of the created software and hardware complex, the optimal mode of work and relieve fatigue, conduct a series of experiments to check the effectiveness of the proposed work and rest schedule.

Theoretical and methodological foundations for studying the effect of digital fatigue on human functional health. The digital economy, based on a qualitatively new type of ICT, changes and transforms all spheres of modern production and social life. The digital economy not only provides leadership in increasingly global forms of competition in the areas of efficiency, productivity and innovation, but also uses fundamentally new digital forms of communication between people and takes into account the individual principles of people's needs, as well as the opportunities offered by artificial intelligence.[12] The digital society based on a complex of technological, institutional and social radial innovations raises many important topics. The development of the digital economy will continue to grow rapidly, but since the positive aspects of this process fall into the perspective of research, we would like to focus on the negative impact of all ongoing processes on human health.

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[10] Abbasi-Kesbi, R., Memarzadeh-Tehran, H., & Deen, M. J. (2017). Technique to estimate human reaction time based on visual perception. Healthcare technology letters, 4 (2), 73-77.

[11] Baesmat, A. S., & Lakshmi, V. (2021). Progress of medical undergraduates to an era of computer vision syndrome and insomnia as an aftermath of increased digitalization during covid-19 pandemic. European Journal of Molecular & Clinical Medicine, 7 (11), 8225-8233.

[12] Enoka, R. M., & Duchateau, J. (2016). Translating fatigue to human performance. Medicine and science in sports and exercise, 48 (11), 2228.

In particular, from the above material, it can be seen that the main working link will be the young generation, who are well versed in the skills of working in the IT sphere. It is pleasant to raise the issue of maintaining health, avoiding visual fatigue and digital fatigue of the nervous system of young people during their education, as well as all stages of life. Since the central nervous system plays a dominant role in the regulatory processes occurring in the human body, it is preferable to take into account its state when assessing human health. As psychophysiological parameters characterizing the state of the human nervous system, psychophysiological parameters of the state of the visual analyzer are used, since the effectiveness of its functioning depends, first of all, on the level of functioning of the central nervous system.

In connection with the socio-psychological, socio-economic crises inevitable in the new conditions of development, the governments of many countries, assessing the prospects for development, are faced with the need to develop special national programs to strengthen and develop the health of the population.[13]

It is now known that the main factor that determines human health is a lifestyle (50-55%). The impact of environmental factors on health is estimated at 20-25% of all impacts, 20% are biological (hereditary) factors and 10% are related to health deficiencies and defects. At the same time, risk factors are not disclosed, and there are no available fatigue diagnostic devices. The intensification of the educational process goes in different ways. Often a consequence of intensification is the appearance in a modern person of states of visual fatigue, overwork. The overwork creates the prerequisites for the development of acute and chronic health disorders, the development of nervous, psychosomatic and other diseases. From an acute state, fatigue can become chronic[14]. Of course, fatigue is not explained by any one factor – it is determined by a combination of various reasons, among which a significant place is occupied by mental and physical overload, inadequate to the body's capabilities, static body position during work, "monotony". So, in order for society and subsequent generations to be healthy, the causes of youth discomfort should be investigated and diagnosed in time using simple methods.

According to the Vision Council of America (VCA), digital visual fatigue is physical visual discomfort after a person has spent more than 2 hours in front of a digital monitor, mainly on devices such as desktops, laptops, tablets, and e-readers. This is due to the placement of the computer screen and smartphone at a short or medium distance from the visual analyzer. A combination of factors such as screen proximity, frequency and duration of use, and exposure to high-energy blue beams from video monitors contribute to faster and aggravate severe symptoms of digital visual fatigue. It is impossible to imagine the life of modern society without digital devices, but people should be aware of their negative impact on health. It should also be clear how to reduce the induced visual fatigue, how to take into account the level of fatigue after work. A person's labor activity should not only minimize pathological reactions in him but ensure the complete restoration of the spent body resources during the rest period between loads. For this reason, the psychophysiological response to stress should be within the range of physiological adaptations and should not exceed the compensation threshold.

The development of this problem is closely related to the achievements in the field of psychodiagnostics of functional states developing in the process of a person's labor activity or his studies. The functional state of the human body is a complex symptom system of various processes, functions and individual characteristics and, basically, determines the level of its activity and general characteristics of the behavior. When researching on diagnosing and predicting the effectiveness of an employee's or student's activity, different theoretical approaches to the problems of studying working capacity were used. There is an approach to predict health status by determining the sequence of phases of the health curve, the relationship with the functional state, or determining the phases of the adaptive process, involving the use of two

[13] Kuznetsova, V., & Azhmukhamedov, I. (2020). Advantages and Risks of Using the Digital Educational Environment. ARPHA Proceedings, 3, 1369.

[14] Godik, E. E., & Gulyaev, Y. V. (1991). Functional imaging of the human body. IEEE Engineering in Medicine and Biology Magazine, 10 (4), 21-29.

types of indicators in the assessment process, including performance indicators, direct performance indicators, as well as indirect indicators of functional status and psychophysiological assessment.

It is impossible to provide one general information indicator for employees of all types and conditions of activity. This is due to the fact that the psychological structure of the activity and the psychophysiological functional system that implements this type of activity are determined. It should be noted that the stability of indicators in a given individual affects the determination of the functional state and performance (they are different for different individuals), which makes them as less situationally independent as possible. On the other hand, to assess the functional state, indicators are desirable, which, ideally, would be unambiguous for all individuals, and would be uniformly and linearly dependent on the intensity of external and internal influences. The abstract formulation of the problem of information parameters is incorrect. Because under various external influences the indicator parameters have different meanings and, therefore, different information content. At the same time, the general requirements for all selected parameters should be correlated with the effectiveness of the activity, but in various aspects the effectiveness of the activity depends not only on labor productivity, but also on the type of activity.[15] For any specialist, the effectiveness of activity is not only labor productivity, but also the psychophysiological "price" of activity. Analysis of the published materials allows us to conclude that at present there is no consensus on the most appropriate system for monitoring and predicting performance, which was the reason for further research.

Most researchers continue to pay attention to the development of physiological and psychophysiological methods for assessing the functional state, based on the principle of complexity. The principle of complexity, which is a feature of experimental research at the last stage, determines the number of complex diagnostic methods (the polygraph method is still widespread), which, in principle, leads to the development of various methods up to biochemistry. The diagnostic value of these complex methods is determined by the level of correlation with the performance, its qualitative and quantitative indicators.[16] Methods or techniques for assessing and predicting fatigue are multivariate and can be described in a number of ways. So, for example, this approach can be complex and multi-level, multifunctional, specific for specific sequences and specialties, or vice versa, singlelevel, non-specific, objective, operational-dynamic, etc.

Currently, devices and methods for assessing conditions are under development and improvement. Fatigue is studied according to REG, EMG, heart rate, photoplethysmogram. The parameters of the accuracy, stability and reliability of these indicators, the sensors and methods of fixing the sensor to the object, the integrity of the transmitted information were improved, as well as the equipment for recording these parameters. They are becoming more portable and easy to use, more communication systems are used, and the capabilities of microcontrollers are growing. Nevertheless, the determination of the functional state and the level of adaptation takes a rather long time, therefore the results come with a time lag, which can pose a danger to the health of both the person himself and the environment.

The development of a method for assessing and predicting fatigue using fewer monitoring parameters, as well as economic losses, can be effectively used and reduce medical and preventive costs, and will reduce the risk of man-made emergencies. Establishing relationships between occupational, environmental and social stressors and the resulting consequences for humans – anthropoecological fatigue, stress diseases, accelerated biological aging, is necessary to determine an effective public health policy. The joint efforts of biologists, physicians, psychologists and sociologists are aimed at establishing the relationship between chronic stress reactions and chronic fatigue and biological aging and diseases.

Physiological study of the functional state of the body is a number of experimental methods. EEG and "eye tracking" are widely used by modern specialists to determine psychophysiological

[15] Park, S., Choi, D., Yi, J., Lee, S., Lee, J. E., Choi, B., ... & Kyung, G. (2017). Effects of display curvature, display zone, and task duration on legibility and visual fatigue during visual search task. Applied ergonomics, 60, 183-193.
[16] Ji, Q., Lan, P., & Looney, C. (2006). A probabilistic framework for modeling and real-time monitoring human fatigue. IEEE Transactions on systems, man, and cybernetics-Part A: Systems and humans, 36 (5), 862-875.

characteristics. However, a more general method is based on recognizing the number of blinks per unit of the critical flicker fusion frequency (CFFF). Fatigue diagnostics should focus on identifying stressors and stressful situations, measuring stress levels, and identifying people with burnout.

After a preliminary analysis of modern scientific literature on the study of the functional state of the body during fatigue and under the influence of stress factors, we decided to study in detail the devices for measuring and diagnosing CFFF as the most effective indicator of all pathophysiological changes. As a result of constant stay in stressful situations and information load, the concentration of attention and the level of control, taken separately from one mechanical process in the younger generation, decreased, which naturally caused the appearance of new devices for the control of fatigue on the market of diagnostic devices.[17] We used a smartphone and a proprietary device to determine the critical flicker fusion frequency. The use of computer technologies for the prevention of diseases includes the use of various mobile applications to maintain a healthy lifestyle, physical culture and sports through the control of individual physiological and anthropometric indicators. These programs vary in complexity and can be used by patients alone or in collaboration with a doctor.[18]

By the end of 2014, smartphone apps were announced in all European countries. Similar to Instagram, doctors can share clinical images and with medical students. At the same time, the information remains confidential – the patient's face is automatically dimmed, and access to the patient's medical or other personal information is not provided. The most promising direction is the development and implementation of various diagnostic devices that connect to smartphones.[19]

Mobile phones are becoming a kind of express laboratory and diagnostic equipment. According to forecasts, the main market share of mHealth products will be occupied by devices (such as smart glasses, watches, bracelets, etc.) that register various health parameters and send them to a doctor wirelessly. A Taiwanese expert invention based on "smart" clothing, which includes many sensors and uses a smartphone as a central communication device to obtain important vital signs (body temperature, ECG, heart rate) is very promising. New programs and devices make disease prevention and early diagnosis more effective and improve health management systems. Devices become more functional and smaller. Each person has the opportunity to control their health individually. Electronic patient records can be combined with other applications such as appointment reminders or medication reminders. The future lies in the integration of mobile technologies with other types of medical informatization, which was the basis of the author's diagnostics and monitoring of fatigue of a modern person[20].

There is an increasing need to prevent visual fatigue of personal computer users, which is associated with the widespread use of computer technology. To reduce the current medical support, reduce the need for special ophthalmological equipment and, ultimately, simplify the service of users of personal computers (PCs), the assessment and change of the functional state of visual acuity should be carried out directly at the workplace using reliable and affordable methods. Therefore, it is advisable to use non-invasive and non-pharmacological agents to prevent chronic visual fatigue and optimize visual function with increased stress on the visual system due to the ubiquity of PC.

Conclusion. Based on the declared concept of technology and human interaction, human health sciences are actively developing with the dynamic development of scientific and technological progress. The health of all people depends on the influence of external and internal

[17] Karvekar, S. B. (2019). Smartphone-based human fatigue detection in an industrial environment using gait analysis. Rochester Institute of Technology.

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factors. The amount of incoming information is increasing and at this stage of social development, the problem of preserving and shaping the health of the population is important and relevant, since it is directly related to the issues of security and independence. The norm of health is a certain level of a functional state, a characteristic of its reserve capabilities and normative quality. It is necessary to define a new strategy for maintaining health, based on the social value of individual health and the idea of a responsible attitude of each person for their health in front of society and society in front of a person.

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