

Organizational and pedagogical conditions of ICT health-saving usage at school: guidelines for teachers

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Abstract. The article describes the organizational and pedagogical conditions of information and communication technology (ICT) health-saving usage at middle school. The model of realization of named conditions and the model of cooperation of participants of the educational process within health-saving use of ICT was developed. The examples and hints of how to implement the organizational and pedagogical conditions of ICT health-saving usage are given.

An empirical study showed that in the experimental group that studied under the authors' conditions, the number of students demonstrated high results in three directions (attention stability and mental capacity, healthy vestibular-motor reactions, positive psycho-emotional state) that are much ahead of those obtained in the control group. Consequently, the obtained data showed the effectiveness of the conditions developed by the authors. It is emphasized that the named conditions can be realized only through the concentration of efforts and concerted interaction of all parties of the educational process.

Keywords: Information and Communication Technology (ICT), Health-Saving Use of ICT, School Teacher, School Students, Organizational and Pedagogical Conditions.

1 Introduction

At the present stage of the society development, information and communication technologies (ICT) have become an integral part of human life, integrating into all spheres of social activity, leading to the development of the information society, updating and intensifying the processes of data exchange, professional and interpersonal communication, acquiring knowledge, etc.

The educational field, including general secondary education, has undergone significant changes. Informatization of general educational institutions leads to the search for new effective teaching approaches and methods, revision of educational standards, the content of disciplines and curricula, the introduction of advanced technologies, etc. The use of ICT in educational activities helps to diversify the range of didactic tools, increase the opportunities for improvement of the pedagogical process.

Along with this, it is widely known that students' work with ICT is associated with increased mental, nervous, emotional and visual load (M. Ciccarelli, S. Dockrell, A. Dymova, A. Hainsworth, H. Hun, K. Jacobs, V. Lamanauskas, I. Muhametzyanov, N. Polka, T. Tran, P. White, H.Ch. Woo, et al.).

Thus, training sessions in computer class cause long-term preservation of the working posture forced and the corresponding static load, strain of visual receptors, etc. Analysis of studies of the impact of these remedies on the health of students, obtained by experts in various industries (M. Ciccarelli, S. Dockrell, A. Hainsworth, P. Hakala, T. Tran, I. Williams, R. Zlamanski, et al.) allows us to assert that often the negative consequences are due to human factors and are related to non-compliance with basic ergonomic, psychological and sanitary requirements. This is especially true for middle school students (teenagers) who are experiencing complex processes of physiological and socio-psychological formation (D. Elkonin, E. Erikson, E. Hazen, V. Kutishenko, L. E. Levine, R. A. Sanders, L. Vyhotskyi, et al.).

Adolescent health statistics look disappointing. Thus, according to the Ministry of Health of Ukraine, in the last years, the health of teenage children remains unsatisfactory with a negative tendency to worsen [3]. Since 2010, the number of teenagers aged 15–17 who are not engaged in physical activity at all has been increasing. The average time spent by them at a computer on the Internet is up to 2 hours on weekdays and up to 6 hours a day on weekends [2]. This is due to various socio-economic factors: social life, low level of medical knowledge and valeological culture, low level of safe living skills and health-saving competence, indifferent attitude of adults, etc.

According to the Concept of the New Ukrainian School [7], the educational establishment should create the optimal conditions for maintaining and promoting the health of all participants in the educational process. Therefore, it is important for teachers working with adolescents to be competent in creating the right learning conditions and designing a health-friendly educational environment.

2 The presentation of main results

2.1 Organizational and pedagogical conditions of ICT health-saving usage at middle school

An important basis for the health-saving use of ICT in the educational process is compliance with appropriate organizational and pedagogical conditions.

As a rule, the elements of organizational and pedagogical conditions include material and technical base, forms, methods, aids, technologies of the pedagogical activity, conceptual theories and principles of the organization of training, the professionalism of educators, artificially created and objectively formed pedagogical situations, etc.

We consider organizational and pedagogical conditions as a component of the pedagogical system, a set of specially created conditions, which are the result of purposeful concerted interaction of the participants of the educational process, which allows achieving the set goals, namely – ICT health-saving usage in the educational process.

We have identified a range of organizational and pedagogical conditions for the health-saving use of ICT at school: 1) formation of a health-saving component of students' digital competence, 2) interdisciplinary integration of the health-saving content of different subjects, 3) compliance with the sanitary and hygiene requirements for the arrangement and equipment of computer training rooms, 4) ensuring the adaptability of the student's workplace, 5) quality of hardware and software, 6) pedagogically balanced selection of ICT tools, 7) changing different activities in the lesson (including physical relaxation after working with ICT), 8) creating a psychologically favorable atmosphere in the educational process, 9) coordinated interaction of all subjects of the educational process.

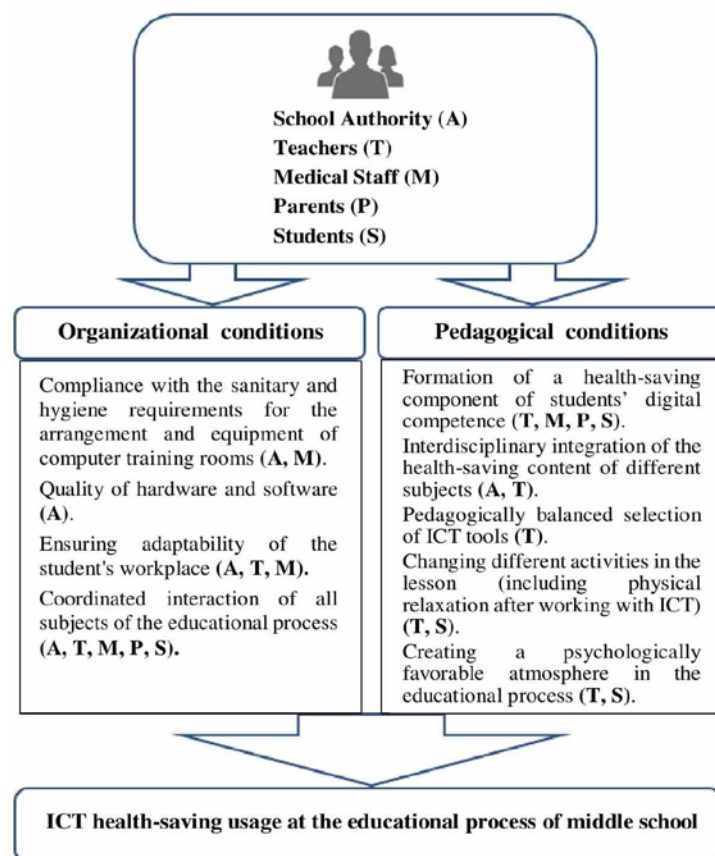


Fig. 1. Model of realization of organizational and pedagogical conditions of health-saving use of ICT at the school level

In figure 1 the model of realization of named conditions is presented, as well as it is defined those who should be responsible for their implementation: school authority, educators, medical workers, parents, students.

Let us consider these conditions and discuss in more detail those ones which can be implemented with the participation of teachers.

Formation of a health-saving component of students' digital competence. As a result of our research, we conclude that knowledge and skills and of health-saving use of ICT should be considered within the digital competence as one of its components, because:

1. Effective work with ICT is impossible without the knowledge and observance of norms and requirements for their safe, health-saving use.
2. The formation of competences for the safe use of ICT must precede their direct use in the educational process.
3. The development of competence in health-saving use of ICT should be conducted concurrently with the use of ICT throughout the study period, and mainly during the study of computer sciences.

Formation of a health-saving component of students' digital competence involves the formation of a set of relevant knowledge, skills, attitudes, beliefs, motivations aimed at maintaining physical and mental well-being and health. We believe that this is the basis for ensuring the safe use of ICT. The author's methodology for the development of this competence is presented in the article [6]. Mainly the realization of this task is assigned to teachers.

Interdisciplinary integration of the health-saving content of different subjects. The formation of the health-saving component of students' digital competence, their ability to use ICT safely, should occur systematically and consistently, not only during the study of computer science, but also other educational subjects of the school cycle: biology, informatics, physics, physical culture, etc., as well as in the form of messages and discussions during electives, thematic classes, etc. The table provides an example of how teachers in different subjects can introduce health-saving content into the learning process.

Table 1. Table 1. Hints for introducing health-saving content in teaching school subjects

Subject	Integration of health-saving content concerning for the use of ICT
Native/foreign language and literature, foreign language	Reading texts, writing works, translations, essays, discussing health-saving issues (5-9 classes ¹).
Natural science	Formation of concepts about systems of inanimate nature, incl. general concepts of information systems and objects; developing skills to assess the level of environmental safety as a sphere of life (5 class [*]).

* According to the curriculum of the middle school (Ukraine)

Biology	The study of the characteristics of the adolescent organism, its vulnerable aspects, the potential negative effects of the environment and the possibilities of their avoidance. Formation of the idea of the essence, value, and interconnectedness of all systems of the human body (6-9 classes*).
Physics	Formation of concepts about electromagnetic waves, X-ray, ultraviolet, infrared radiation, ionization of air, the nature of their occurrence and impact on humans (7-9 classes*).
Health Basics	Formation of knowledge about health and safety of life, healthy lifestyle, ability to use the knowledge gained in practice. Acquisition of safe behaviors that enhance the physical, social, spiritual and mental health components. Formation of value attitude to one's life and health, positive attitude to the rules of a healthy and safe lifestyle and observance of them (5-9 classes*).
Computer Science	Learn the basics of using ICT safely. Formation of concepts about computer architecture, software and hardware, rules for their safe use. Formation of knowledge about the ergonomics of the workplace, sanitary and hygienic norms of work with PCs, their observance during the lessons (5-9 classes*).
Extra-curricular activities	Conducting thematic sessions on the problem of the safe use of ICT. Discussion of computer addiction, unauthorized use of computer equipment, potential threats and consequences for adolescents, options for avoiding them (5-9 classes*).

Compliance with the sanitary and hygiene requirements for the arrangement and equipment of computer training rooms. Compliance with this condition minimizes the potential negative impact of the remedies on the body of the younger generation, helps to avoid overwork and maintain a stable performance throughout the lesson. Among the main ones, there are the requirements for training rooms, lighting, air-thermal regime, equipment and organization of workplaces, time regulations for the work of students with ICT, etc. The main responsibility for their compliance rests with the heads of educational institutions and teachers. There is currently no standard in Ukraine to regulate the use of modern gadgets at school for different age groups. Therefore, its development remains on the agenda.

Ensuring adaptability of the student's workplace. The adaptive workplace of the student should match his/her age, height, posture, and its components (desk, chair, armrests, monitor placement, keyboards, etc.) should be comfortable and ergonomic, without hampering movements or creating unnecessary load on the bone, muscular system, vision, etc. Besides, adaptability implies that individual components of the workplace can be adjusted (adapted) depending on the individual characteristics and needs of the student (e.g., height, vision, etc.). The teacher needs to make sure that before the start of the class, the students pre-configure (adapt) the workplace for the comfortable use of ICT.

Quality of hardware and software. In international standards ISO 9000:2000 quality is characterized as a set of characteristics of the object that meet the requirements of the consumer. In our case, the quality of ICT is determined by its safety for the consumer's health (lower radiation, better image quality, ergonomics, etc.). Obviously, a modern LCD will have less of a negative impact on the user than a display with a ray tube. Therefore, we consider such ICT better in terms of health-saving. The basic guidelines that will allow you to choose better products are discussed in the guide [4, pp.

148-150].

Pedagogically balanced selection of ICT tools. The effectiveness of the learning environment depends not only on the quantity and quality of the means used in it but also on how pedagogically balanced they are applied. We believe that the use of ICT in a lesson is well-considered and pedagogically appropriate if the complete solution of specific didactic tasks cannot be fully implemented or complicated without their use. For example, to clarify phenomena, concepts, theories, etc. that cannot be observed and explored in the ordinary context (space objects, micro-objects, historical events, etc.).

When planning a lesson, the teacher should carefully consider the appropriateness of using ICT in the study of a topic in general and in a specific part of the lesson, in particular, to balance the potential benefits to the educational process and the health risks to students. New technologies do not have to completely replace and displace traditional techniques but instead, complement them harmoniously. By optimizing pedagogically the frequency and duration of work with ICT, the health-saving effect of their use can be enhanced.

Changing different activities in the lesson (including physical relaxation after working with ICT). Maintaining a high level of students' working capacity is possible at the expense of rational organization of the lesson, change of different types of activity, following the correct posture during each type of activity, holding of physical short breaks.

Physical short breaks should be an integral part of the lesson. The generally accepted norm is to conduct a short physical warm-up lasting 1-2 minutes every 20-35 minutes during a lesson, whether or not ICT was used. After working with ICT, one needs to include a functional warm-up for the eyes, wrist, back and neck in the complexes of dynamic pauses. Dynamic pauses can take place either under the guidance of the teacher or by the student on their own (e.g. at home). In this case, special timer programs will be useful to set the appropriate time range for the break reminder (e.g. «SYE Timer», «Opti-Ergo EyeSaver», «Eyes Saver», «Time On», «Tadam», etc.).

Creating a psychologically favorable atmosphere in the educational process. Stress, chronic emotional tension of both students and teachers, are negative factors that are destructive to the well-being and psychophysical state of the younger generation. The ability of the teacher to prevent and neutralize unwanted emotional reactions, constructively resolve conflicts in the student group, attests to his/her ability to manage the educational process, creating a healthy atmosphere in the classroom.

Coordinated interaction of all subjects of the educational process. Provision and implementation of the named organizational and pedagogical conditions of health-saving use of ICT are possible only by combining the efforts and coordination of influence and actions of all subjects of the educational process: heads of educational institutions, pedagogical staff, medical staff, parents, students, etc. Mass media, cultural, civic organizations, etc. may play an important role in this process.

Let's take a closer look at the key functions of the main stakeholders of the educational process (figure 2).

The main responsibility for creating the appropriate organizational environment relies on the educational institution authority – head (director) of the school and his/her deputies. Thus, the director oversees the implementation of the relevant rules and regulations, sanitary and ergonomic standards, provides a comprehensive approach to

health care support of the educational process. In part, he/she can also influence the purchase of quality hardware and software tools, ergonomic furniture, climate control and more.

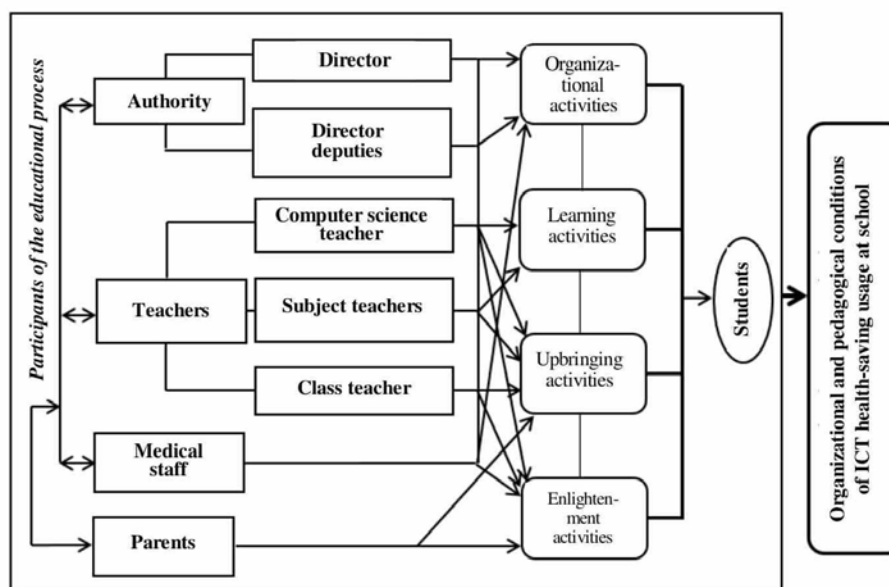


Fig. 2. Model of cooperation of participants of the educational process within health-saving use of ICT

The powers of the deputy director of educational work include the organization of educational activities aimed at forming the health competence of teachers, students, and parents, in the form of thematic evenings, meetings with experts, etc.

The functions of pedagogical staff include improvement of the educational process based on improving the efficiency of health-saving, enlightenment activities. The primary role should be attributed to the computer science teacher, as the chief specialist in the use of ICT, responsible for the equipment of the computer class and compliance with proper sanitary and hygiene requirements. The direct work of students with ICT should be preceded by training on their health-saving use and introductory safety training, which should be the responsibility of the computer science teacher.

The formation of a health-saving component of students' digital competence, as one of the most important organizational conditions for the health-saving use of ICT, should occur systematically and consistently, not only when studying computer science, but also in other subjects. The main role in this belongs to teachers.

An important participant in the educational process is the class teacher. The main functions and forms of his/her influence include the following: holding thematic sessions and parental meetings on the problem of the safe use of ICT; discussion of com-

puter addiction, unauthorized use of computer equipment, its potential threats and consequences for the adolescent organism, and how to avoid them; preparation together with students of relevant projects (thematic wallpapers, weeklies, etc.).

Healthcare professionals should play a direct role in creating the school's health care environment in general and in the health care organization of the educational process in particular. Their main functions include keeping records of students' health status, updating information on potential negative consequences of the use of ICT, communicating this information to other subjects of the educational process, monitoring the organization and compliance with sanitary and ergonomic conditions, checking and assessing lessons from a health-saving point of view, etc.

Students need to exercise self-regulation, self-control, and self-reflection in the context of health-saving, both during school and at home; to develop a health-saving component of digital competency, enhancing knowledge and skills on health-saving use of ICT.

Parents are important participants in the educational process. Their full inclusion requires participation in educational activities organized at school, self-education, conversations with the class teacher, other teachers, and medical staff, educational work with children on the health-saving use of ICT, organization of a health-saving home and educational environment for children at home.

Thus, we have identified and characterized the main organizational and pedagogical conditions of health-saving use of ICT in the educational process. All named conditions can be realized only through concentration of efforts and coordinated interaction of all subjects of the educational process. And the main role belongs to the teacher.

2.2 Implementation of organizational and pedagogical conditions of ICT health-saving usage at middle school

Each school can determine its ways of implementing named organizational and pedagogical conditions, depending on the tasks, available resources, staff, etc. We propose some hints and examples based on our experience (table 2).

Table 2. Examples of how to implement the organizational and pedagogical conditions of ICT health-saving usage

№	Organizational and pedagogical conditions	Measures conducted
1	Formation of a health-saving component of students' digital competence.	Teaching students according to the author's methodology (within a specialized training course, elective, etc.) [4, 6].
2	Interdisciplinary integration of the health-saving content of different subjects.	Conducting a thematic seminar-presentation for subject teachers (to explain the essence of named condition). Introductory training for teachers under the author's manual [4].
3	Compliance with the sanitary and hygiene requirements for the arrangement and equipment of computer training rooms.	Checking the compliance of the computer class equipment with the current hygiene standards. For example, checking if the peripherals (printer, scanner, router) are located far enough from the students (3 m and more), etc.

4	Ensuring adaptability of the student's workplace.	Interviewing students about the adaptability of their workplaces (orally or in writing). For example, we use a questionnaire developed by the British company "Borough Council of King's Lynn & West Norfolk" [8], which we adapted to our study.
5	Quality of hardware and software.	Checking the computer class if it is equipped with state-of-the-art equipment that minimizes the negative impact on users' health (e.g. LCDs). Updating the equipment as needed (via budget, sponsorship, etc.).
6	Pedagogically balanced selection of ICT tools.	Including ICT in the lesson just in a case if the complete solution of specific didactic tasks cannot be fully implemented without their use. Using ICT within acceptable time limits for the selected age group of students of 5-9 classes (20-25 minutes).
7	Changing different activities in the lesson (including physical relaxation after working with ICT).	Performing relaxation exercises after the completion of working with ICT, including physical relaxation.
8	Creating a psychologically favorable atmosphere in the educational process.	Establishment of cooperation with subjects of the educational process, in particular parents. Application of democratic teaching style, use of interactive methods, game techniques. This facilitates the establishment of a psychologically favorable atmosphere, the inclusion of each student in educational work.
9	Coordinated interaction of all subjects of the educational process.	We have taken several steps: - A thematic seminar-presentation for subject teachers was held. The authors' manual [4] was provided. - A series of training sessions for the students by the authors' methodology, aimed at forming their health-saving component of digital competence. Educational guidelines [4, 5] are provided. - Parents were interviewed to draw their attention to the problem. A recommendation booklet "Using ICT without harm to health".

2.3 Research of efficiency of organizational and pedagogical conditions of ICT health-saving usage

For verification the efficiency of organizational and pedagogical conditions named above, a range of diagnostic methods were used:

- to determine the level of attention stability and mental capacity – psychological methodology of E. Kraepelin in the modification of R. Schulte;
- to examine vestibular-motor reactions – K. Trynus method;
- to determine the psycho-emotional state of students – authors' questioner.

We consider all mentioned (attention stability and mental capacity, healthy vestibular-motor reactions, positive psycho-emotional state) to be the important elements of the effective and health-saving educational process.

The diagnostic involved the formation of control and experimental group of students (CG and EG appropriately), which were formed as follows:

- CG included 143 students of 7-9 classes. These students worked with ICT on computer science lessons in the usual mode. At the beginning and the end of the lesson, diagnostic methods were conducted.
- EG included 137 students of 7-9 classes. For these students, the range of measures described in the previous chapter was applied. At the beginning and the end of the lesson, diagnostic methods were conducted as well.

Using the Student's t-test, we obtained the result ($t = 2,78, t > t_{\alpha}$, at the level of significance $\alpha = 0,05$), which was a confirmation of CG and EG coincidence.

We propose to consider the results obtained in more detail.

The results of the determination of students' attention stability and mental capacity. Attention stability and mental capacity are important psychic properties that directly affect the effectiveness and success of the educational process. Because healthy mental processes are an integral part of overall personal health, the task was to analyze the dynamics of students' attentiveness and mental capacity before and after using ICT, namely a computer.

As a diagnostic tool, we chose the psychological methodology of E. Kraepelin in the modification of R. Schulte, allowing studying the level of attention and mental performance when performing a simple monotonous job. This technique made it possible to evaluate the fatigue of the CG and EG students before and after working at the computer.

Almost identical results were recorded at the beginning of the lesson both in CG and EG. Thus, the high level of attention stability and mental capacity was demonstrated by 68% of CG students and 69% of EG, medium level – 16% of CG and 12% of EG, low level – 16% of CG and 19% of EG.

At the end of the lesson, the EG showed the best results: high level – 52% of CG and 66% of EG, medium level – 32% of CG and 30% of EG, low level – 16% of CG and 4% of EG (Figure 3).

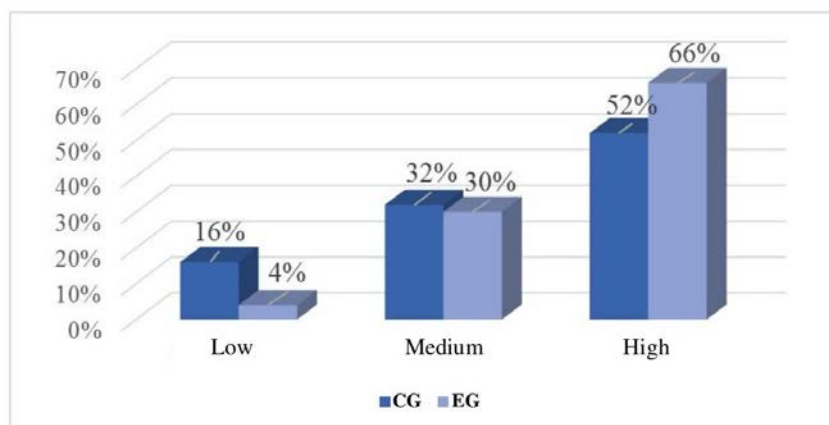


Fig. 3. Level of students' attention stability and mental capacity at the end of the lesson

To test the correctness of the results obtained in the dependent samples, the Fisher test was applied, which showed the validity of the differences between EG and CG, and amounted to 99%.

Thus, students of EG showed higher levels of attention stability and mental capacity at the end ICT computer use than students of CG. Mastering the basic principles of the healthy use of ICT and putting them into practice allows students of EG to stay longer at the high and intermediate levels of mental processes, which are key to effective learning.

The results of examining students' vestibular-motor reactions. As noted by K. Trynus, the vestibular apparatus is the human organ responsible for the perception of linear and angular accelerations, as well as the position of the body in space [1], and it is of great importance for the human mental health.

The range of disorders of the vestibular apparatus functions is quite wide: headache, sleep disorders, darkening of the eyes, dizziness, disorders of movement coordination, memory disorders, irritation, etc. The negative reaction of an organism is possible even after short work with the computer, in case the ergonomic norms and conditions of its use are not observed. In particular, this is manifested in the change of functional state of the vestibular apparatus.

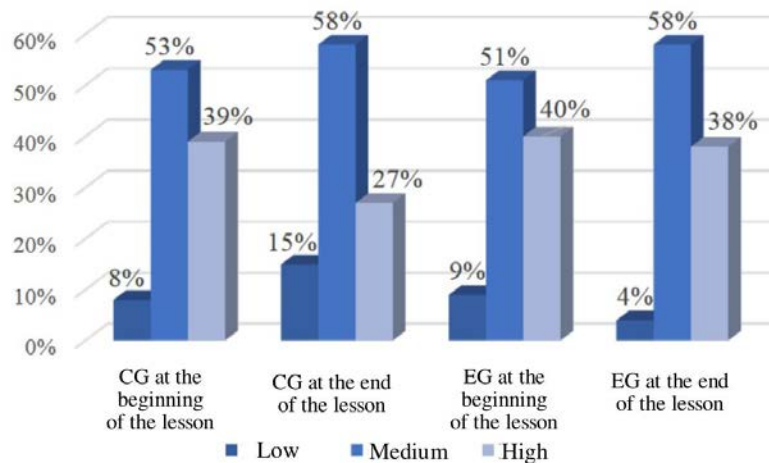


Fig. 3. Dynamics of levels of students' vestibular-motor reactions at the beginning and the end of the lesson

The results obtained (Figure 4) testify to the effectiveness of organizing the educational process of EG students, who worked accordingly to authors' recommendations.

To test the correctness of the results obtained in the dependent samples, the Fisher test was applied, which showed the validity of the differences between EG and CG, and amounted to 99%.

Thus, EG students have higher levels of vestibular-motor reactions at the end of the lesson using ICT than CG students. The results of statistical processing of the data obtained as a result of diagnostics by the method of K. Trynus testified that the health-saving use of ICT in the lesson leads to a longer storage of the level of vestibular-motor reactions of students, which is an integral part of productive learning, the stability of mental processes, efficiency and successful learning in general.

The results of the determination of students' psycho-emotional state. The success of the educational process depends largely on the mental state of the student. The mental state is a set of characteristics of mental activity for a certain period. Mental state includes emotions, attention, anxiety, attitudes, pleasure and dissatisfaction, apathy and inspiration, cheerfulness and fatigue and more. A student's emotional state is an integral part of his/her mental health. Therefore, the establishment of a psychologically favorable atmosphere in the classroom should be organized by the joint efforts of the teaching staff and be aimed at ensuring trust, kindness, free expression of students' opinions, lack of excessive pressure and authoritarianism, tolerance, equal opportunities for self-realization, mutual support, security, etc.

At the lesson when working with ICT, the students' mental and physical sphere indicates the influence of factors of both objective (electric field voltage, electromagnetic radiation, static electricity, increasing the level of ionization of the air, etc.) and subjective nature (overload (static and dynamic), vision strain, mental stress, and fatigue, etc.).

In addition to special methods for determining the psychophysiological state of a person, one way is to analyze the data obtained through self-assessment of the person's state, feelings, emotions. The main evidence of maintaining the students' satisfactory condition is maintaining their interest and enjoyment of the lesson, emotional upliftment, well-being. In this concern, we developed a special questioner.

The answers to the following questions were distributed as follows: at the end of the lesson, most EG students feel their selves interested (82%), feel the pleasure of the lesson (65%) and emotional uplift (57%). CG students, appropriately, demonstrate lower rates: feel interested 72%, feel the pleasure of the lesson 57% and emotional uplift – 43%.

The proportion of students with good feelings at the end of the lesson was 93% in EG and 87% in CG.

Most students stated that they felt light fatigue (41 % in CG and 26% in EG) and physical discomfort (21% in CG and just 6% in EG).

Although the rates of deep fatigue are low in both groups, they are still slightly higher in CG – 3%, whereas in EG only 1%.

In general, the quantitative indicators of the psycho-emotional state of the students obtained via the authors' questionnaire proved the results in EG to be higher than in CG.

Conclusions

Thus, in modern conditions of ICT widespread it is necessary to minimize potential risks connected with their implementation, to assure their health-saving usage among

the young generation. The important task for educators who work with middle school students (adolescents) is to create a safe and health-friendly educational environment.

The organizational and pedagogical conditions for the health-saving use of ICT that we have developed can be of help: 1) formation of a health-saving component of students' digital competence, 2) interdisciplinary integration of the health-saving content of different subjects, 3) compliance with the sanitary and hygiene requirements for the arrangement and equipment of computer training rooms, 4) ensuring the adaptability of the student's workplace, 5) quality of hardware and software, 6) pedagogically balanced selection of ICT tools, 7) changing different activities in the lesson (including physical relaxation after working with ICT), 8) creating a psychologically favorable atmosphere in the educational process, 9) coordinated interaction of all subjects of the educational process.

The proposed models of realization of named conditions of health-saving use of ICT, which include the main responsible parties (school director and his/her deputies, pedagogical and medical staff, students, parents) might be recommended for the implementation at the school level. The main responsible functions belong to the school authority and the main implementation activities belong to teachers.

Still, the named conditions can be realized only through the concentration of efforts and concerted interaction of all parties of the educational process.

The efficiency of organizational and pedagogical conditions of health-saving use of ICT was proved via a range of diagnostic methods, namely concentrated at measuring levels of students' attention stability and mental capacity, vestibular-motor reactions, psycho-emotional state.

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