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The Ecological System of the Digital Educational Environment as a New Definition of Modern Education in the View of Teachers

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***Abstract*---**Digital technologies and products are a new reality of modern education, but the degree of their influence on the ecology of the digital educational environment has not been fully studied. The article examines teachers' ideas about a new definition of education - the ecology of the digital educational environment; about the impact of digital educational products on the cognitive, personal and activity sphere of students. Implement the tasks set, an anonymous online survey of teachers of secondary schools in Moscow, the Moscow region, Voronezh, Nizhny Novgorod, Samara was conducted using the Google form. The article, based on the analysis of teachers' ideas about the ecology of the digital educational environment, risk zones and their impact on the cognitive, personal and activity spheres of students are identified; criteria for assessing the impact of digital educational products on cognitive processes, personal qualities and motivation of students learning activities are determined; indicators for each type of criteria are considered. The article shows, in the view of teachers, digital educational products have an ambivalent impact on the development of a student: they act as a resource, a means of development, and at the same time, they are risky for the development of a student.

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Introduction

Modern digital learning is based on the principle of active learning, unlike traditional (Voiskunsky, 2002; Akhmetova & Nevskaya, 2018; Akimova & Shcherbin, 2018; Bagautdinova & Bagautdinova, 2018; Kornilov, 2017). Students not only receive knowledge in a ready-made form, but also participate in the process of obtaining new knowledge. The main responsibility in this case falls on the students, not on the teacher. Digital education is becoming particularly relevant with the introduction of third-generation federal state standards and related to them reductions in the volume of classroom work and the expansion of forms of independent learning using digital educational technologies and digital educational products. However, the psychological and pedagogical foundations for standardization of digital educational products and digital technologies have not been developed yet (Puchkova et al., 2019; Sorokoumova et al., 2019). The ecological system of the digital educational environment is a stable interconnection of all subjects involved in the process of education and upbringing (Figure 1).

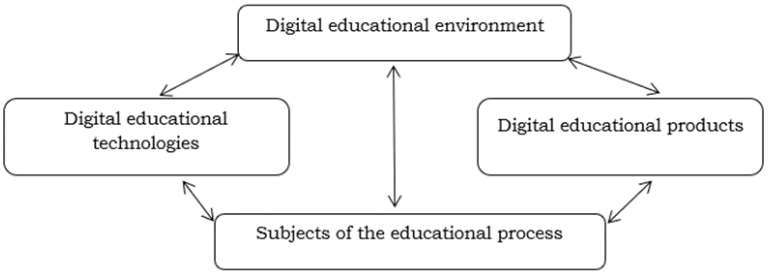

Figure 1. The ecology of the digital educational environment

The digital educational environment includes digital technologies and products that can significantly affect the sustainability of the educational ecosystem, changing and transforming it, affecting the interaction of participants in the learning and upbringing process with each other. Digital educational technologies are the way of organizing the educational environment based on modern information technologies translated into electronic format using computers, tablets, other gadgets and Internet resources. Digital educational products are the result of the work of an individual or a group of persons, expressed in the form of digital educational goods and digital educational services (educational complexes, online platforms, distance learning, computer programs, electronic textbooks, audio and video lectures, electronic notes, multimedia presentations, game simulators, etc.). The subjects of the educational process are primarily teachers and students. As part of the implementation of the Strategy for the Development of the Information Society in the Russian Federation for 2017-2030 (Decree of the President of the Russian Federation, 2017), the Program "Digital Economy of the Russian Federation" (2017) was developed. One of the key institutions that is given special importance in the Program in the context of the development of

digital platforms, technologies, institutional and infrastructural environments is education (Zong & Zhen, 2021; Widana et al., 2020).

Today, there are two diametrically opposed positions of researchers regarding the process of digitalization of the Russian secondary school. The first point of view is the thesis that there is a growing backlog of secondary schools from the requirements of digitalization of the economy and the main spheres of public life, which is expressed in a noticeably limited use of modern effective digital tools and technologies, in particular, to personalize learning and to increase the motivation of students (Grigoriev, 2020). Another opinion reflects the general negative attitude of teachers to the digitalization of school education (Grigoriev, 2020). In order to study the impact of gadgets on students, a survey of Russian teachers and parents was conducted. 1,276 people took part in the survey. The study found that 85% of respondents see a negative impact of gadgets on the eyesight of students; 36% of teachers and parents talk about a negative impact on hearing; 36% of respondents talk about a negative impact on communication; 80% indicate a negative impact on the ability of imagination (Digitalization of education). The analysis of studies by foreign and Russian scientists aimed at studying the negative impact of the use of mobile devices on the health of children and adolescents revealed: violation of phonemic perception, decreased attention, violations in the construction of a cognitive spatial map, decreased ability to switch from one task to another, decreased overall mental performance, deterioration of analytical thinking, decreased indicators of long-term and working memory, decreased academic performance and communication abilities. According to the German sociologist Beck (2011), the global risk society is being formed against the background of the digitalization of society, the economy and the individual, and this leads to an increasing fragmentation of society. The scientist calls the formation of "digital risk" and "digital metamorphosis of society" the reasons for such fragmentation (Beck, 2016). The fundamental difference between the new type of risks is that they cannot be abandoned, they cannot be managed with the help of the best scientific technologies, because they are an immanent part of society (Shaidullina et al., 2018; Kravchenko, 2019).

In this regard, the task of psychological and pedagogical research in the field of developing requirements for modern digital products to reduce negative impacts on the health and psyche of students when using them is actualized (Denisenkova & Krasilo, 2019; Puchkova et al., 2019; Sorokoumova et al., 2019). The pedagogical community has accumulated a large number of digital educational resources used in the educational process of secondary schools (Federal Center for Information and Educational Resources). An important stage, in our opinion, was the Project "School of the Digital Age" (2021), which includes the development, testing and transition to mass use from 2023 of fundamentally new digital educational and methodological complexes, partially or completely replacing traditional textbooks. Today, the question arises about the need to justify the procedure for standardization of digital educational products for secondary schools (Madjdi & Rokhayani, 2021; Jusmawati et al., 2021).

The analysis of the psychological and pedagogical literature of recent years has revealed a fairly large number of works on the problems of creating digital educational products (Bilenko et al., 2019; Bayanova et al., 2019). Researchers

determine the types of educational electronic publications for various levels of education, the specifics of their use for additional education of children and adults; the principles of the development of electronic textbooks (individualization, interactivity, structuring), as well as those principles whose dissemination has not received sufficient justification in pedagogical practice (completeness (integrity) and continuity of the didactic cycle) are revealed; the ratio of didactic principles (visibility, accessibility, systematicity and consistency, connection with practice and theory, science, activity and consciousness, strength) and ways of their implementation in the formation of the interface of electronic textbooks, etc. is analyzed Balalaeva, 2015; Kuzmin & Kuzmina, 2020).

A number of works describe specific didactic requirements due to the use of the advantages of modern information and telecommunication technologies in the creation and functioning of educational electronic publications: adaptability of learning to the level of knowledge and skills, psychological characteristics of the student, the requirement of interactivity of learning, the realization of the possibilities of computer visualization of educational information, the development of the intellectual potential of the student (involves the formation of thinking styles (algorithmic, visual, theoretical), the ability to make an optimal decision or variable decisions in a difficult situation, information processing skills (based on the use of data processing systems, information retrieval systems, databases, etc.), consistency and structural and functional connectivity of the presentation of educational material in the educational electronic publications, the requirement to ensure the completeness (integrity) and continuity of the didactic learning cycle (Nakhalov & Savin, 2016).

Objectives and structure of the study

The analysis showed that the problem of substantiating the requirements for digital products created for secondary school students is not covered in the modern research field. Our research aimed to study teachers' ideas about the impact of digital educational products on cognitive processes, personal qualities and motivation of students' learning activities. It was suggested that digital educational products have an ambivalent value for the learning process: on the one hand, digital educational products act as a resource, a means of student development; on the other hand, they negatively affect cognitive processes, personal qualities and motivation of students' learning activities. To achieve the goal , the following tasks were set:

- To determine the criteria for assessing the impact of digital educational products on the cognitive, personal and activity sphere of students.
- To identify indicators for each type of criterion.
- Based on the analysis of teachers' ideas about the role of digital educational products, to determine the risk zones of their influence on the cognitive, personal and activity sphere of students.
- To show the possibilities of digital educational products in the development of cognitive, personal and activity spheres of students.

During the study, three groups of criteria were identified. The first group is cognitive processes:

- Attention. Its indicators are: concentration, volume, stability, switchability, distribution.
- Memory. Indicators: volume, speed of memorization, strength, accuracy, randomness, readiness for reproduction, noise immunity, speed of reproduction.
- Mind. Its indicators are: speed, flexibility, depth, criticality, breadth, lability, logic, intuitive character.
- Speech. Indicators: content, clarity, expressiveness, effectiveness.

The second group is personal qualities:

- Emotional-volitional sphere. Indicators: willpower, purposefulness, initiative, independence, endurance, determination, energy and perseverance, self-control, anxiety, aggressiveness.
- The value sphere. Indicators are: active life, productive life, cognition, life wisdom, development, freedom, creativity, self-confidence.
- The sphere of self-consciousness. Indicators: an idea of yourself and your goals, a readiness to self-knowledge.
- The communicative sphere. The indicators are: possession of mechanisms of social perception (identification, empathy, reflection, attribution), understanding of oral communications without visual support, understanding of non-verbal means of communication, the ability to establish contact and mutual understanding in communication, expression and protection of one's position in a peer group, fulfilling one's social role in a peer group, determining the social role of a communication partner, forming a desired social status in a peer group, the ability to influence the consciousness and behavior of communication partners, the ability to communicate meaningfully.

The third group is motivation of educational activity:

- The sphere of interaction with the teacher. Indicators: meaningful communication, readiness to work together with the teacher, initiative in educational cooperation, a new form of interaction with the teacher.
- Independence and self-control. Indicators: the ability to learn independently, independence when working with the tasks, the ability to self-study, self-control working with educational tasks.
- Activity-meaningful. Indicators: educational motivation (motivation to study in general, the desire to avoid difficult tasks, the desire to study only in those subjects that you like, readiness to work independently, the motivation to succeed, the desire to study well, the development of self-motivation, focus on financial encouragement from the family for successful studies); understanding of educational material, availability of computer skills, interest in the subject, interest in learning in general, academic performance, availability of actual practical activities, systematization of learning skills, formation of new learning skills, formation of meta-subject actions.

243 teachers from Moscow and the Moscow region, Voronezh, Nizhny Novgorod, Samara took part in the survey. The sample was made up of teachers who took part in the advanced training in IT technologies and engaged in distance learning during the last academic year. All respondents are schoolteachers and work in grades 5-11, 73% are women and 27% are men. Age distribution: 20-23 years - 7.4%; 23-30 years - 21%; 31-40 years - 16%; 41-50 years -21%; 51-60 years - 28.4%; over 60 years - 6.2%. The distribution of the sample by teaching experience is as follows: 0-5 years: 25%; 6-10 years: 7.5%; 11-15 years: 12.5%; 16-20 years: 13.8%; 21-25 years: 11.3%; 26-30 years: 12.5%; over 30 years: 17.5%.

Results

As part of the implementation by the Moscow Pedagogical State University of the scientific research "Development of psychological and pedagogical foundations for standardization of digital educational products/technologies" in September 2021, an anonymous online survey of teachers of secondary schools was conducted at the expense of the federal budget in order to determine the risks and benefits of using digital educational products for the psychological health of students. The questionnaire includes 27 closed questions, which are grouped into 3 blocks: block 1 "Cognitive processes" - 8 questions; block 2 "Personal qualities" - 11 questions; block 3 "Motivation of educational activity" - 8 questions. The questionnaire questions were presented to the respondents in the same order using the Google form. Block 1 "Cognitive processes" contains questions aimed at teachers' understanding of the risks and benefits of using digital educational products for the cognitive processes of students (see Figure 2-5).

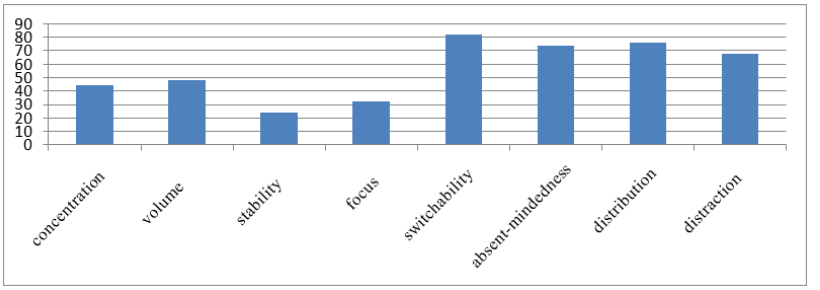

Figure 2. The respondents' answers to the block 1 "Cognitive processes" concerning the development of students' attention in the digital educational environment

The parameters of attention were analyzed: concentration — the degree of intensity of attention on an object; volume — the number of objects that are covered by attention at the same time; stability - the duration of maintaining attention on any object; focus — concentration on one object when distracted from others; switchability — the speed of arbitrary transfer of attention from one object to another; distraction - the inability to focus on anything specific for a long time; distribution is the performance of two or more actions simultaneously with the dispersion of attention between them; distraction is the involuntary

movement of attention from one object to another, or from the main activity to objects that are not important for its successful implementation.

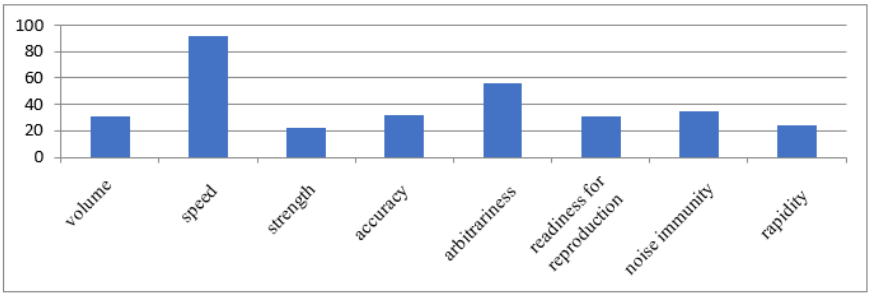

Figure 3. The respondents' answers to the block 1 "Cognitive processes" concerning the development of students' memory in the digital educational environment

The parameters of memory were analyzed: volume — the amount of educational material that the student is able to memorize for a certain time; speed — the time for which the student remembers a certain amount of educational material; strength - the duration of the preservation of educational material in the memory of the student; accuracy — the correctness and speed of reproduction of educational material to the students; arbitrariness — conscious goal setting and the application of certain efforts to memorize the educational material; readiness for reproduction - readiness to promptly reproduce the memorized educational material in consciousness; noise immunity — the ability to resist the sound background, interference, concentrate on the main thing that needs to be stored in memory for subsequent reproduction; rapidity — the amount of time required for the student to reproduce educational material in a timely manner.

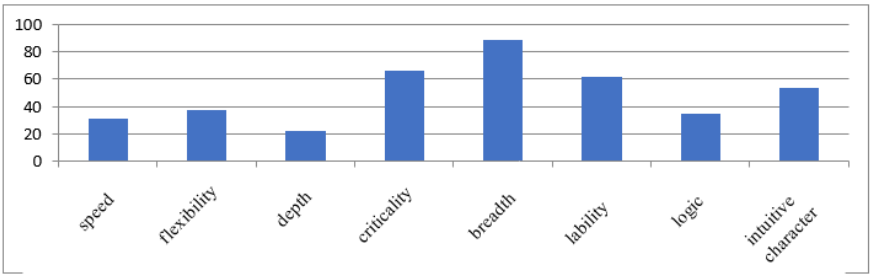

Figure 4. The respondents' answers to the block 1 "Cognitive processes" concerning the development of students' thinking in the digital educational environment

The parameters of thinking were analyzed: speed — the ability to find right solutions to a cognitive problem in a time deficit; flexibility - the ability to choose adequate algorithms for solving a cognitive problem when their conditions change; depth - the ability to penetrate into the essence of a cognitive problem, to find its solution and to anticipate its further development; criticality - the ability to objectively evaluate one's own and others' solutions to a cognitive problem;

breadth - the ability to integrate knowledge from various fields of science and practice to solve a cognitive problem; lability is the ability to quickly switch from solving one task to performing another, without making mistakes; logic is the ability to follow a certain sequence when solving a cognitive task, i.e. the order determined by logic; intuitive character is the ability to solve a cognitive task with a lack of initial data.

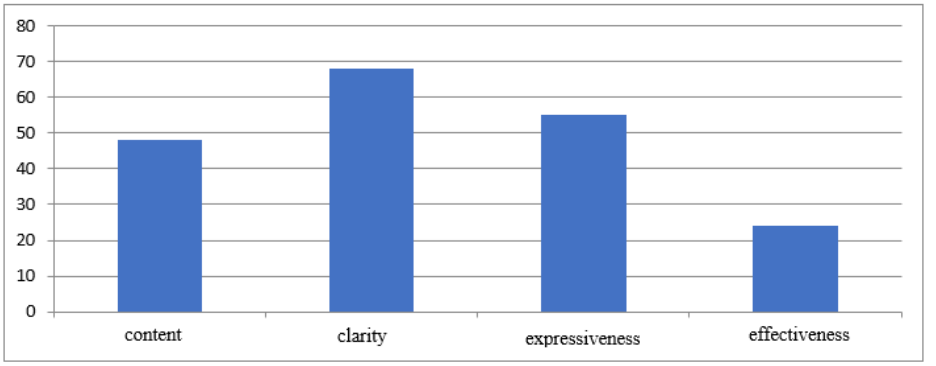

Figure 5. The respondents' answers to the block 1 "Cognitive processes" concerning the development of students' speech in the digital educational environment

Speech indicators were analyzed: content — a number of thoughts expressed in speech; clarity — the correct construction of sentences, the use of logical accents; expressiveness — the richness, variety of linguistic means; effectiveness — the power of persuasion of speech. The analysis of the answers in the first block shows the specifics of teachers' understanding of the features of the cognitive processes of a student when using digital educational products: switchability, attention distribution are developing, focus, concentration and stability of attention are deformed; memorization speed, readiness and speed of reproduction are developing; memorization strength, reproduction accuracy and memory volume are deformed; speed and flexibility of thinking, its intuitive character are developing; depth, criticality and breadth of thinking are deformed; there are difficulties in the oral expression of one's thoughts, "curtailment", impoverishment of the emotional expressiveness of speech, the expressiveness of speech, its content and clarity for the interlocutor are deformed (Nugraha et al., 2020; Aryani et al., 2016).

The most problematic area, from the point of view of teachers, is the impact of digital learning on the speech development of students - among those developing or undergoing deformation, only negative parameters of speech development are present. The block "Personal qualities" contains questions aimed at teachers' understanding of the risks and benefits of using digital educational products for the personal sphere of students. (Figure 6)

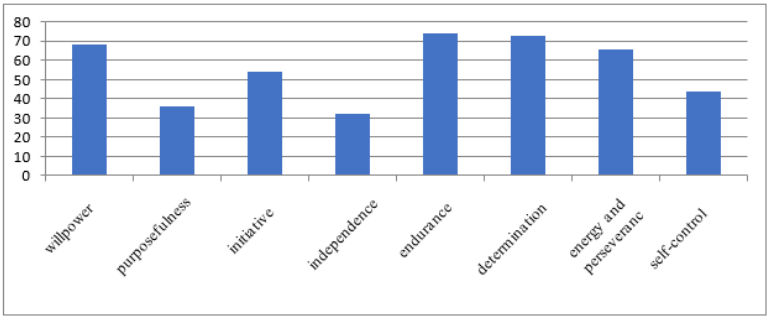

Figure 6. The respondents' answers to the block 2 "Personal qualities" concerning the development of the emotional and volitional sphere of students in the digital educational environment

The following indicators were analyzed: willpower - overcoming obstacles, giving up something; purposefulness - an active focus on results; initiative - the desire for independent social initiatives, activity; independence - the ability to act without support; endurance - the ability to slow down actions, feelings, thoughts; determination - the ability to make a decision and implement it; energy and perseverance - concentration of forces to achieve the goal, stubbornness; self-control - the ability to control one's emotions, thoughts and behavior. An analysis of the responses in the second block showed that half of the respondents believe that the use of digital educational products can increase anxiety and aggressiveness of students, the other half holds the opposite opinion. The same discrepancy of assessments can be found on the issue of changing the emotional reactions of students in the learning process. The ambivalent opinion of the majority of teachers regarding such qualities as independence, purposefulness and self-control is also revealed: they are both simultaneously developed by students when using digital educational products and are deformed. In addition, there is a loss of initiative of students (Ulug et al., 2011; Unianu, 2012).

There were no contradictions in the respondents' opinions when determining the value determinants. From their point of view, first of all, there is a development of freedom, knowledge and creativity, but there can also be a deformation of values such as life wisdom, active and productive life. The analysis of respondents' answers about the development of the sphere of self-knowledge of students revealed the division of the sample into two subgroups. One of the subgroups – the majority of respondents - believes that the use of digital educational products contributes to the formation of an adequate idea of oneselves and one's goals among students and develops their readiness for self-knowledge. Another subgroup does not agree with this. Describing the communication process, the majority of respondents note the development of verbal and non-verbal means of communication among schoolchildren, the formation of the ability to express and defend their position in a peer group. Among the characteristics that negatively affect the communication process, teachers include difficulties in establishing contact and mutual understanding, perception of a communication partner (Garg et al., 2001; Kowalski & Limber, 2007).

Block 3 "Motivation of educational activity" contains questions aimed at identifying the motivation of teaching and understanding by teachers of the risks

and benefits of using digital educational products for the educational activities of students (Figure 7).

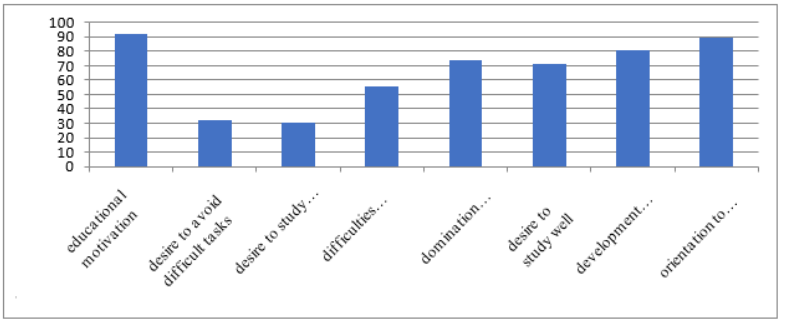

Figure 7. The respondents' answers to the block 2 "Motivation of educational activity" of students in the digital educational environment

The analysis of the respondents' responses in the third block showed that against the background of the generally positive attitude of students to learning with the help of digital products, teachers indicated only negative characteristics of educational motivation: the desire to study only in subjects that students like; the desire to avoid difficult tasks; difficulties in maintaining motivation in individual work. Also, according to most teachers, the motivation for learning and the desire to study well, in general, decrease. Most teachers name the following main "problem areas" of students' learning activities: inability to learn independently, difficulties in understanding educational material, an increase in the number of non-independently done educational tasks. At the same time, most teachers see the potential for the development of schoolchildren in the increasing role of independence, in the emergence of new and systematization of existing educational skills (Moore, 1989; Bascompte, 2007).

Discussion

The most acute problem of the widespread use of digital educational products in the educational process in secondary schools is a decrease in the level of speech development of students. This is concretized in the difficulty of students in the oral expression of thoughts and beliefs, emotional impoverishment and expressiveness of speech, the content of speech and the ability to convey a thought to the interlocutor deteriorates. The process of formation of communicative personality traits also suffers: students experience difficulties in establishing contact and mutual understanding, they have poorly developed perceptual communication mechanisms (empathy, reflection, identification, attribution). The motivational sphere of students' personality requires special attention. There is a pronounced decrease in motivation and desire to learn. Schoolchildren show cognitive interest only in "favorite" subjects. In addition, a violation of the volitional sphere has been established: the desire to avoid difficult tasks is a characteristic of students, also lack of initiative takes place (Peitz & Waelbroeck, 2006; Nylén & Holmström, 2015).

The survey data revealed a fairly large layer of ambiguous assessments by teachers of the impact of digital educational products on the development of cognitive, personal and activity spheres of students. This concerns, first of all, cognitive processes: the concentration of attention develops, and the switchability decreases, the speed of memorization increases, and noise immunity suffers, the speed of thinking (the ability to find right solutions to a cognitive task in a time deficit) develops, and the depth of thinking (the ability to penetrate into the essence of a cognitive task, find its solution and anticipate its further development) does not develop. If we analyze the impact of digital products on the self-consciousness of schoolchildren, then, according to the teachers, such qualities as readiness for self-knowledge, independence, the formation of an adequate idea of oneself and one's goals, purposefulness and self-control are simultaneously developed and deformed. The respondents noted the development of students' values of freedom, cognition and creativity in the process of working with digital products. The data obtained by us demonstrate the dynamics of the pedagogical community's ideas about the role of digital educational products in the development of the cognitive, personal and activity spheres of students (Smith et al., 2015; Papastergiou, 2009).

Conclusion

The ecological system of the digital educational environment as a new definition of modern education includes both developing and deforming components of the use of digital educational products and technologies. Generalization of the data obtained allows us to draw the following conclusions. Digital technologies and digital products have already become an integral part of society today, which cannot be abandoned. Their widespread penetration into the educational environment requires a deep scientific analysis of the mechanisms and results of the impact of products on the cognitive, personal and activity sphere of students. The results of the study indicate the ambiguous impact of digitalization on the personal development of schoolchildren. Speech development, communicative and motivational spheres of the student's personality are most negatively affected. The reason for this is the excessive algorithmization of educational content, its fragmentation, the prevalence of written tasks, individual rather than group work, the predominance of the visual series, reliance on the process of recognition rather than arbitrary reproduction of the material, lack (and sometimes complete absence of tasks) for reasoning, etc.

In this regard, the problem of standardization of requirements for digital educational products developed for secondary schools is being updated. These requirements will draw the attention of developers to the need to introduce mandatory tasks within the sections of textbooks aimed at minimizing the risks of deformation of both cognitive processes and substructures of personal and activity spheres of students, will form the prerequisites for the fullest use of the advantages of digital products. An important point, in our opinion, is the understanding of the fact that the content and specific tasks of training are the leading factors in choosing digital technologies and products, justifying their pedagogical expediency.

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