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OF DIGITAL TECHNOLOGIES ON EDUCATIONAL EFFICIENCY

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Mardankulov Jasur Amirddinovich
Jizzakh Regional Pedagogical Skills Center, PhD, Associate Professor.

Abstract

This article analyzes the role of electronic textbooks and digital learning systems in the educational process, their advantages over traditional teaching methods, problems in their implementation, and the importance of multimedia tools in consolidating students' knowledge. The study highlights the possibilities of electronic learning resources in ensuring interactivity, flexibility, and an individual approach. It also indicates the necessary organizational and pedagogical conditions for the effective implementation of digital resources in schools and higher education institutions.

Keywords

electronic textbook, digital education, multimedia, interactive education, individual education, educational technologies.

Introduction. The digitalization of the education system is one of the most relevant directions of modern pedagogy. The rapid development of information and communication technologies has introduced new tools, methods and approaches to the educational process. In particular, electronic textbooks, distance learning platforms, multimedia resources and artificial intelligence-based learning systems are emerging as important factors in increasing the effectiveness of education.

Although the traditional education system has served as the main form of education for many years, in today's conditions of globalization and digital transformation, there is an increasing need to update the content of education, to transform it into an interactive and flexible form. In this context, it is important to scientifically analyze the potential of electronic textbooks and digital educational systems.

In the modern educational paradigm, electronic educational resources and digital learning platforms, while radically transforming traditional pedagogical methodologies, provide a logical continuation of the traditions of classical teaching. A comparative analysis of these systems shows that the most important aspect of digital resources is the possibility of dynamic updating of information and its

content relevance. If the frequency of processing and printing of traditional printed publications is on average 3–5 years, creating a discrepancy with the rapid development of science, electronic textbooks allow editing content in real time and enriching it with the latest scientific results. At the same time, the hypertext structure provides the reader with the opportunity to systematize knowledge by using non-linear navigation, that is, by instantly switching from the concept being studied to related external sources [1] .

In terms of pedagogical mechanisms for delivering information, the static nature of traditional textbooks is being replaced by multimedia interactivity in electronic resources. Audio-visual components, animated models, and interactive graphics increase the level of student perception of the material, transforming complex abstract concepts into concrete visual images. In this process, the learner rises from a passive consumer of information to an active subject. The integration of forums, chats, and social networks in digital ecosystems forms a collaborative (collective) communication of students, even allowing them to participate in the joint creation and enrichment of educational content [2] .

Finally, ergonomically and functionally, electronic textbooks are distinguished by the perfection of the information search and sorting system. The time and intellectual resources spent on finding information in traditional books are minimized in the digital environment through algorithmic search systems. This creates ample opportunities for the learning process to focus not on technical actions, but on direct analysis of the content and in-depth mastery of the subject.

The organization of the learning process in a digital learning environment fundamentally changes not only the technical means, but also the dynamics of the classroom and the architecture of pedagogical relations. In this process, the traditional lecture format is replaced by the “flipped classroom” model. In this approach, fundamental theoretical information is presented to students in a multimedia format before the lesson, while direct classroom activities are focused on creative discussions, analysis of problem situations and the implementation of collective projects. In this case, the role of the teacher changes from a provider of information to a moderator of the learning process and curator of digital content.

In terms of individualization of education, electronic systems offer adaptive learning algorithms. This technology allows you to dynamically change the level of complexity in accordance with the learning speed and intellectual potential of each learner. Automated pedagogical monitoring and diagnostic systems, unlike traditional subjective assessments, provide quick and objective feedback on student achievement, which serves as an effective tool for managing the quality of education.

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At the same time, integration into the e-learning environment is characterized by the emergence of a number of systemic difficulties and technological barriers. In particular, the need for pedagogical subjects to have a high level of digital competence and the increase in the visual and cognitive load in receiving information from a computer screen require special methodological attention. Also, the high dependence on digital infrastructure and stable communication channels, the lack of unified standards for creating electronic resources create certain difficulties in ensuring quality control in this area. Nevertheless, a rational synthesis of traditional and electronic methods is considered the most optimal strategy for increasing the effectiveness of modern education [3] .

The process of integrating digital resources in secondary education is a multifaceted problem that requires overcoming complex technological, methodological and organizational barriers. Analysis of scientific and pedagogical sources allows us to divide the main dysfunctions in this area into the following systemic areas:

Infrastructure and technical and operational problems. The primary obstacle to the formation of a digital education ecosystem is the lack of a fundamental technological base and the moral obsolescence of existing resources. The sustainable operation of learning management systems (LMS) requires not only modern server equipment, but also a highly qualified IT staff that provides cybersecurity protocols and conducts systematic diagnostics. Outages in the technical service system can lead to information "noise" and flooding of platforms with unverified information. At the same time, ergonomic limitations of hardware, in particular, the negative impact of prolonged viewing of information through a display on visual and cognitive health, remain one of the physical barriers to digital education.

Transformation of the pedagogical corpus and a competency-based approach. Working in a digital environment requires a teacher to have a high level of digital literacy in addition to classical pedagogical skills. In practice, there is a shortage of personnel between the training of graduates of higher pedagogical education in electronic methodologies and the needs of real schools. A modern teacher must not only use ready-made resources, but also take on the role of a moderator who designs and edits digital content and manages remote communication in a virtual environment. This requires the introduction of systematic retraining and new models of professional development [4] .

Unification and quality control of didactic content. Today, the lack of unified state and international standards for the creation of electronic educational literature leads to methodological fragmentation of materials created by different developers.

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Creating a high-quality, interactive multimedia product is a complex technological process involving educators, programmers, designers and installers. In conditions of resource scarcity, there are often cases of using scanned copies of paper publications or open sources (for example, Wikipedia) that have not undergone academic verification. Such an approach reduces the didactic potential of digital education, reducing it to the level of a mere electronic copy of a traditional textbook.

Economic and organizational determinants and mechanisms for increasing cognitive activity in digital didactics. The process of forming a digital educational environment involves not only pedagogical, but also deep financial and organizational transformations. Economic barriers to the implementation of these systems are mainly explained by the high level of initial capital investments. However, in many cases, the ineffectiveness of technological integration is due to strategic mistakes - the introduction of technology not for pedagogical optimization, but for the sake of formal "innovation" or prestige. As a result of such "superficial digitization", electronic duplicates of paper processes appear, which, instead of reducing the workload of the teacher and student, increases it due to duplication. At the same time, the lagging behind of the methodological base in the pace of innovation limits the didactic potential of digital resources.

From the point of view of subjective-psychological factors, digital education requires a high level of self-determination and volitional qualities from the student. In a distance and electronic format, the student must become an independent subject of learning from an object of external control. This transition period can create certain difficulties for students prone to cognitive passivity, but a properly designed multimedia environment can help to overcome these problems [6] .

Mechanisms for increasing the educational effectiveness of multimedia materials are implemented through the following pedagogical tools:

- Cognitive engagement and interactive collaboration: Multimedia tools elevate the learner from a passive receiver of information to a researcher who engages in cooperative interaction with content. The integration of social-communicative platforms implements the principle of social constructivism.
- Sensory modality and information convergence: The synthesis of audio, video, and animation components simultaneously activates multiple perceptual channels, which improves the distribution of cognitive load and the retention rate of material in long-term memory.
- Gamification and motivational drivers: Gamification elements such as points systems, badges, and competitive rankings enrich the learning process with game

dynamics. This increases the learner's intrinsic motivation and responsibility for completing tasks.

• Artificial intelligence-based adaptive trajectory: Neural networks and algorithms analyze each user's learning rate and adapt the material to their intellectual potential. This prevents boredom or frustration caused by excessive complexity by keeping the learner in the "zone of proximal development" [5] .

Digital educational technologies, based on the principles of cognitive psychology and neuropedagogy, fundamentally increase the efficiency of information acquisition and memory retention. In this process, micro-learning strategy plays an important role. The division of complex theoretical concepts into small, logically completed cognitive units optimizes the load on the learner's working memory. As a result, it becomes possible to avoid information overload and mental fatigue syndrome, which are characteristic of traditional academic lectures. Such a modular structure, in turn, allows for spaced repetition facilitates the use of the methodology, which is one of the most effective didactic methods that ensures the stable transfer of acquired knowledge from short-term memory to the long-term memory system.

From the perspective of sensory modalities of information reception, the synchronous transmission of visual and audio signals — for example, dynamic slideshows or annotated video lectures — enhances cognitive integration. This approach, in accordance with the theory of dual coding, simultaneously activates different parts of the brain, deepening the semantic analysis of educational material. At a more complex level, immersive technologies (XR, VR, AR) allow students to operate in realistic simulated environments. Based on the principle of "learning by doing", these immersive practices serve to develop professional skills and consolidate experiential knowledge without real-life risks.

As a methodological basis of e-learning, the development of students' subjective position and independent learning competencies is of particular importance. Digital resources not only stimulate cognitive activity, but also personalize the educational trajectory through individual correction mechanisms. Automated diagnostic systems identify "discontinuities" and gaps in the student's knowledge and provide adaptive recommendations to eliminate them, which guarantees the strength of the fundamental base before moving on to the next more complex stages. At the same time, social tools such as videoconferencing, forums and collaborative chats create an ecosystem of collective responsibility and mutual support in the digital environment. This solves the problem of academic isolation, which is often encountered in a distance format, and forms an effective social learning environment based on self-management.

Analyses have shown that electronic textbooks and digital learning systems have the following advantages:

1. Rapid updates and relevance of information - Electronic learning resources can be updated continuously. This allows students to use the latest information. In printed textbooks, this process takes more time.

2. Increase interactivity and interest - Electronic resources allow the use of audio, video, animation, simulations, and interactive tests. As a result:

- It becomes easier to understand complex topics;
- student activity increases;
- the ability to work independently is formed.

3. Individual approach - Digital platforms can provide materials tailored to each student's level of knowledge, pace, and needs, which ensures the personalization of the learning process.

4. Effectiveness of control and assessment - Electronic tests, automated assessment and monitoring systems allow for a quick and objective determination of a student's level of knowledge.

5. The effect of multimedia tools on memory - Multimedia-based learning:

- enhances information recall;
- reduces cognitive load through microlearning;
- increases showiness;
- creates an immersive learning environment.

The results of the study show that electronic textbooks do not completely negate traditional education, but rather serve as an effective tool to improve it. However, there are a number of problems in the implementation of digital education:

Infrastructure problems - Many educational institutions have inadequate internet quality, servers, and technical equipment.

Digital competence of teachers - To effectively use electronic resources, educators must have high levels of ICT training.

Content quality and standardization - The lack of uniform standards for creating electronic textbooks negatively affects quality.

Students' readiness for independent learning - Digital learning requires a high level of self-control and motivation.

Therefore, to effectively organize digital education, it is necessary to improve the system of pedagogical design, technical support, methodological services, and teacher training.

In conclusion, electronic educational resources and digital learning platforms are important pedagogical tools that are taking the modern education system to a

qualitatively new level. They create great opportunities for increasing the interactivity of the educational process, individualizing knowledge, and developing students' independent thinking and practical skills. Multimedia, adaptive algorithms, and digital monitoring tools increase the efficiency of deeper learning of educational materials and long-term retention of knowledge.

At the same time, the success of digital education is closely related not only to the availability of technological tools, but also to their correct implementation on a scientific and methodological basis, the development of digital competence of educators, the creation of quality content and the formation of a solid infrastructure. Therefore, the rational integration of traditional and digital teaching methods is the most optimal strategy that ensures the efficiency, flexibility and competitiveness of modern education.

Electronic textbooks and digital learning systems have great potential to improve the quality and efficiency of education. They serve to update educational content, increase student engagement, establish individualized learning, and improve the control system.

However, the effectiveness of these systems depends on the following factors:

- solid technical infrastructure;
- quality electronic content;
- digital competence of educators;
- methodological and organizational support.

In the future, further improving e-learning resources based on artificial intelligence, developing adaptive learning platforms, and expanding innovative approaches in education will remain urgent tasks.

Recommendations:

1. Strengthening digital infrastructure - It is necessary to introduce high-speed internet, modern computer equipment, and stable LMS platforms in educational institutions.

2. Improving the digital competence of educators - Regular training courses should be organized for teachers on creating electronic resources, using multimedia tools, and distance learning methodologies.

3. Creating quality electronic content - It is recommended to create interactive, methodologically well-designed electronic textbooks and multimedia materials across disciplines.

4. Development of uniform standards - It is advisable to establish national standards and quality criteria for the creation, evaluation, and implementation of e-learning resources.

5. Expanding individualization of education - Adaptive platforms and artificial intelligence-based monitoring systems that are tailored to the needs and abilities of students should be used.

6. Widespread use of multimedia and interactive methods - It is recommended to increase student interest and engagement through video, animation, virtual labs, and gamification elements.

7. Developing independent learning skills in students - Focus should be placed on developing self-management, time management, and independent learning competencies in a digital environment.

8. Strengthening methodological and psychological support - It is necessary to establish a system of methodological assistance, technical advice, and psychological support for students and teachers in the process of digital education.

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