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DIGITAL TECHNOLOGIES AS A MEANS OF MAINTAINING THE QUALITY OF EDUCATION IN WARTIME

TECNOLOGIAS DIGITAIS COMO MEIO DE MANTER A QUALIDADE DA EDUCAÇÃO EM TEMPO DE GUERRA

LAS TECNOLOGÍAS DIGITALES COMO MEDIO PARA MANTENER LA CALIDAD DE LA EDUCACIÓN EN TIEMPOS DE GUERRA

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ABSTRACT: This article analyses the potential of digital technologies to ensure the quality of education during martial law, highlighting their importance in crisis contexts. The study examines the role of innovative educational approaches related to accessibility, inclusion, academic performance, effective monitoring, safety, and teacher professionalism. Digital pedagogical tools such as online platforms, interactive resources, gamification, and immersive technologies are explored. The research included a pedagogical experiment with online platforms, demonstrating their value in optimizing distance learning in times of war. Advantages were identified, such as increased student interest and motivation, improved learning, and expanded inclusion, as well as risks of information overload, dependency, and reduced social interaction. The study demonstrates that digital solutions favour educational continuity, the development of cognitive, critical, and social skills, and promote sustainable motivation and creative learning in conflict contexts.

KEYWORDS: Digital technologies. Educational losses. Online platforms. Immersive technologies. Interactive education.

RESUMO: *O artigo analisa o potencial das tecnologias digitais para garantir a qualidade da educação durante a lei marcial, destacando sua importância em contextos de crise. O estudo examina o papel de abordagens educativas inovadoras relacionadas à acessibilidade, inclusão, desempenho acadêmico, monitoramento eficiente, segurança e profissionalismo docente. São exploradas ferramentas pedagógicas digitais, como plataformas online, recursos interativos, gamificação e tecnologias imersivas. A pesquisa incluiu uma experiência pedagógica com plataformas online, demonstrando seu valor para otimizar o ensino a distância em tempo de guerra. Identificam-se vantagens como aumento do interesse e motivação dos alunos, melhoria da aprendizagem e ampliação da inclusão, bem como riscos de sobrecarga informacional, dependência e redução da interação social. O estudo comprova que as soluções digitais favorecem a continuidade educacional, o desenvolvimento de competências cognitivas, críticas e sociais, além de promover motivação sustentável e aprendizagem criativa em contextos de conflito.*

PALAVRAS-CHAVE: *Tecnologias digitais. Perdas educativas. Plataformas online. Tecnologias imersivas. Educação interativa.*

RESUMEN: *Este artículo analiza el potencial de las tecnologías digitales para garantizar la calidad de la educación durante la ley marcial, destacando su importancia en contextos de crisis. El estudio examina el papel de los enfoques educativos innovadores relacionados con la accesibilidad, la inclusión, el rendimiento académico, la supervisión eficaz, la seguridad y la profesionalidad docente. Se exploran herramientas pedagógicas digitales como plataformas en línea, recursos interactivos, gamificación y tecnologías inmersivas. La investigación incluyó un experimento pedagógico con plataformas en línea, demostrando su valor para optimizar la educación a distancia en tiempos de guerra. Se identificaron ventajas, como un mayor interés y motivación del alumnado, una mejora del aprendizaje y una mayor inclusión, así como riesgos de sobrecarga de información, dependencia y reducción de la interacción social. El estudio demuestra que las soluciones digitales favorecen la continuidad educativa, el desarrollo de habilidades cognitivas, críticas y sociales, y promueven la motivación sostenible y el aprendizaje creativo en contextos de conflicto.*

PALABRAS CLAVE: *Tecnologías digitales. Pérdidas educativas. Plataformas en línea. Tecnologías inmersivas. Educación interactiva.*

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INTRODUCTION

The crisis of war in education is manifested in the forced transition to distance learning, which leads to educational losses and a decrease in the quality of knowledge, as well as in the negative psycho-emotional state of participants in the educational process. The key goal of the modern educational concept is the comprehensive development of the individual in the learning process, which should be integrated and inclusive, provide for a variety of forms of presentation of educational material, implementation of digital solutions, multimedia technologies and interactive elements. A high level of quality education under martial law can only be achieved if a favourable psychological microclimate is created for the effective implementation of innovations, the combination of elements of traditional and digital education, and the adaptation of students to new forms of interaction.

Researchers have paid considerable attention to this issue in an interdisciplinary context. The authors (Sailer et al., 2021; Semenets-Orlova et al., 2022; Sarker et al., 2019; Williamson et al., 2020) analyse the digital potential in the educational context, in the format of media education, gamification, mobile learning applications, and interactive platforms. Singh (2021) explores the potential of immersive environments to create realistic learning experiences. A number of researchers (Parveen & Ramzan, 2024) consider effective methods for developing key skills and abilities in the digital environment using a project methodology and case study approach. The potential of online education in the context of war is explored by Londar and Pietsch (2023), and Tlili et al. (2024).

It is obvious that modern educational technologies based on digital solutions assimilate the most relevant educational trends - creative communication, integrated implementation of problem-based learning and dialogic approach. At the same time, modern teachers should be motivated to continuous self-improvement and professional growth, active integration of modern educational solutions and use of the potential of information technology.

International experience shows that there is an urgent need for cooperation between the government and the public in implementing innovative learning models that will contribute to the further development and rethinking of educational strategies during post-war recovery. In the crisis circumstances of martial law, it is necessary to develop the resilience of the education system by adapting to new realities. Digital technologies can significantly improve the quality of learning, and thus the relevance of an expanded analysis of their role in education is beyond doubt.

LITERATURE REVIEW

The scientific discourse in the field of the studied problem is characterized by the polarity of conceptual views on ensuring the quality of education in crisis conditions. Purike and

Aslan (2025), Van Der Vlies (2020) consider digital skills of teachers as the basis for effective integration of technology into the educational process. These include the ability to use digital tools, including artificial intelligence (further AI) to create educational content, personalize education and organize online learning, ensure effective communication, critically evaluate digital information, maintain data security, and comply with ethical standards in the digital space. Scientists emphasize the role of online platforms and mobile learning in the development of students' creative abilities and communication competence, which requires the formation of sustainable professional competence of teachers and their readiness for innovation and continuous self-improvement.

The publication by Bojović et al. (2020) proposes to maximize the use of modern information systems to improve distance education—interactive platforms, gamification, storytelling, and online tools. Such tools, according to the authors, help to increase the motivation and involvement of students, develop logical and critical thinking, improve the quality of classes, and allow for the integration of an integrated educational approach.

The conceptual boundaries of the issue of using digital opportunities and artificial intelligence in education are expanded in the publications of Bernacki et al. (2020), Wang et al. (2024), who focus on the development of personalized educational trajectories using artificial intelligence, big data analysis, and experience personalization. The authors offer their own vision of the process of forming the digital competence of modern students, substantiating the potential of interactive technologies to combine individual and group forms of work, maximize the integration of discussion practices, project-based learning, and online training.

Researchers Gabarda Méndez et al. (2023) emphasize that the integration of artificial intelligence into education requires special attention to ethical aspects. The authors assure that neural networks contribute to the development of critical thinking and problem-oriented search for targeted solutions to a situation, and elements of virtual reality in the form of immersive simulations allow for the involvement of the cognitive sphere and reflection.

The issue is discussed in the publications of Alemán de la Garza et al. (2019), Sharma and Singh (2024), which analyse the potential of artificial intelligence in the context of the integrated implementation of problem-based learning and adaptive personalized education systems, the development of effective automated assessment systems and the creation of digital educational hubs. Scientists identify elements of gamification and mobile learning as innovative areas of modern learning. According to their observations, game collaboration increases motivation to learn, promotes better learning, and mobile applications allow optimizing the spatial and temporal aspect of the educational process.

At the same time, de Souza and Debs (2024) identify related challenges and risks to the active digitalization of education: the impact of the digital educational field on the cognitive sphere of students, the ethical component and the risks of developing dependence on

ready-made intellectual solutions. Scientists emphasize the problem of managerial support for the digital progress of education, the need to eliminate the imbalance between innovative and traditional forms of education. The researchers draw attention to the need to optimize the psychological environment of the educational process through positive-pole communication and increase the motivation of students through effective structuring of the educational process, unhindered feedback, emotional intelligence and creativity.

The authors of Criollo-C et al. (2021) study the potential of online platforms for the development of critical thinking, engagement, and creativity. Scientists are exploring the methodology of digital project-based learning, prioritizing the maximum development of students' personal learning and creative potential. The rapid development of online learning platforms, according to scientists, necessitates increased attention to the capabilities of AI in higher education. Digital tools that are currently actively used in Moodle, Google Classroom, Zoom, Google Meet, Word Pad, etc. can significantly improve the quality of education and the level of student learning.

Despite the increased scientific interest in the issue under study, a critical analysis of the potential opportunities for integrating digital technologies into education to improve its quality requires an expanded approach and actualization in light of the challenges of martial law.

The aim of the study is to analyse the potential of modern digital technologies in ensuring the quality of education under martial law.

RESEARCH METHODS

The main materials of the study were selected publications for 2020-2025, which are indexed in leading scientific databases (Web of Science, Scopus), as well as statistics from official sources. The keywords used for the search were digital technologies, educational losses, online platforms, immersive technologies, interactive education, quality of education, martial law. The main criteria for excluding and including scientific papers and publications in the methodological sample of the study are the level of reliability and validity of information, as well as the spatial and temporal indicator in the context of its representativeness. The sample size is 25 items. Given the practical realities, the size of the sample of sources was considered appropriate, providing sufficient scientific and statistical power.

In the course of the study, the following general scientific methods were applied: analysis and synthesis, comparison, structural and logical method, systematization, generalization, and abstraction. The chosen methods allowed us to comprehensively study the effectiveness of modern technologies in the context of pedagogical solutions and innovative teaching methods. The methods also made it possible to determine the main criteria and definitions, identify the

most influential factors on the effectiveness of technology integration in the educational process of primary school, and critically assess the associated risks and negative consequences.

To reduce the internal bias in the publications used for this study, an open access and data reuse strategy was applied. This involved providing access to the full study data, including raw data and code, which allowed for verification of results and additional analysis, if necessary, thereby reducing the impact of bias.

As part of the study, a pedagogical experiment was conducted with high school students and students of a professional college in the academic year 2024-2025. A control group (31 students) and an experimental group (33 students) of students were formed. The sample was formed on the basis of voluntary participation. The criteria for selecting respondents were: representativeness of the participants, the possibility of regular attendance at classes to ensure the reliability and completeness of the experiment. The duration of the study chosen by was three months, as a prerequisite for the success of an experimental study is its connection to practice. The participants provided informed consent. Also, the confidentiality of information about the research results was ensured.

The study of problems is carried out in the conditions of a real pedagogical process. The survey results were summarized using quantitative analysis methods. The method of comparative analysis was used to interpret and compare the results.

RESEARCH RESULTS

Against the backdrop of education modernization, digital innovations are essentially the result of finding original and non-standard solutions to various pedagogical problems. The quality of education implies ensuring accessibility, inclusiveness, high level of academic achievement, effective monitoring, safety and friendliness of the educational environment, and the level of professionalism of teachers.

In the context of the challenges of martial law, digital solutions can increase the effectiveness of learning and the formation of the necessary skills, and involve the use of: interactive technologies for the implementation of practice-oriented learning strategies; elements of gamification and multimedia technologies for audiovisualization of educational material; smart cards and sequences for the development of critical thinking skills, logical and verbal competencies and communication; artificial intelligence for personalization, increasing the motivation of students.

An expanded description of modern digital technologies for improving the quality of education against the backdrop of martial law challenges is given in Table 1.

Table 1
Potential of digital technologies in modern education

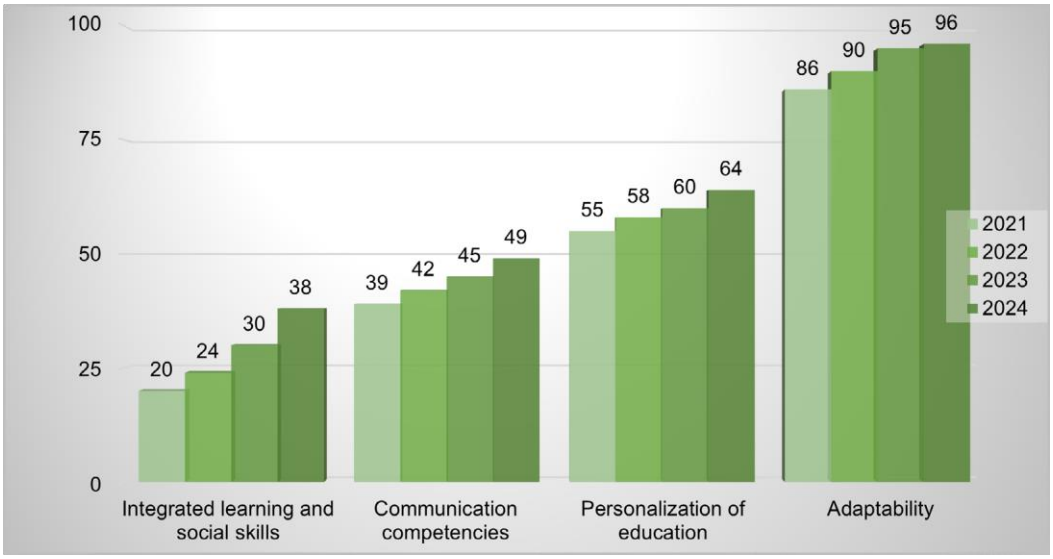
Type of technology	Example of a solution	Opportunities
Online platforms for distance learning	HUMAN	A convenient system for maintaining electronic document management, conducting online lessons, submitting and checking homework, receiving feedback from students, and communicating with them. Teachers can create their own lessons on the platform and use them later. The basic version of the program is free, and its functionality is sufficient for distance learning.
	Google classroom	A free web service created by Google for educational institutions, where teachers can create and check assignments stored in individual student folders on Google Drive.
	MOODLE	A learning platform that allows to present educational material in various formats (text, presentation, video, web page); test and survey students using closed and open-ended questions.
Gamification	LearningApps	A free platform that allows to create interactive games and exercises in various subjects. You can add photos, pictures, sound, or video to exercises. The platform has ready-made tasks that can be edited.
Mobile applications	Quizlet	Helps to create and study flashcards to help to memorize information on any topic.
Interactive technologies and audiovisualization	Liveworksheets	Allows to turn traditional printable worksheets (doc, pdf, jpg...) into interactive, self-correcting online exercises that is called "interactive worksheets". They can contain sounds, videos, drag-and-drop exercises, arrow combinations, multiple choice, and even speaking exercises that students have to do with a microphone.
	Padlet	A multimedia resource where people can create, edit, and store information for free. It is a virtual wall where people can attach photos, files, links to websites, and notes.
Smart maps and sequence	Draw.io.	This is a free multifunctional service with a fairly simple interface. It allows to create mind maps, as well as various diagrams, tables, flowcharts, simple infographics, and presentations.

Note. Developed by the author.

Digital technologies allow to release significant resource potential for the development of sustainable skills and abilities in students, improving the quality of education during martial law. It is advisable to highlight the areas of use of digital tools in educational institutions in the European Union (EU) (Figure 1).

Figure 1

Digitalization of education in EU countries, 2021-2024, % of efficiency



Note. European Agency (2024).

As Figure 1 shows, EU educational institutions pay special attention to personalizing education and increasing adaptability. Indicators of successful social and psychological adaptation of students at the group level include general satisfaction with the relationship with the environment in the educational field, positive social identity, intergroup tolerance; at the personal level—actualization of the need for self-respect and self-actualization, high activity, emotional stability. In the context of wartime challenges, the issue of adaptability of students is of particular importance.

In order to test the impact of digital educational solutions on the quality of education in wartime, the study conducted a pedagogical experiment with high school students and students of a professional college in the academic year 2024-2025. A control group (31 students) and an experimental group (33 students) of students were formed.

The average values of the learning coefficient used for the evaluation were determined by formula (1):

$$KN1 = A1/N1 \quad (1),$$

where KN1 is the learning coefficient; A1 is the qualitative indicator of learning; N1 is the maximum possible result (in points) of qualitative training.

Before the experiment, the initial level of the studied skills of students was assessed (Figure 2).

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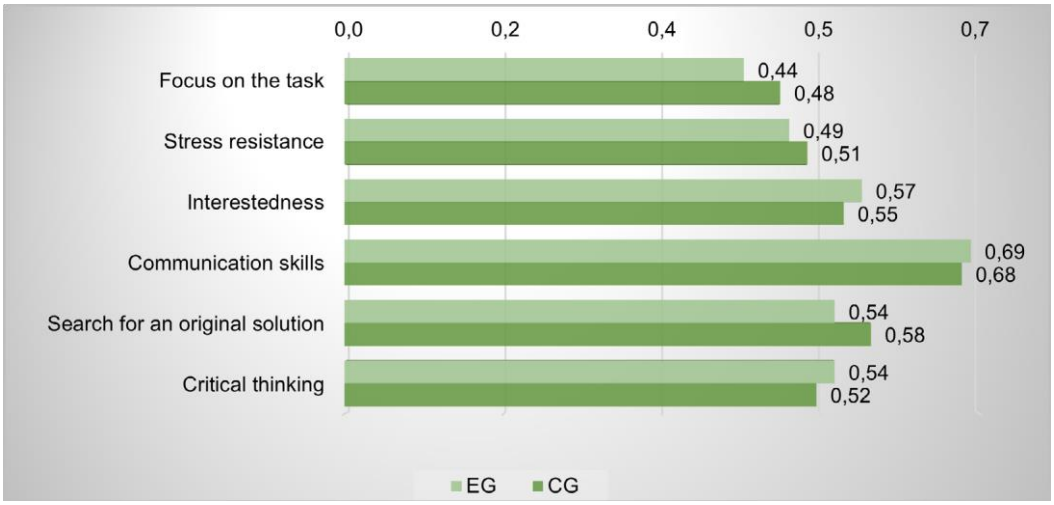
Figure 2
Initial level of skills of students (by the coefficient of learning)



Note. Compiled by the author.

In the educational process of the EG, digital capabilities of online platforms were used: elements of gamification and embodied learning, project tasks, audiovisual method (Table 2). The CG studied using traditional educational methods.

Table 2
Structure of digitalization of the educational process of EG respondents

Digital educational solution	Pedagogical tools	Practical platforms	Number of training hours
Online platforms for distance learning	Interactive simulations; scoring and rating system; virtual reality	MOODLE Google Classroom	10
Interactive technologies and audiovisualization	Discussion, presentations, video content, survey forms	Liveworksheets Padlet	10
Mind maps and sequel	Create mind maps, charts, tables, infographics, and presentations.	Draw.io	8

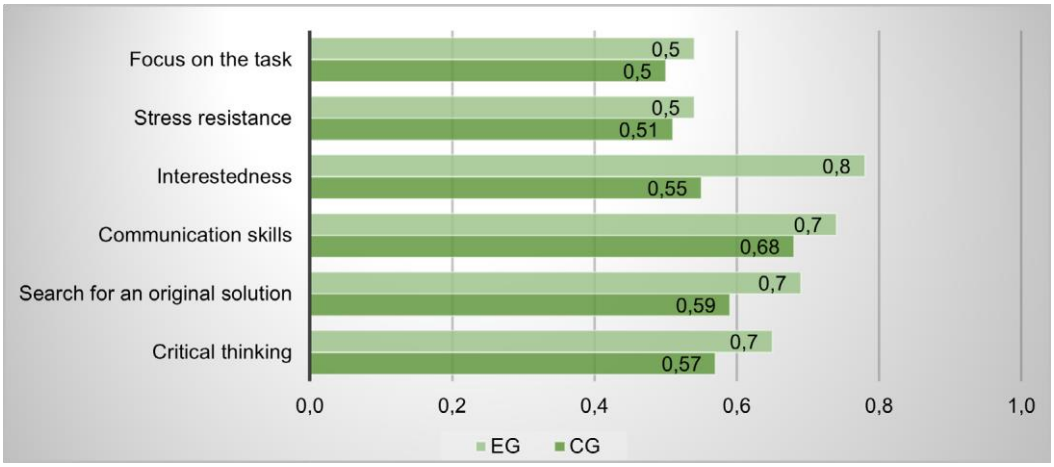
Note. Created by the author.

After the training, the dynamics of students' skills in the EG and CG, which characterize the level of quality of education, was re-analysed (Figure 3).

According to the results of the experiment, the use of digital technologies in the educational process has a number of advantages, as it involves the emotional sphere and the sensory system, allows visualizing abstract and complex concepts, stimulates the development of creativity and problem-oriented thinking. The results of the experiment demonstrate significant positive dynamics in the skills of EG students, especially in the aspects of interest, critical

thinking and the search for non-standard solutions. In general, the aspects of the positive impact of digital technologies on the quality of education include:

Figure 3
Control of the level of skills (by the learning rate)



Note. Compiled by the author.

- Optimization of the psychological microclimate, safety and friendliness of the educational environment;
- Adaptability and flexibility of learning, the possibility of personalization;
- Increasing the interest and motivation of students;
- Inclusiveness through a variety of approaches, methods, and forms of presenting educational information.

At the same time, there are certain related challenges, disadvantages and risks, in particular, difficulty in accessing the necessary technical support, risks of overdependence on digital learning tools, deterioration of health and cognitive processes, slowing down the development of social competence due to the preference for interactive learning, deterioration of the quality of social interaction and contact, and the possibility of excessive overload with information flows (Haleem et al., 2022).

Also, it is necessary to emphasize the key role of the teacher in the process of introducing digital technologies. Teachers must be competent in the practical functionality of new tools, be able to effectively integrate their elements based on key pedagogical principles, primarily gradualism and balance (Hawkridge, 2022). In general, motivation and reflection play an important role in the development of innovative education: motivation determines the orientation of the student to active interaction and information activities, and reflection allows

to form the correct attitude of the student to himself, his own activities and the world around him, which is especially important in the crisis conditions of martial law.

Educational losses caused by military events require a comprehensive approach to overcoming them. Timely diagnostic work to determine the level of basic knowledge and identify gaps, corrective work involving digital educational resources, and intensification of psychological support will help maintain a sustainable level of education quality in crisis conditions and form new ways of crisis management in education.

DISCUSSION

The scientific discourse on the role of integrating digital innovations into pedagogical practice to improve the quality of education is represented by different interpretations of the principles, advantages and challenges of the process, its prerequisites for effectiveness. The need to form a unified conceptual approach to the anti-crisis model of integrating innovative technological solutions is advocated by Gabriel et al. (2022). The researchers have implemented a number of experimental solutions for the integration of mixed reality tools, characterized by the involvement of tactile and sensory capabilities and reflection. Scientists draw attention to the importance of personal and social skills—communication skills, variability of behavioural reactions, successful socialization and teamwork, which must be considered when building concepts of digitalization of education.

At the same time, Chiu (2024) analyses the possibilities of interactive and machine learning, AI for personalized learning and monitoring of the educational environment. The author emphasizes the benefits of AI, while it is necessary to supplement the outlined concept with potential risks of using AI in the educational process, including: digital inequality due to social gaps, ethical issues of personal data collection, risks of technology dependence and displacement of effective traditional methods.

Supriani et al. (2022) argue for the effectiveness of using online platforms in the concept of inclusive learning strategies that take into account different types of information perception, involve gamification, video tutorials, and audio materials. Also, the educational process should be comprehensive and assimilate logical and verbal abilities, cognitive activity, and the cognitive sphere.

In continuation, Qureshi et al. (2021) substantiate the feasibility of using gamification to develop critical and creative thinking, communication processes, independent decision-making skills, and teamwork. The author emphasizes the need to partially replace traditional educational algorithms with the integration of online communication tools in the format of project-based learning, functional chats, media products, and mobile applications. This will

preserve the benefits of traditional education and ensure complementarity with the needs of modern society, developing information processing speed, attention and memory, having an educational impact, and developing communication tools.

The current study demonstrates the effectiveness of digital technologies in improving the quality of education in a crisis social environment. Similar conclusions were reached by Valverde-Berrocoso et al. (2021), focusing on the potential of mobile applications and online platforms to develop practice-oriented learning, improve learning, and increase the engagement of students at the emotional level. In the context of Ukraine, digital technologies require significant investment and methodological support for effective integration into the general education process. International targeted projects can provide significant support in this context, including those focused on improving the digital skills of teachers and the adaptability of curricula to the innovative format. The primary benefits of digitalizing education during martial law include increased access to educational materials, flexibility and adaptability of the learning environment, resilience to crisis situations, and prompt feedback.

It should be noted that the study has some limitations: a narrow sample, the duration of the experiment, and the resource intensity of long-term research. Future research should focus on analysing the effectiveness of immersive technologies in the system of practice-oriented education under martial law.

CONCLUSION

The study identifies the role of digital tools in ensuring the quality of education during martial law. Modern solutions include mobile learning and online platforms, personalization, interactive technologies and audiovisualization, gamification, smart cards, which have proven to be an effective means of developing academic performance, expanding active interaction with learning materials, and improving targeted skills. Online resources provide for maximum personalization of learning, increase its inclusiveness, ensuring an increase in the quality of education—accessibility, inclusiveness, level of academic achievement, monitoring efficiency, safety and friendliness of the educational environment, and the level of professionalism of teachers.

The practical significance of the results lies in the possibility of using them to develop programs for adapting the learning environment to the requirements of digitalization under martial law. The study has certain limitations, such as the small sample size and short duration of the experiment.

Prospects for further research are seen in the development of a practical strategy for the fragmented digitalization of general education with the use of immersive technologies, which would best meet the needs of modern youth and increase the latter's resilience and adaptive capacity.

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