UDC 371.2: 371.3: 378

Liubomyra Odosii,
PhD in Chemical Sciences, Associate Professor,
Hetman Petro Sahaidachnyi National Army Academy, Lviv
https://orcid.org/0000-0003-2438-7759
Lidiia Parashchuk,
PhD in Technical Sciences, Associate Professor,
Hetman Petro Sahaidachnyi National Army Academy, Lviv
https://orcid.org/0000-0002-4049-2033
Nataliia Chubinska,
PhD in Pedagogical Sciences,
Lviv Polytechnic National University, Lviv
https://orcid.org/0000-0002-4803-2453
Yeremiia Odosii,
Lviv Polytechnic National University, Lviv
https://orcid.org/0009-0003-7272-2619
DOI: 10.33099/2617-1775/2025-01/155-163

INFORMATION AND COMMUNICATION TECHNOLOGIES AS A FACTOR IN ENHANCING THE EFFECTIVENESS OF THE EDUCATIONAL PROCESS

The article examines the impact of information and communication technologies (ICT) on the educational and cognitive competence of a teacher as well as on learning efficiency. It analyzes how modern digital tools contribute to the improvement of pedagogical skills and the development of cognitive skills and critical thinking of cadets. The main aspects of the ICT use in the educational process are identified. Particular attention is paid to the advantages and challenges of introducing technologies into the educational process, namely the use of electronic textbooks, online courses, virtual laboratories and interactive platforms. Ways are proposed to optimize the use of ICT to increase the effectiveness of learning and develop the competencies of future specialists.

The role of ICT in the transformation of traditional approaches to teaching is analyzed, which allows the formation of a new model of interaction between teachers and cadets. The importance of forming the information and communication competence of a teacher as an integral part of his/her professional development is revealed. The article outlines how the introduction of ICT contributes to the individualization and differentiation of the educational process, provides access to quality educational content, and creates conditions for independent, research, and project activities of cadets.

The article discusses practical examples of integrating digital tools into the educational process, including the use of cloud services, testing platforms, educational blogs, and videos. It is noted that the effective use of ICT requires appropriate training of teachers, methodological support and development of digital culture in the educational environment. The author also emphasizes the need to develop cadets' information literacy and skills for the safe and responsible use of digital resources.

Thus, it is substantiated that ICTs are a powerful factor in the modernization of education, which not only increases the efficiency of the educational process, but also ensures the training of competitive specialists capable of critical thinking, creativity and continuous self-development.

Key words: *information and communication technologies; educational and cognitive competence; digital education; interactive learning; online resources.*

Introduction. Modern education is undergoing significant transformations due to the development of ICT [1, p. 145]. The use of digital tools is becoming not only

an auxiliary learning tool, but also an integral part of the educational process. The formation of educational, cognitive and research competence of higher education cadets requires new approaches to the organization of the educational environment based on the integration of ICT. At the same time, there is a problem of effective implementation of such technologies to achieve quality results [2].

The issue of using ICT in the educational process has been studied by many scholars. The works of V. Bykov, N. Morse and others who consider the methodological aspects of digital learning are noted [3–6]. However, a number of aspects, such as the problems of adaptation to work with ICT and methods of professional development, remain insufficiently studied.

ICTs significantly enhance the quality of the learning process by developing pedagogical skills and fostering cadet autonomy through personalized educational resources. They promote creative thinking, motivation, and communication. Digital platforms, online courses, and simulations support interactive, two-way knowledge exchange, especially in distance and blended learning. However, successful ICT integration requires not only technical infrastructure but also methodological frameworks [7, p. 212].

Key digital resources include open-access libraries (e.g., Google Scholar, BASE, arXiv, Vernadsky Library) and educational platforms (Coursera, Prometheus, EdX, Udemy), which offer flexible, self-paced learning and certification. A notable tool is MOODLE, an open-source platform facilitating interactive teaching via modules, forums, and assessment tools, enhancing communication and learning quality [8].

Analysis of relevant research. In the conditions of digitalization of all aspects of life in modern society, a new economic, cultural, social, scientific, educational reality is created for its members, which determines the importance of the readiness of each individual for successful personal and professional self-realization in this fundamentally new reality. In such a situation, the higher education system is entrusted with an important mission to ensure the successful transition of humanity to the digital era, which implies the need to make appropriate changes to the processes of organization and implementation of cadet training processes. As a response to current requests from the state, various digital technologies are being actively introduced in higher education today, which significantly expand the didactic capabilities of all participants in the educational process by transforming classroom contact learning into an open virtual space of rooms, libraries, laboratories. In turn, the digitalization of higher education requires the creation of an appropriate environment that encourages learning subjects to act in conditions of multifacetedness and lack of certainty in many situations [4, p. 26].

Thus, under the concept of «digital educational environment» scientists understand: a structured set of various technologies and means of communication that are based on uniform educational and technological standards and provide free access to participants in the educational process to digital tools to support their cooperation; a set of digital educational tools, resources and technologies that ensure an effective educational process in the conditions of digitalization (O. Kuzminska [9, p. 25]); a set of organizational and pedagogical conditions for training applicants that contribute to

the formation of motivation for self-education and self-development and constitute a key block in the formation of professional readiness of future specialists through information resources and services (O. Mikhalova, O. Morozov) [10, p.37]. According to the conclusions of scientists Kavats O., Hnatushenko V., Kibukevych Y., Kavats Y., the new generation digital educational environment is a virtual reality that combines the latest generation of educational resources, acquiring today the format of a digital platform to which all participants in the educational process have access [11, p. 59]. As Ovcharuk O. notes, the specified environment combines programs, educational services and educational process management tools, which makes it possible to comprehensively implement such important functions as: drawing up a work schedule for all participants in educational interaction, selecting and presenting the necessary information, managing the received data, conducting analytics on the course and results of learning (including through testing), using multimedia in work, selecting and implementing tools for collaboration and communication, as well as tools for exchanging materials and supporting learning [12, p. 271].

The purpose of the article is to analyze the impact of ICTs on the formation of educational and cognitive competence of pedagogical activity, as well as to identify key areas for optimizing their use in the educational process.

Research methods. The study employed a combination of general scientific and pedagogical methods to analyze the impact of ICTs on the educational process. Theoretical methods included analysis, synthesis, comparison, and generalization of scientific sources on ICT use in education. Empirical methods were implemented through a pedagogical experiment aimed at evaluating the effectiveness of ICT-based learning compared to traditional methods.

The experiment was carried out in three stages: organizational-preparatory, formative (including the diagnostic, formative, and control sub-stages), and analytical-summarizing. Two groups of cadets were selected: a control group, taught using traditional methods (lectures, seminars, printed textbooks), and an experimental group, where learning was based on the MOODLE digital platform and other ICT tools.

Data collection tools included entrance tests, formative assessments, and final evaluations to track the dynamics of knowledge acquisition. The effectiveness of ICT integration was measured through statistical comparison of learning outcomes between the two groups, using formulas to calculate qualitative indicators of knowledge growth and the effectiveness coefficient. This quantitative approach allowed for evidence-based conclusions regarding the pedagogical value of ICT implementation.

Results. The author's team, together with the teaching staff of the Department of Electromechanics and Electronics of the National Army Academy, conducted a pedagogical experiment that allowed to analyze and confirm the impact of ICT on the quality of the educational process. The comparative method was used to study the quality of learning in two groups, one of which is experimental and the other control. In the control group, classes are conducted using the traditional methodological approach, which is aimed at the gradual formation of mental actions that form an

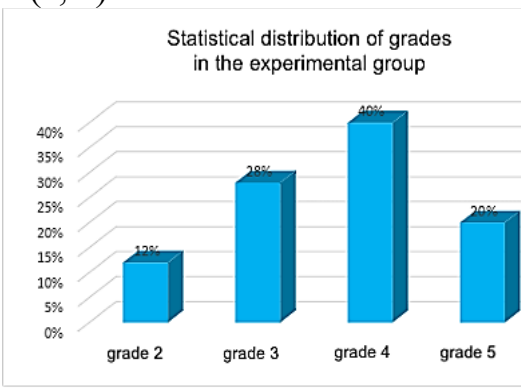
inseparable, unified integrity. This method involves classroom training with lectures and laboratory classes using the classical method.

In the experimental group, the work is carried out using a creative approach, which involves the introduction of a new experimental factor into the educational process, namely the use of the MOODLE information and learning environment as a single open learning management system that helps to solve pedagogical problems where individual learning opportunities are provided for self-movement, self-growth and, ultimately, self-realization of their capabilities.

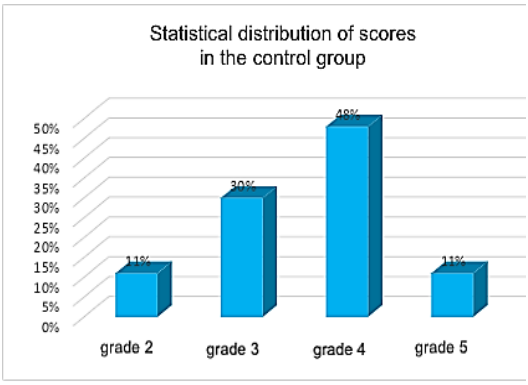
The pedagogical experiment took place in three stages:

– *organizational and preparatory*;
– *the formative* (including diagnostic, formative, and control sub-stages);
– *the analytical-summarizing*.

The research stage involved determining the initial level of knowledge of the experimental (E) and control (C) groups of applicants through the entrance test. The statistical distribution of assessments of initial knowledge of both groups is shown in Figure 1 (a, b).



a)



b)

Figure 1. Statistical distribution of initial knowledge scores in the experimental (a) and control (b) groups.

The groups that showed the closest qualitative indicator of initial knowledge were selected: $P_e = 3.68$; $P_c = 3.59$.

The increase in knowledge, skills or abilities (E) in the experimental (D_e) and control (D_c) groups is determined by the difference in the quality indicators of residual knowledge of the experimental (K_e) and control (K_c) groups and the quality indicator of initial knowledge P_e and P_c, respectively, according to formulas 1and 2, where

$$D_e = K_e - P_e \quad (1)$$

$$D_c = K_c - P_c \quad (2)$$

The effectiveness of the experimental factor is calculated by formula (3)

$$E = D_e - D_c \quad (3)$$

The indicator E shows the impact of the new factor on the learning process or its effectiveness in comparison with any other factor. When $P_e = P_c$, then $D_e = K_e$ and $D_c = K_c$, respectively.

If cadets have no prior knowledge about the phenomenon under study or this knowledge is the same in the control and experimental classes, then the comparative

effectiveness of the factor can be found using formula 4. According to it, efficiency is defined as the difference between the average final level of knowledge of the experimental class and the average final level of the control class.

$$E = K_e - K_c \quad (4)$$

The essence of the experimental factor was the organization of cadet-centered learning using different types of information resources and the use of the MOODLE platform. This approach helps to expand the autonomy of the cadet through the rational use of time, creating opportunities for flexible learning paths, and stimulates independent work.

This learning model is aimed at expansion the autonomy of cadets by creating opportunities for flexible learning paths, which stimulates the independent work of higher education cadets, supports the introduction of innovative pedagogical technologies and creates an atmosphere of mutual respect and understanding between cadets and teachers.

The curriculum of the discipline provides for various types of classes, which are accompanied by educational and methodological multimedia materials (presentations, educational films, and online video resources). At the same time, the «Forum» resource is provided for constant communication with the teacher and the group, as well as clarification of unclear issues. Such information support allows the applicant to receive organizational and advisory support in order to implement their individual educational trajectories. To familiarize yourself with the methodology of laboratory work, an electronic manual is provided, with a video methodology for performing laboratory work, which provides visualization of laboratory experiments. There is also an independent work of the applicant as a result of which applicants must complete a test.

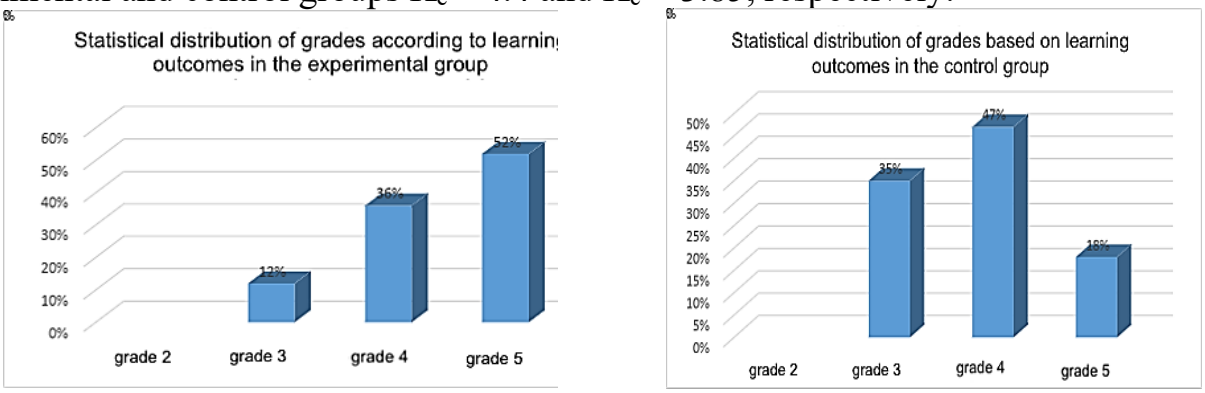
The platform provides control over the implementation of each type of lesson, which is monitored by the teacher and cadets. This ensures quality control of the educational process, as well as the implementation of the procedure for preventing academic dishonesty at all stages of the educational process.

At the end of the training, a final control (differentiated test) is conducted as the final result of the educational activity. The resource provides for a room with video communication, where cadets have the opportunity to communicate directly with the teacher via video conference. The same video conferences are provided for each class, for communication and information support of cadets. Such an organizational approach allows us to provide support at all stages of training.

In particular, to provide feedback between the participants of the educational process, it is proposed to conduct a «feedback» by creating a buzz form using the QR-code link. This approach ensures the implementation and maintenance of effective communication between the participants of educational activities (teacher-cadet). It allows the teacher to understand what needs to be improved and changed without external pressure or negative evaluation and to get real thoughts and ideas. An example of feedback communication through a Google forms.

Based on the scores received by members of both groups based on the results of studying the discipline, we obtained the distribution of scores presented in Figure

2. According to the results of the control measure, the learning outcome (K) was determined by calculating the qualitative indicator of residual knowledge of the experimental and control groups $K_e = 4.4$ and $K_c = 3.85$, respectively.



a) b)

Figure 2. Statistical distribution of residual knowledge scores in the experimental (a) and control (b) groups

From the results obtained, the increase in knowledge, skills or abilities (D_e and D_c), respectively, was determined:

$D_e = K_e - P_e = 4.4 - 3.68 = 0.72$

$D_c = K_c – P_c = 3.85 - 3.59 = 0.26$

According to the results of the experiment, the effectiveness of the experimental factor was determined:

$E = 0,72-0,26= 0,46$

Considering the above results, it was found that ICT has a positive impact on learning, which contributes to increasing the efficiency of the educational process.

Conclusions. The study has shown the positive impact of information and communication technologies on the educational process. It has been established that ICTs have significant potential for improving the quality of education and play an important role in the modern educational process and contribute to the development of cadet independence, increase interest and cognitive activity, and form skills for independent learning. Interactive learning tools, multimedia resources and online platforms make the educational process more flexible, accessible and effective, and also allow educators to effectively develop critical thinking and improve their communication skills. Therefore, the effective use of ICT contributes to the creation of a dynamic, interactive and effective learning environment that meets the needs of modern learning.

Further research is seen in developing, implementing and integration of digital technologies is not only a tool for diversifying teaching methods, but also a means of professional growth in the activities of a teacher. It is important that teachers constantly improve their ICT competencies, focusing on modern educational challenges.

ЛІТЕРАТУРА

1. Bykov V.Yu. Revitalizing education through the integration of cloud technologies. Educational Dimension. 2023, №8, p. 143–167. https://doi.org// 10.31812/ed.598

2. Shyshkina M. Emerging Technologies for Training of ICT-Skilled Educational Personnel. In: Ermolayev V., Mayr H.C., Nikitchenko M., Spivakovsky A., Zholtkevych G. (eds) Information and Communication Technologies in Education, Research, and Industrial Applications. ICTERI 2013. Communications in Computer and Information Science. 2013, vol 412. p. 274-284. https://doi.org// 10.1007/978-3-319-03998-5_14.

3. O. Buinytska, L. Varchenko-Trotsenko, & B. Hrytseliak, Digitalization of higher education institution, Educological discourse. 2020, №1 (28) p. 64-79. https://doi.org//10.28925/2312-5829.2020.1.6.

4. Chasnikova O.V., Dubrovina I.V., & Zinchenko,O.M. ICT concepts in education of Ukraine: conceptualization, the New Ukrainian School, National educational electronic platform, pedagogy. International Journal of Science Annals. 2020 №3(1), p. 24–29. https://doi.org//10.26697/ijsa.2020.1.03.

5. Shmakova, A., Ryzhova, Y., & Suhorukhih, A. The impact of ICT education on humanistic innovative potential. Education and Information Technologies. 2022, №27(2), p. 227–245. https://doi.org//10.1007/s10639-021-10674-1.

6. Bozkus K. School and Teacher Information, Communication and Technology (ICT) readiness across 57 countries: The alignment optimization method. Education and Information Technologies. 2022, №28, p. 1273–1297. https://doi.org//10.1007/s10639-022-11233-y.

7. Sharov S., Pavlenko A., Sharova T., Chorna, O. Analysis of Developers of Online Courses on Ukrainian Platforms of MOOC. International Journal of Emerging Technologies in Learning (iJET). 2021, № 16(05), p. 201–213. https://doi.org// 10.3991/ijet.v16i05.18581

8. Al-Azawei A., Parslow P., Lundqvist, K. A systematic review on trends in using Moodle for teaching and learning. International Journal of STEM Education. 2016, №3(1), p. 44. https://doi.org//10.1186/s40594-021-00323-x

9. Mochurad L., Shakhovska K., Montenegro S. Parallel Solving of Fredholm Integral Equations of the First Kind by Tikhonov Regularization Method Using OpenMP Technology. In: Shakhovska, N., Medykovskyy, M.O. (eds) Advances in Intelligent Systems and Computing IV. CSIT 2019. Advances in Intelligent Systems and Computing. 2020, vol 1080. p. 25-35 https://doi.org/10.1007/978-3-030-33695-0_3

10. Shved A., Kovalenko I., Davydenko Y. Method of Detection the Consistent Subgroups of Expert Assessments in a Group Based on Measures of Dissimilarity in Evidence Theory. In: Shakhovska, N., Medykovskyy, M.O. (eds) Advances in Intelligent Systems and Computing IV. CSIT 2019. Advances in Intelligent Systems and Computing. 2020, vol 1080. p. 36-53. https://doi.org/10.1007/978-3-030-33695-0_4

11. Kavats O., Hnatushenko V., Kibukevych Y., Kavats Y. Flood Monitoring Using Multi-temporal Synthetic Aperture Radar Images. In: Shakhovska, N., Medykovskyy, M.O. (eds) Advances in Intelligent Systems and Computing IV. CSIT 2019. Advances in Intelligent Systems and Computing. 2020, vol 1080. p. 54-63. https://doi.org/10.1007/978-3-030-33695-0_5

12. Овчарук О.В. Цифрове освітнє середовище для вчителів та учнів: підтримка організації навчання Модернізація педагогічної освіти у глобальному вимірі безпеки соціально-турбулентного світу : збірник матеріалів міжнародного форуму . Вид-во УДУ імені Михайла Драгоманова, м. Київ, Україна. 2023, с. 270-272.

REFERENCES

1. Bykov V.Yu. (2023). Revitalizing education through the integration of cloud technologies. *Educational Dimension*, 8, 143–167. https://doi.org// 10.31812/ed.598 .

2. Shyshkina M. (2013). Emerging Technologies for Training of ICT-Skilled Educational Personnel. In: Ermolayev V., Mayr H.C., Nikitchenko M., Spivakovsky A., Zholtkevych G. (eds)

Information and Communication Technologies in Education, Research, and Industrial Applications. ICTERI 2013. *Communications in Computer and Information Science*, vol 412. 274-284. https://doi.org// 10.1007/978-3-319-03998-5_14.

3. O. Buinytska, L. Varchenko-Trotsenko, & B. Hrytseliak. (2020). Digitalization of higher education institution, *Educological discourse*, 1 (28), 64-79. https://doi.org//10.28925/2312-5829.2020.1.6.

4. Chasnikova O.V., Dubrovina I.V., & Zinchenko,O.M. (2020). ICT concepts in education of Ukraine: conceptualization, the New Ukrainian School, National educational electronic platform, pedagogy. *International Journal of Science Annals,* 3(1), 24–29. https://doi.org//10.26697/ijsa.2020.1.03 .

5. Shmakova, A., Ryzhova, Y., & Suhorukhih, A. (2022). The impact of ICT education on humanistic innovative potential. *Education and Information Technologies*, 27(2), 227–245. https://doi.org//10.1007/s10639-021-10674-1 (United States of America0..

6. Bozkus K. (2022). School and Teacher Information, Communication and Technology (ICT) readiness across 57 countries: The alignment optimization method. *Education and Information Technologies*, 28, 1273–1297. https://doi.org//10.1007/s10639-022-11233-y .

7. Sharov S., Pavlenko A., Sharova T., Chorna, O. (2021). Analysis of Developers of Online Courses on Ukrainian Platforms of MOOC. *International Journal of Emerging Technologies in Learning (iJET)*, 16(05), 201–213. https://doi.org// 10.3991/ijet.v16i05.18581.

8. Al-Azawei A., Parslow P., Lundqvist, K. (2016). A systematic review on trends in using Moodle for teaching and learning. *International Journal of STEM Education*, 3(1), 44. https://doi.org//10.1186/s40594-021-00323-x .

9. Mochurad L., Shakhovska K., Montenegro S. (2020). Parallel Solving of Fredholm Integral Equations of the First Kind by Tikhonov Regularization Method Using OpenMP Technology. In: Shakhovska N., Medykovskyy M.O. (eds) Advances in Intelligent Systems and Computing IV. CSIT 2019. *Advances in Intelligent Systems and Computing*, vol 1080, 25-35 https://doi.org/10.1007/978-3-030-33695-0_3 .

10. Shved A., Kovalenko I., Davydenko Y.(2020). Method of Detection the Consistent Subgroups of Expert Assessments in a Group Based on Measures of Dissimilarity in Evidence Theory. In: Shakhovska, N., Medykovskyy M.O. (eds) Advances in Intelligent Systems and Computing IV. CSIT 2019. *Advances in Intelligent Systems and Computing*, vol 1080, 36-53. https://doi.org/10.1007/978-3-030-33695-0_4.

11. Kavats O., Hnatushenko V., Kibukevych Y., Kavats Y. (2023). Flood Monitoring Using Multi-temporal Synthetic Aperture Radar Images. In: Shakhovska, N., Medykovskyy, M.O. (eds) Advances in Intelligent Systems and Computing IV. CSIT 2019. *Advances in Intelligent Systems and Computing*, vol 1080, 54-63. https://doi.org/10.1007/978-3-030-33695-0_5.

12. Ovcharuk, O.V. (2023). Tsyfrove osvitnie seredovyshche dlia vchyteliv ta uchniv: pidtrymka orhanizatsii navchannia. [Digital educational environment for teachers and students: support for the organization of learning Modernization of pedagogical education in the global dimension of security in a socially turbulent world] In: *Modernizatsiia pedahohichnoi osvity u hlobalnomu vymiri bezpeky sotsialno-turbulentnoho svitu: zbirnyk materialiv mizhnarodnoho forumu*, 270–272. (in Ukrainian).

РЕЗЮМЕ

Любомира Одосій,
кандидат хімічних наук, доцент,
Національна академія сухопутних військ
імені гетьмана Петра Сагайдачного, м. Львів
Лідія Паращук,
кандидат технічних наук, доцент,
Національна академія сухопутних військ
імені гетьмана Петра Сагайдачного, м. Львів

Наталія Чубінська,
кандидат педагогічних наук,
Національний університет «Львівська політехніка» , м. Львів
Єремія Одосій,
Національний університет «Львівська політехніка», м. Львів

Інформаційно-комунікаційні технології як чинник підвищення ефективності освітнього процесу

У статті розглянуто вплив інформаційно-комунікаційних технологій (ІКТ) на навчально-пізнавальну компетентнність та ефентивність навчання. Проведено аналіз та встановлено оцінку впливу сучасних цифрових технологій щодо удосконалення педагогічної майстерності та розвитку когнітивних навичок і критичного мислення здобувачів освіти. Визначено ключові аспекти використання ІКТ в освітньому процесі. Запропоновано шляхи оптимізації використання ІКТ для підвищення ефективності навчання та розвитку компетентностей майбутніх фахівців.

Здійснено аналіз ролі ІКТ у трансформації традиційних підходів до навчання, що дає змогу формувати нову модель взаємодії між вчителем і здобувачами освіти. Окреслено, як впровадження ІКТ сприяє індивідуалізації та диференціації навчального процесу, забезпечує доступ до якісного освітнього контенту, а також створює умови для самостійної, дослідницької та проєктної діяльності здобувачів освіти. Обґрунтовано, що ІКТ виступають потужним чинником модернізації освіти, який не лише підвищує ефективність навчального процесу, а й забезпечує підготовку конкурентоспроможних фахівців, здатних до критичного мислення, творчості та постійного саморозвитку. Виявлено, що використання таких цифрових інструментів, як відеоконференції, онлайн-тести, форуми, електронні підручники та інтерактивні лабораторії сприяє підвищенню мотивації, покращенню взаємодії між учасниками освітнього процесу та розвитку навичок самостійної роботи.

Наукова новизна полягає у кількісній оцінці результативності використання цифрових освітніх технологій та доведенні їх ефективності у системі вищої військової освіти. Практичне значення роботи полягає у статистичній обробці результатів вхідного та підсумкового контролю знань, визначення приросту у якості засвоєних знань та ефективності впровадження таких технологій у навчальний процес.

Перспективи подальших досліджень пов'язані з розробленням ефективних стратегій цифрової трансформації освіти та створенням загальної моделі організації цифрового навчального середовища.

Ключові слова: *інформаційно-комунікаційні технології; навчально-пізнавальна компетентність; цифрова освіта; інтерактивне навчання; онлайн-ресурси.*