INFORMATION TECHNOLOGIES AS A FACTOR OF SUSTAINABLE DEVELOPMENT AND INCREASING THE COMPETITIVENESS OF GRADUATES OF HIGHER EDUCATION INSTITUTIONS OF UKRAINE IN THE CONTEXT OF WAR

Abstract. The article is devoted to the study of information technologies as a factor in increasing the competitiveness of graduates of higher educational institutions in Ukraine in the conditions of war, using the example of the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”. The study contains an analysis of the Information and Communication Technologies Development Index at the global, regional, and national levels as a factor in sustainable development and increasing the competitiveness of graduates of higher education institutions. A comparative analysis of Internet users by age structure was carried out regarding the acquisition of skills and abilities in the field of information and communication technologies. The specifics of the implementation of information technologies in the field of education in European countries and
Ukraine, in particular, are revealed. It should be noted that the acquisition of skills and abilities in ICT application is uneven. The analysis of IT application possibilities in the field of higher education made it possible to highlight their main advantages and certain risks of implementation in wartime conditions. The study reveals the impact of military actions on the possibilities of using information technologies both among students and among university teachers. It presents the transformation trends of national universities, and the perception of teachers and students of ICT to improve the level of the educational process.

The article determines that Ukraine has a high potential in the field of ICT, including due to the high level of mastery of basic skills by most of the population. The analysis of the indicators of the level of innovative activity of the country, the level of mastery of information technologies, and the level of GDP per capita shows their significant relationship.

The conducted research testifies to the importance of introducing information technologies in education, as it will contribute to obtaining quality education in the conditions of war in Ukraine.

**Keywords:** information technologies in education; index of development of information; communication technologies; the competitiveness of university graduates

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**ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ ЯК ФАКТОР СТАЛОГО РОЗВИТКУ ТА ПІДВИЩЕННЯ КОНКУРЕНТОСПРОМОЖНОСТІ ВИПУСКНИКІВ ВИЩИХ НАВЧАЛЬНИХ ЗАКЛАДІВ УКРАЇНИ В УМОВАХ ВІЙНИ**

**Анотація.** Стаття присвячена вивченню інформаційних технологій як чинника підвищення конкурентоспроможності випускників вищих
навчальних закладів України в умовах війни на прикладі Національного технічного університету України «Київський політехнічний інститут імені Ігоря Сікорського». У дослідженні проведено аналіз індексу розвитку інформаційно-комунікаційних технологій на глобальному, регіональному та національному рівнях як чинника сталого розвитку та підвищення конкурентоспроможності випускників вищих навчальних закладів. Проведено порівняльний аналіз користувачів мережі Інтернет за віковою структурою щодо набуття вмінь і навичок у сфері інформаційно-комунікаційних технологій. Розкрито специфіку впровадження інформаційних технологій у сферу освіти європейських країн та України зокрема. Слід зазначити, що набуття вмінь і навичок у сфері застосування ІКТ відбувається нерівномірно. Аналіз можливостей застосування IT у сфері вищої освіти дав змогу виділити їх основні переваги та певні ризики впровадження в умовах воєнного часу. Дослідження розкриває вплив військових дій на можливості використання інформаційних технологій як серед студентів, так і серед викладачів ВНЗ. Представлено тенденції трансформації національних університетів, сприйняття викладачами та студентами ІКТ для підвищення рівня навчального процесу.

У статті визначено, що Україна має високий потенціал у сфері ІКТ, у тому числі завдяки високому рівню оволодіння базовими навичками більшої частини населення. Аналіз показників рівня інноваційної активності країни, рівня володіння інформаційними технологіями та рівня ВВП на душу населення показує їх значний взаємозв'язок.

Проведене дослідження свідчить про важливість впровадження інформаційних технологій в освіту, оскільки це сприятиме отриманню якісної освіти в умовах війни в Україні.

**Ключові слова:** інформаційні технології в освіті; індекс розвитку інформації; комунікаційні технології; конкурентоспроможність випускників ВНЗ.

**Problem statement.** The COVID-19 pandemic and Russia's war against Ukraine have caused chaos in the labour market, which has also affected the European labor market, as not all sectors of the economy can meet the demand for specialists. Currently, the labor market needs drastic changes as we see high unemployment, productivity growth with stagnant wages, and economic recovery with declining vertical mobility for many segments of the population [1]. Solving problems begins with an education system that would be more effective not only in training but also in retraining specialists, in allocating them to promising paths of career development, which would allow graduates of higher educational institutions in Ukraine to compete in the labor market in wartime conditions. The
pandemic changed educational institutions, schools, and universities, they learned to work remotely. Therefore, in today's conditions, information technologies are and remain an important factor in sustainable development.

**Analysis of recent research and publications.** Most researchers consider information technologies from the point of view of using their capabilities to increase work efficiency and support decision-making in scientific activities [2], [3], [4], [5]. In the scientific literature, there are publications on the advantages and disadvantages of certain information and communication technologies. Researchers are looking for new ways of using various information systems and platforms for use in the educational process in order to improve the quality of education and the competitiveness of university graduates [6]-[9].

N. Dabas [8] believes that thanks to information and communication technologies, the educational process has become more interesting for students, which has generally increased the level and quality of the educational process. Anisimova O. and Spektor A. reveal the essence of various platforms for the educational process and propose the implementation of ePortfolio technology for universities [10]. L. Kartashova and L. Benderets believe that in the era of informatization and the development of scientific and technical progress, higher education is a powerful stimulus for labour activity, and the training of specialists should be carried out on principles from general to special. This provides an opportunity to quickly adapt to new technologies, implement them in professional activities, and search for methods of increasing their efficiency [6].

All these studies are relevant today, and the future is based on the development of information technologies in the educational process, although not in all fields of knowledge to the full extent (medicine, transport, and various types of technologies), but in the conditions of war, it is necessary to investigate the possibility of using these technologies as a pedagogical team so and students during the educational process.

**The purpose of the article** is to analyse the expediency and effectiveness of introducing information technologies into the educational process in the context of military operations on the territory of Ukraine. The main tasks of the research: to investigate the impact of information technologies on the degree of development of society; to analyse the possibility, expediency, and necessity of using information technologies in teaching the teaching staff and students; to investigate the effectiveness of using information technologies in universities under martial law conditions in Ukraine.

**Presenting main material.** Today, information technologies are widely used in all spheres of social life, both in production and in the everyday life of an average citizen [11]. The International Telecommunication Union compiles an index of the development of information and communication technologies for all countries of the
The ICT Development Index is a combined indicator that characterizes the progress of the countries of the world in terms of the development of information and communication technologies (ICT). The index was developed in 2007 on the basis of 11 indicators used by the International Telecommunication Union in its assessments of ICT development. It combines these indicators into a single criterion, which is designed to compare the achievements of the countries of the world in the development of ICT and can be used as a tool for comparative analysis at the global, regional and national levels. These indicators relate to access to ICT, use of ICT, and skills, i.e. practical knowledge of these technologies by the population of the countries covered by the study. The authors of the research methodology emphasize that the level of ICT development today is one of the most important indicators of the economic and social well-being of the state [12].

The report Measuring digital development: Facts and figures 2021 [13] states that approximately 4.9 billion people were Internet users in 2021 (63% of the world's population). Compared to 2019, there was an increase of almost 17%.

At the same time, it should be noted that the acquisition of skills and abilities in ICT application is uneven. Research [14] shows significant differences in skill levels between age groups and between occupations, but relatively smaller differences between men and women, especially at younger ages. Only in 23% of countries did more than 60% of people report one of the basic skills. For standard skill components such as creating an electronic slide presentation, in almost 70% of countries, less than 40% of individuals used them during 2018-2020. Thus, the problem of increasing the level of training of personnel with the use of modern information technologies is gaining relevance. The average level of basic knowledge in EU countries is 54%, and the leaders are Iceland, the Netherlands, Finland, Norway, Switzerland, Ireland, and other highly developed countries [3].

The European Commission monitors the digital progress of member countries with the help of the Digital Economy and Society Index (DESI) reports [4], which helps member countries to identify priority areas of action in the direction of digital policy implementation. The DESI 2022 results show that most Member States have made progress in their digital transformation, but business adoption of key digital technologies such as artificial intelligence and big data remains low, also among EU leaders. An insufficient level of digital skills hinders future growth prospects, deepens the digital divide, and increases the risk of digital exclusion [9]. Recently, the active use of IT in the field of education has begun. In particular, as already noted earlier, ICT in education began to be actively used during the pandemic, which made it possible to organize the educational process in a distance format.

In the EU countries, the European Framework for the Digital Competence of Educators (DigCompEdu) was created - a structure that provides a common reference system to support the development of digital competencies of teachers in
Europe [15]. To date, the Skills Agenda for Europe and the Europe 2020 flagship initiative Agenda for New Skills for New Jobs have been developed. In 2022, the European Commission introduced DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills, and attitudes [2]. This is one of the most modern European strategic documents in the field of educational standards. The edition contains more than 250 new examples of knowledge, skills and attitudes that help to work confidently, critically and safely with digital technologies, including artificial intelligence, controlled systems, and more. The program outlines five competency areas: information and digital literacy, communication and collaboration, digital content creation, safety, and problem-solving, specifying descriptors from eight levels of mastery. The description of each level includes knowledge, skills and abilities. We believe that DigComp 2.2 should be used to develop training programs at various levels, including in the field of education in Ukraine.

At the same time, each country has its specifics for the introduction of information technologies in the field of education. In particular, in Estonia, in 2013, the Ministry of Education and Science introduced a new institution, the Information Technology Foundation for Education, to provide ICT and e-learning for school leaders in the field of educational management, to achieve greater synergy between different institutions in the field of the country's development, and to provide impetus to the development of the teacher's digital competence to ensure the improvement of the quality of education and increase the competitiveness of the country [5]. In Estonia, teachers must upgrade skills in ICT every 3 years.

In Lithuania, the development of the digital competence of the country's citizens was started with the adoption of the Lithuanian Information Society Development Program for 2014–2020, which provided for the development of skills and motivation of Lithuanian citizens to use ICT; development of electronic content and development of ICT infrastructure; development of open access of citizens to electronic resources [5].

In foreign countries, one of the tools for evaluating the work of a teacher and the management system of an educational institution is self-evaluation. As evidenced by the experience of Norway [16], a specially created structure - the Norwegian Centre for ICT in Education - is engaged in the development and application of educational measurement tools and research monitoring the quality of education. In particular, the use of ICT provides qualitatively new opportunities for heads of educational institutions and teachers to identify current problems and make the necessary management decisions and also helps to ensure the effectiveness, efficiency, and effectiveness of the work of an educational institution. In foreign countries, one of the tools for evaluating the work of a teacher and the management system of an educational institution is self-evaluation. It should be noted that Ukrainian institutions of higher education also actively use teachers' self-evaluation.
mechanisms through annual ratings. In particular, in KPI named after Igor Sikorsky, a teacher rating system was introduced, which allows for evaluating the results of work for the current academic year and identifying potential for further development. Among the evaluation indicators, indicators of the use of information technologies in the educational process are widely used.

According to expert assessments [14], Ukraine has a high potential in the field of ICT, including due to the high level of mastery of basic skills by most of the population. The analysis of the indicators of the level of innovative activity of the country, the level of mastery of information technologies and the level of GDP per capita shows their significant relationship. Therefore, we believe that the issue of increasing the level of mastery of ICT by the population is extremely important, especially considering the need for the post-war recovery of Ukraine's economy.

The analysis of IT application possibilities in the field of higher education made it possible to highlight their main advantages: the possibility of implementing the educational process is unpredictable.

Research. The research was conducted at the National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute». Teachers and students of the specified institution were involved as participants. The research was conducted in compliance with all ethical norms. The section contains an analysis and justification of scientific results. The division into units are recommended.

A number of empirical methods were used to conduct the research. In particular, the critical analysis of scientific literature made it possible to determine research directions. Descriptive statistics methods were used to solve the problems in the article. Also, the method of the statistical experiment was used to analyse the researched problem and process empirical data with further systematization. A quantitative method was used to process respondents' answers. To get answers to the questions, semi-structured interviews were conducted. Four stages of the research were used: questionnaire preparation, data collection, data analysis and formation of results.

Survey instruments. An online questionnaire was chosen for the survey. This method was chosen due to the limitations caused by the conditions of the COVID-19 pandemic, as well as martial law. The main advantages of this method are a wide range of respondents, as well as a minimum amount of time. The survey was conducted via Google Forms submission. The questionnaire was developed on the basis of a preliminary analysis of the relevant literature. The questionnaire consisted of 2 parts. The first part contained questions about respondents' data (teacher/student; age; gender; course for students; work experience for teachers). The second part contained questions about information technologies in education during the war. The research was conducted from September-November 2022.

This study examined attitudes toward information technologies in education:
1) Do you have access to a phone/computer with the Internet to fully use information technologies for learning?
2) Are information technologies used in your university for training during the war?

3) Do you consider it expedient to use information technology in higher education in view of the war?

4) What information technologies do you use most when studying at the university during the period of military operations in the country?

5) Do you think that the use of information technologies in education is effective in achieving the goals of education during the war?

6) In your opinion, should information technology be used in higher education after the end of the war?

7) In the 2023 year, is it necessary to continue studying online using information technologies or to study offline?

Each item of the survey could be evaluated by the respondent on a 5-point Likert scale with a range of answers from 1 – “completely disagree” to 5 – “completely agree”.

Survey respondents. Teachers and students of the National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» were selected for the study. The total number of teaching staff and students is about 25,000 people (information taken from the website of the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”). 500 questionnaires were sent for the survey. Of these, 304 were returned, of which 51 were rejected due to errors and/or missing data. Accordingly, 253 questionnaires were used for the final analysis. The response rate of 41% is considered satisfactory. The characteristics of the respondents are presented in Table 1.

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As a result, 253 responses were received. Characteristics of respondents: 74% students, 26% teachers. Of them, 77% were women and 23% were men. The largest number of answers came from 1st-year students (29%), the smallest - from 2nd-year master's students (2%). As for teachers, the following took part in the survey: 32% have been working for less than 5 years, 50% from 6 to 10 years, 11-15 years - 11%, more than 15 years - 8%.

**Availability of access to a phone/computer with the Internet for the use of information technologies in education.** In order to analyse the use of information technologies in education, a survey was conducted regarding the access of students and teachers to a phone/computer with Internet. Because it is very important for learning with the help of information technology during the war in Ukraine.

As for students, 48% have access to the Internet (20% completely and 28% almost completely), 47% have partial access, 2% and 3% have little or no access, respectively. The results of the survey are shown in fig. 1.

![Fig. 1. Results of a survey of students regarding access to the Internet (source: constructed by the authors)](image1)

If we analyse the possibilities of teachers (Fig. 2), then: have to access - 19% constantly and 38% almost constantly, partial access - 36%, almost no access 7% (5% almost do not have and 2% completely do not have constant access to the Internet).

**Application of information technologies in education during the war.** The results regarding the use of information technologies by students while studying at a university during the war are shown in fig. 3.

Accordingly, the majority of student respondents “completely agree” (37%) or “partially agree” (32%) with the statement about the use of information technologies at the university during the period of military operations. 13% of students have certain doubts about the use of information technologies in education. Only 15% of students believe that information technology is not used in education.

The responses of the teaching staff of the university regarding the use of information technologies in education were analyzed (Fig. 4).
Fig. 3. Results of a student survey on the use of information technologies in education (source: constructed by the authors)

Fig. 4. The results of a survey of teachers on the use of information technologies in education (source: constructed by the authors)

Analysis of teacher survey data shows the following: do not use educational information technologies - 2%; hardly used - 8%; partially used - 15%; often use information technologies in education - 41%; fully use the possibilities of information technologies - 34%.

The necessity of using information technologies in education during the war. If we analyse the results of the student survey regarding the need to use information technologies in education, then: completely disagree with this statement - 1%; partially disagree - 8%; hard to say - 28%; partially agree - 47%; fully agree - 16% (Fig. 5).

Fig. 5. Results of a survey of students regarding the necessity of using information technologies (source: constructed by the authors)

Fig. 6. Results of a survey of teachers regarding the necessity of using information technologies (source: constructed by the authors)

Teachers, in turn, consider it necessary to use information technologies in education (Fig. 6) partially (53%) or completely (26%). Some teachers do not see the appropriate use of information technologies at all (1%) or partially (7%). Teachers who have not yet decided make up only 13%.
Use of information technologies in education in the context of war. As a result of a survey of students on the use of information technologies at the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, it was established that most of them use the following technologies in their studies (Fig. 7): Moodle Sikorsky - 24%; Google class - 43%; Social networks - 22%; E-mail - 7%; other - 4%.

As for teachers, their opinions regarding the use of information technologies in education were distributed as follows: Moodle Sikorsky - 26%, Google class - 58%, Social networks - 12%, E-mail - 3%, other - 1% (Fig. 8).

Effectiveness of using information technologies in education. If we analyse the survey on the effectiveness of using information technologies (Fig. 9), then 85% of students consider them effective (62% fully agree with the statement, 23% partially agree).
The teaching staff, in turn, expressed their views on the effectiveness of using information technologies in education as follows: completely disagree - 1%, partially disagree - 2%, difficult to say - 7%, partially agree - 57%, completely agree - 33% (Fig. 10).

Feasibility of using information technologies after the war. In the opinion of 85% of students, information technologies should be used in the future. But only 2% do not fully or partially agree on the need to use information technologies in education (Fig. 11).

The majority of teachers (58% partially agree and 34% fully agree) support the introduction of information technologies in education in the future (Fig. 12).

Use of information technologies in the 2023 year. The results of the student survey indicate that: ready to study only remotely - 70%; can to study in the classrooms - 19%; don't know yet - 9%; will not be able to study because they are in the occupied territories - 2% (Fig. 13).
As for the teachers, their opinions about education in the 2023 year were evenly distributed: ready to work remotely - 70%; can teach in classrooms - 19%; do not know yet - 9%; cannot work because they are in the occupied territory – 2% (Fig. 14).

**Conclusions.** The study proved that the degree of development and dissemination of information technology contributes to an increase in the level of development of the population. An analysis of data from international analytical agencies showed that countries that pay significant attention and funding to information technology have a higher level of well-being of the population. Accordingly, the biggest users are young people.

The conducted research contributes to the fact of the importance of introducing information technologies in education, as it will contribute to obtaining quality education in the conditions of the war in Ukraine. And it is also important to note that the introduction of information technologies will contribute to the development of modern technologies and increase the level of competitiveness of graduates of higher educational institutions in Ukraine in the domestic and international markets. As a result of the application of information technologies, it is worth expecting an increase in the quality of education, and the acquisition of relevant knowledge and competencies.

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