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DOI: 10.34866/xz18-9809

State and prospects of digital transformation of education and science of Ukraine in the strategic partnership with the EU countries

Stan i perspektywy edukacji i nauki w Ukrainie w strategicznym partnerstwie z krajami UE w kontekście transformacji cyfrowej

Słowa kluczowe: cyfryzacja, transformacja cyfrowa, technologie komputerowe, edukacja, nauka, kompetencje cyfrowe.

Streszczenie: W artykule dokonano analizy obecnego stanu i perspektyw cyfrowej transformacji edukacji i nauki na Ukrainie w ramach strategicznego partnerstwa z Unią Europejską. Scharakteryzowano podstawowe zasady transformacji cyfrowej. Przedstawiono informacje na temat zobowiązań Ukrainy w dziedzinie nauki i technologii, a także edukacji, szkoleń i młodzieży na rzecz realizacji strategicznych partnerstw sektorowych w ramach Układu o stowarzyszeniu UE-Ukraina. Ukazano fazę realizacji Porozumienia w tych obszarach. Uwzględniono główne inicjatywy państwowe i projekty międzynarodowe w ramach cyfryzacji szkolnictwa wyższego, zawodowego oraz nauki Ukrainy, a także systemy oprogramowania i sprzętu komputerowego oraz systemy zautomatyzowane, których funkcjonalność zapewnia realizację inicjatyw cyfrowych. Ponadto określono perspektywy cyfrowej transformacji edukacji i nauki na Ukrainie dla realizacji strategicznego partnerstwa z krajami UE.

Key words: digitization, digital transformation, computer technologies, education, science, digital competence.

Abstract: The article analyzes the current state and prospects of digital transformation of education and science in Ukraine within the strategic partnership with the European Union. The basic principles of digital transformation have been characterized. Information is provided on Ukraine's commitments in science and technology, as well as education, training and youth, for the implementations on strategic sectoral partnerships under the EU-Ukraine Association Agreement. The progress of implementation of the Agreement in these areas is analyzed. The main state initiatives and international projects within the framework of digitalization of higher, professional higher and vocational education and science in Ukraine, as well as software and hardware systems and automated systems whose functionality ensures the implementation of digitalization initiatives are considered. Furthermore, prospects for the digital transformation of education and science in Ukraine for the implementation of strategic partnership with EU countries are determined.

Relevance of research

The full-scale war in Ukraine has become a test and a shock for both Ukrainian society and the Ukrainian education and science system. In the context of the intensification of hostilities, an important issue is to ensure the continuous and high-quality functioning of Ukrainian educational and scientific institutions, further implementation and development of state educational initiatives, as well as compliance with the state's strategic course towards Ukraine's full membership in the European Union (EU). Among the approved strategic and operational goals for the development of higher education in Ukraine [1] are the following: integration of the Ukrainian education and science system into the European Higher Education Area (EHEA) and the world education area; creation and implementation of the industry of innovative technologies and distance learning tools; digitalization of all processes in the higher education system, as well as ensuring the quality and accessibility of higher education. Thus, it is advisable to analyze the current state of the digital transformation of education and science in Ukraine, which will contribute to the post-war recovery of the sector and the implementation of the strategic partnership with the EU.

Formulation of the problem

The higher education system of Ukraine has several advantages that create development opportunities and are the basis of its competitiveness. Among the main advantages, it is worth noting the following [1]:

1. *A network of higher education institutions (HEI) is developed*. According to the World Higher Education Database, the Ukrainian network of universities is one of the densest: there are 6.7 universities per 1 million population, for comparison in Poland this indicator is 9.2, in Germany and Great Britain – 4, 3, and 3.7 universities, respectively.

2. *Regulatory and legal provision of higher education close* to the EPO determined by the terms of the Association Agreement between Ukraine and the EU; the Paris Communiqué of 2018; a new list of specialties, which should contribute to the academic mobility of students and the recognition of diplomas of Ukrainian higher education institutions; amendments to the Law of Ukraine «On Education».
3. *Attractiveness for foreign students* argued that it is prestigious and profitable to get an education in Ukraine. Compared to other European countries, the cost of education in Ukraine is much lower. The top 5 countries of origin of foreign students are India, Morocco, Turkmenistan, Azerbaijan, and Nigeria [2].
4. *Availability of world-class universities*. 6 Ukrainian universities are included in the QS World University Ranking, which evaluates the performance of the leading institutions in the country.
5. *Powerful human capital*. The level of higher education coverage of the population of traditional official school age is high – 82.7%. According to this indicator, Ukraine took 14th place out of 131 countries in the 2020 Global Innovation Index, Germany took 28th place, and Poland and Great Britain took 34th and 46th place, respectively.

However, despite the existing competitive advantages of the higher education system of Ukraine, some trends pose a threat to the state's innovative development in the field of education. Such trends are educational emigration – the departure of Ukrainian students to receive higher education abroad; inconsistency of the content and quality of higher education with the current needs of society and the national economy; weak integration of Ukrainian higher education into the global and European educational and scientific space.

In the field of science, it is also worth noting certain problems that slow down the process of implementing certain strategic directions of development. A negative trend is observed regarding the decrease in the number of organizations engaged in scientific and technical activities, the number of scientific workers is decreasing accordingly; insufficient demand for the results of domestic research [3]; insufficient level of informational and logistical support of scientific research and scientific and technical development. There is also a need to strengthen the link between «education-science-innovation».

The digital transformation of education and science in Ukraine with the introduction of automated solutions, modern computer technologies, and tools is an urgent task that will contribute to increasing the efficiency of educational and scientific activities, progress in the field, and integration of the system of education and science of Ukraine into the European area of higher education.

Analysis of publications

The study of digitalization as a condition for the development of the education system is devoted to the work of Guraliuk A. G. [4]. The author considers aspects of digitalization in higher education as an organizational and pedagogical condition for improving the quality of education. Digitalization of education in modern society: problems, experiences, and prospects are considered in the works of R. Hurevych, L. Konoshevsky, N. Opushko, who analyze the process of digitalization of modern education in the context of improving the training quality of future teachers and the convergence of education with science. Business processes in the context of digitalization are considered by scientists V. Dergachova, Y. Vorzhakova, and O. Khlebynska. The connection between changes in universities and the general digitalization of society is highlighted in the work of I. Varzhanska. It is also worth noting the works of Ukrainian scientists Punko I., Batsko T., Bilobabchenko O., and Poterlevych N., who analyze the need to involve multimedia teaching aids and modern computer information and communication technologies in the practice of training specialists. However, attention should be paid to the current state of digital transformation in the field of education and science in Ukraine in the context of adherence to the course of integration of the education system into the EHEA and strategic partnership with the EU.

The purpose of the article is to analyse the current state and prospects of the digital transformation of education and science in Ukraine for the need to speed up the process of integration of the system of education and science into the European space of higher education within the framework of Ukraine's strategic partnership with EU countries.

Methodological foundations of research

Use of methods of analysis, generalization, and systematization.

Presentation of the main research material

Digital transformation (digitalization) is the transformation of existing analog (sometimes electronic) products, processes, and business models of an organization based on the effective use of digital technologies [5]. According to the analytical reports of the Davos Economic Forum, the most common modern digital technologies are the Internet of Things, robotization and cyber systems, artificial intelligence, big data, paperless technologies, additive technologies (3D printing), cloud and fog computing, unmanned and mobile technologies, biometric technologies, quantum technologies, identification technologies, and blockchain. This list is not exhaustive and can be supplemented.

The main principles of digitization include [5]:

1. Digitalization should ensure that every citizen has equal access to services, information and knowledge provided on the basis of information, communication and digital technologies.

2. Digitalization should be aimed at creating benefits in various areas of everyday life, improving the quality of service provision, including education.
3. Digitalization is a tool for economic growth by increasing efficiency, productivity and competitiveness through the use of digital technologies.
4. Digitalization should contribute to the development of the information society and the media.
5. Digitalization should be focused on international, European and regional cooperation in order to integrate Ukraine into the EU and enter the European and global markets.
6. Standardization is the basis of digitalization and one of the main factors in its successful implementation.
7. Digitalization should be accompanied by an increase in trust and security. Information security, cybersecurity, and protection of personal data of digital technology users are prerequisites for digital development.
8. Digitalization as an object of focused and comprehensive public administration aimed at removing legislative barriers, launching national-level digital transformation projects which attract appropriate investments, and stimulate the development of digital infrastructures.

The priority sectors and initiatives for digitalization in Ukraine are formulated in the documents «Digital Agenda of Ukraine» [6] and «Concept of Development of the Digital Economy and Society of Ukraine» [7]. The priority areas of digitalization include education and science.

Digital transformation in education and science is a comprehensive work on building an ecosystem of digital solutions in education and science, including the creation of a secure electronic educational environment, provision of the necessary digital infrastructure for educational and scientific institutions, raising the level of digital competence, digital transformation of processes and services, as well as automation of data collection and analysis [8].

The Association Agreement between Ukraine and the European Union, in particular Title V. Economic and Sectoral Cooperation [9, 10] defines Ukraine's commitments in the fields of science and technology, as well as education, training and youth to implement strategic sectoral partnerships.

Cooperation between Ukraine and the EU in the field of science and technology provides for: exchange of information on policy in the field of science and technology; joint implementation of scientific programs and research activities; joint study of activities aimed at promoting scientific progress, technology transfer and know-how; training through implementation of exchange programs for researchers and specialists; organization of joint activities on scientific and technological development; taking measures aimed at developing favorable

conditions for conducting research and introducing new technologies, as well as proper protection of intellectual property of research results; activation of regional and other international cooperation; exchange of experience in the field of management of scientific research institutions with the aim of developing and improving their abilities to carry out and participate in scientific research.

*Cooperation between Ukraine and the EU in the field of education, training and youth*provides for: reform and modernization of the higher education system; promoting rapprochement in the field of higher education, which takes place within the framework of the Bologna process; increasing the quality and importance of higher education; deepening of cooperation between higher educational institutions; expansion of opportunities of higher educational institutions; activation of mobility of students and teachers; simplifying access to higher education; carrying out activities aimed at intensifying the exchange of information, practice and experience, to encourage closer cooperation in the field of vocational education and training.

Fig. 1. Display of information on the progress of implementation of the plan of measures for the implementation of the Association Agreement in IAS «Pulse»

The progress of the implementation of the Association Agreement between Ukraine and the EU is carried out on an ongoing basis by the information and analytical system (IAS) for monitoring the implementation of the Association Agreement «Pulse of the Agreement», which was developed and implemented in 2017, the

system is publicly available [11]. The interface of the information and analytical system graphically displays the monitoring data of the implementation of the plan of measures for the implementation of the Agreement and the progress of implementation by sections, in particular by the sections «Education, Training and Youth» and «Science, Technology and Innovation, Space», fig. 1.

According to IAS «Pulse», overall progress in the implementation of tasks under the section «Education, Training and Youth» as of 2021 amounted to 86% of the total volume of tasks; according to the section «Science, Technologies, and Innovations, Space» – 60%. End date of tasks 31.10.2024.

Obligations, the degree of implementation which is partial or needs to be implemented under the section «Education, Training and Youth», category «Education» include [11, 12]:
- ensuring constant exchange of information with EU institutions regarding joint programs in the field of education;
- compliance with the requirements for the documents that make up the European system for evaluating the level of qualifications and education;
- ensuring the functioning of the system of internal quality assurance of higher education following European standards and recommendations on quality assurance of higher education;
- providing access to lifelong learning.

Obligations under the section «Science, Technologies, and Innovations, space», the degree of implementation of which is partial, or needs to be implemented, include [11, 12] in the category «Science and technologies»:
- creation of favorable conditions for the activation of innovative activities, the implementation of innovations, and the functioning of innovative infrastructure;
- creation of conditions for the integration of the national technology transfer network into European networks;
- reorganization and optimization of the network of scientific institutions and scientific divisions of educational institutions of higher education;
- creation of a new system of management and financing of science;
- introduction of additional mechanisms for stimulating technology transfer.

The digital transformation of education and science will contribute to the fulfillment of obligations to exchange information, increase the quality and accessibility of higher education, intensification of innovative activities, as well as technology transfer.

The synergistic effect of the digitization of the fields of education and science will have a positive impact on the further development of the information society at the expense of ensuring the general availability of information and communication technologies, the implementation of online services (e-learning), ensuring the parties exchange information and experience in the effective functioning of electronic communications, fig. 2.

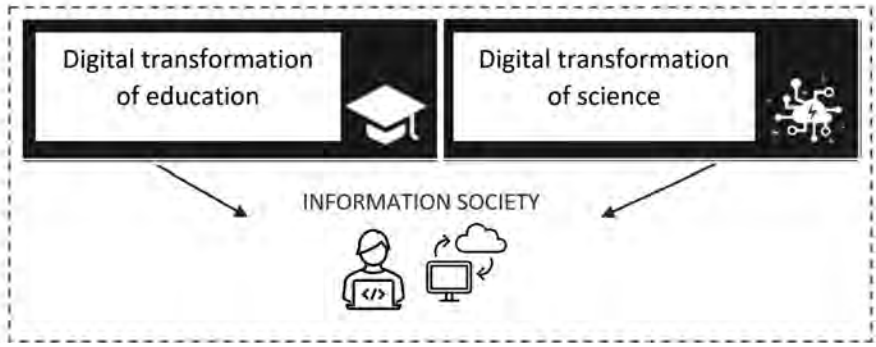

Fig. 2. Synergistic effect of digitization of the fields of Education and Science

State initiatives within the scope of digital transformation of higher, professional higher and professional (vocational and technical) education in Ukraine are the following [8, 13]:

Admission campaign for obtaining professional pre-higher and higher education. Submission of applications by entrants in electronic form and corresponding accounting of these applications by the Ministry of Education and Science of Ukraine.

An introductory campaign for obtaining a professional (vocational and technical) education. Creation of a new module to display the admission, as well as the electronic office of the entrants.

Pre-university training of foreigners. Creation of a new module for entering information about foreign students of preparatory departments into the Unified State Electronic Database on Education (EDEBO), taking into account the data when entering educational institutions.

Ordering documents about education. Implementation of registration of diplomas of Doctor of Philosophy / Arts, and Doctor of Science with the assignment of a registration number in the EDEBO by higher education institutions and scientific institutions.

Annexes of the European model to documents on higher education. Implementation of functions for the formation of European-style applications.

Electronic licensing in the field of education (e-licensing). Implementation in EDEBO of the display of the license examination conducted by the expert commission of the licensing body, the generation of verification reports of the licensee's compliance with the license requirements following the new version of the Licensing Conditions for Conducting Educational Activities.

EDEBO data exchange with external systems. Expanding the interaction of the «EDBO» with state automated systems and information resources, including by

integrating additional services and clients into the EDEBO (with the help of an application software interface or tools of the electronic interaction system of state electronic information resources «Trembita»).

Monitoring the employment of graduates. Creation and modernization of a single electronic system for monitoring the employment of graduates to inform stakeholders about the career trajectories of graduates and make management decisions.

State initiatives for digital transformation in the field of science in Ukraine [8]:

Register of Ukrainian research infrastructures (Register of infrastructures). Creation and full functioning of a digital system of unified information profiles of Ukrainian research infrastructures (including existing equipment and specialists who work directly on it).

Open Ukrainian scientific citation index. Improvement of the Open Ukrainian Scientific Citation Index by ensuring the use of a wide range of databases on the publications of Ukrainian scientists.

E-documents in Diya. Work continues the implementation of electronic documents about education on the portal and in the «Diya» mobile application. Currently, a draft resolution has already been developed for the regulatory regulation of the display in electronic form of information contained in documents about basic secondary, full general secondary, professional (vocational-technical), vocational pre-university, and higher education employing the Unified state web portal of electronic services using a mobile application «Diya».

The main Software and Hardware Complexes (SHC) and Automated Systems (AS), the functionality of which ensures the implementation of state initiatives for digitalization in the field of education and science, are shown in Table 1. Also, students, applicants, teachers, and educational managers have the opportunity to use 46 services that help them receive educational services remotely or online [8].

Joint international educational projects on the digitization of the industry are:

Education chatbot @EducationUaBot, the main task of which is a convenient form of informing about the current state of the educational process in Ukraine and the world. Displaced participants in the educational process, namely education seekers and teaching staff, can quickly find information about educational institutions of all levels in different settlements, find out about opportunities to continue studying or teaching during the war in each region, restore personal documents about education, etc. Created with the support of the Swiss DECIDE project.

*SELFIE (Self-reflection on Effective Learning by Fostering the Use of Innovative Educational Technologies)*is a free, easy-to-use online tool for self-assessment of educational institutions, aimed at helping to assess the effectiveness of the implementation of innovative digital technologies in the educational process,

Table 1. Existing Software and Hardware Systems, and Automated Systems for the implementation of digital transformation of education and science in Ukraine

SHC	Appointment
Unified State Electronic Database on Education (EDEBO)	AS whose functions are to collect, verify, process, store and protect information about the education system, ensures electronic licensing of educational activities; accreditation of educational programs; electronic admission; verification of the authenticity of educational documents; and other needs of the industry.
Management System for Vocational Education (EMIS)	automation of the processes of collection, verification, analysis, storage, distribution and use of disaggregated data on qualitative and quantitative indicators of the education system, in particular for making management decisions.
National Electronic Scientific Information System (URIS)	AS with data aggregation functions in the field of scientific and scientific and technical activities of Ukraine; aggregation of information useful to domestic scientists, employees of scientific institutions and higher education institutions on a single resource.
Automated Information Complex of educational management (SHC «AICOM»	SHC is intended for the processing of state electronic information resources and personal data in the field of education within the framework of a single integrated environment in order to ensure the transition to electronic document management.
Unified Interdepartmental Information System on recruitment of foreign entrants to higher education institutions	pilot (experimental) project in within the scope of the international technical assistance «EU4DigitalUA: Interoperability, e-services, cyber security», regarding the recruitment and training (internship) of foreigners and stateless persons to the higher education institutions of Ukraine.
Electronic Scientific Information System	provides a single point of access to state digital services for scientific purposes, as well as the creation of unified information profiles of Ukrainian scientists and aggregation of information in the field of science.
Unified Electronic System of Competitive Financing of Scientific Research	transfer to electronic form of the process of competitive funding of scientific research, submitting an application for competitive funding, selection of experts, reporting, etc.
Web platform «Science and Business»	online platform for communication and effective interaction of representatives of business and the scientific community.

finding out at which stage of digital development the educational institution is. SELFIE was developed by the Joint Research Center of the European Commission and research institutes of EU countries.

A laptop for every teacher. Under the terms of the partnership with Google and UNICEF, 43,000 laptops were handed over to Ukrainian educators. Part of the

computer equipment received will be given to teachers who suffered from attacks by the Russian Federation. A survey is also being prepared regarding the educational needs of institutions of professional pre-higher and higher education.

Adherence to the determined course on digitization of higher education will contribute to the full fulfillment of obligations under the Association Agreement and will create favorable conditions for the development of innovative activities and the integration of the national technology transfer network into European networks.

The key promising trend of digital transformation in education and science of Ukraine is the further digitization of institutions of higher education and science, which is seen in increasing the effectiveness of the use of digital technologies in the educational process and scientific activity; creating a digitally accessible and modern educational environment; the achievement by employees and students of education of a high level of digital competences, as well as the availability of data exchange for the needs of education and science [14, 15].

Digitalization of higher education institutions. Ukrainian University 2030 is not only a physical space but also a digital one. Teacher-student interaction takes place on online platforms, which are one of the tools for managing the educational process and content, online courses, online lectures with remote access for each participant in the educational process. Analyzing data from online platforms using artificial intelligence will allow personalizing the educational process by leveling the difference in perception and learning processes among students. The key indicators for analysis are the time intervals of the materials, which are focused on offering individualized learning plans. In addition, the use of artificial intelligence can adapt the same discipline to different specialties, which ensures that students receive the most important and applicable information. It is also planned to further use virtual and augmented reality technologies for information assimilation (simulation, modeling experiments and performing practical tasks); engaging digital assistants or chatbots that answer questions in real time about the learning process, financial aid, dormitory life, leisure activities, city trips, and much more [14].

Achieving a high level of digital competence. Digital competence (digital literacy) can be broadly defined as the confident, critical, and creative use of computers to achieve goals related to work, employment, education, leisure, and social life. Digital literacy is recognized by the EU as one of the eight key competencies for lifelong learning. The updated EU Digital Competence Framework (DigComp 2.0) presents five main competence blocks:

1. Information literacy and data skills: the ability to search, evaluate, filter, and use data, information, and digital content.
2. Communication and interaction: the ability to communicate, share information, and use public and private services through the use of digital technologies; knowledge of «netiquette» – knowledge of the rules of behavior and etiquette

in the digital environment; digital identity management, i.e., creating and managing digital accounts.
3. Digital content: creation, ability to change, improve, and use digital content; awareness of copyright and licensing policies for data, information, and digital content; ability to write program code.
4. Security: the ability to protect devices and content, knowledge of security measures, understanding of risks and threats; protection of personal data and privacy; ability to avoid health risks and threats to physical and psychological well-being when using digital technologies and possible dangers in the digital environment (cyber abuse); understanding of the impact of digital technologies on ecology, environment, and their use that may cause damage, such as critical infrastructure, etc.
5. Problem-solving: the ability to solve technical problems that arise with computer hardware, software, networks, etc.

Data exchange for the needs of education and science. Data in the field of education and science should be available to scientific and pedagogical workers and stakeholders, following the need of ensuring: access to educational analytics and data following the requirements of legislation; effective interaction between state registers; access to a person's educational data in a personal account; access to data in the field of science using the National Electronic Scientific Information System; improvement of the Open Ukrainian Citation Index. Data in the field of education and science should be used to make management decisions at all levels: improvement of the monitoring system of employment of graduates of educational institutions; improvement of accounting of pedagogical, scientific, and pedagogical workers; improvement of registration of education recipients; creation and introduction of an accounting system in the field of professional development of pedagogical and research-pedagogical workers; development and implementation of the register of research infrastructures; ensuring the creation of education documents and their annexes in the Unified State Electronic Database on Education; introduction of an automated reporting system by educational institutions; transfer of the reporting procedure in the field of science to a paperless format; introduction of the National Student Survey. transfer of the reporting procedure in the field of science to a paperless format; introduction of the National Student Survey. transfer of the reporting procedure in the field of science to a paperless format; introduction of the National Student Survey.

Conclusions

Analysis of the current state of the digital transformation of education and science in Ukraine showed a high level of progress in the implementation of the Association Agreement between Ukraine and the EU in the fields of «Education, Training and Youth» and «Science, Technology and Innovation, Space». To fulfill obligations in the field of education and science, the degree of implementation of which is partial, or

needs to be implemented, modern implemented and experimental state initiatives on digitization of education and science were considered; joint international projects and hardware and software complexes. It has been established that the synergistic effect of the digitalization of the fields of education and science is the development of the information society of Ukraine. The prospects for the digital transformation of education and science in Ukraine are to increase the effectiveness of the use of digital technologies in the educational process and scientific activity; create a digitally accessible and modern educational environment; the achievability by employees and students of education of a high level of digital competences, as well as ensuring the availability of data exchange, which will contribute to the development of the fields of education and science of Ukraine and further strategic partnership with EU countries.

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