

DOI: <https://doi.org/10.34069/AI/2022.58.10.22>

How to Cite:

Reshetylov, K., Rajab Aljad, R., Panchenko, H., Bukliv, R., & Vynograd, O. (2022). Digital transformation of education and science: responses to modern challenges. *Amazonia Investiga*, 11(58), 202-211. <https://doi.org/10.34069/AI/2022.58.10.22>

Digital transformation of education and science: responses to modern challenges

Transformación digital de la educación y la ciencia: respuestas a los retos actuales

Received: October 1, 2022

Accepted: November 29, 2022

Written by:

Kyrylo Reshetylov⁹²<https://orcid.org/0000-0002-7114-9107>**Reyad Rajab Aljad**⁹³<https://orcid.org/0000-0002-2104-7401>**Hanna Panchenko**⁹⁴<https://orcid.org/0000-0002-3946-9004>**Roksoliana Bukliv**⁹⁵<https://orcid.org/0000-0002-3837-5794>**Oleksandr Vynograd**⁹⁶<https://orcid.org/0000-0002-1520-9881>

Abstract

The relevance of the study is due to the rapid digitalization and computerization of both the educational process and research activities. New challenges are prompting the creation of a new digital educational environment. Relying on the latest digital technologies, scientific paradigms are changing towards creating interdisciplinary areas of research. The article aims to analyze the main trends of digital transformation of the educational and scientific sphere. The article is based on the use of theoretical pedagogical research methods: analysis, synthesis, induction, and deduction. Content analysis of scientific literature showed that researchers do not pay enough attention to the analysis of tools for implementing the elements of digitalization in the educational and research processes. The results of the study were actualization of the understanding of the content and essence of the digitalization of the educational process, coverage of the competence approach to the implementation of digitalization, analysis of the formation of new interdisciplinary areas of research work. Practical significance: the

Resumen

La pertinencia del estudio se debe a la rápida digitalización e informatización tanto del proceso educativo como de las actividades de investigación. Los nuevos retos están impulsando la creación de un nuevo entorno educativo digital. Apoyándose en las últimas tecnologías digitales, los paradigmas científicos están cambiando hacia la creación de áreas interdisciplinarias de investigación. El objetivo del artículo es analizar las principales tendencias de la transformación digital del ámbito educativo y científico. El artículo se basa en el uso de métodos teóricos de investigación pedagógica: análisis, síntesis, inducción y deducción. El análisis de contenido de la literatura científica mostró que los investigadores no prestan suficiente atención al análisis de las herramientas para implementar los elementos de la digitalización en los procesos educativos y de investigación. Los resultados del estudio fueron la actualización de la comprensión del contenido y la esencia de la digitalización del proceso educativo, la cobertura del enfoque de competencias para la implementación de la digitalización, el análisis de la formación de

⁹² Senior Lecturer Department of Ukrainian Language, Literature and Culture, Faculty of Linguistics, National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute», Kyiv, Ukraine.

⁹³ Lecturer State of Libya / the city of al khoms Elmergib University Libyan Ministry of Education, Libyan.

⁹⁴ Candidate of Sciences in Public Administration, Associate Professor of the Department of Public Administration and Regional Studies, Faculty of Public Management and Administration, Educational and Scientific Institute of Public Service and Management, National University "Odesa Polytechnic", Ukraine.

⁹⁵ Candidate of technical Sciences, Docent, Associate Professor Department of Chemistry and Technology of Inorganic Substances, Institute of Chemistry and Chemical Technologies, Lviv Polytechnic National University, Ukraine.

⁹⁶ Candidate of Pedagogical Sciences, Associate professor of the department of cynology, Territorially separated branch «Khmelnysky branch of the Academy of the State Penitentiary Service», Ukraine.



creation of recommendations on the implementation of digital competence acquisition tools for effective adaptation to the new digital educational environment in Ukraine and the disclosure of its additional benefits. In conclusion, it is noted that this study opens a broad discussion on the prospects for changing both educational and scientific paradigms in Ukraine and the world.

Keywords: digital technologies of education, educational environment, research activities, innovative education, e-Learning.

Introduction

The traditional school was formed with a focus on the present in its day manufactory production. The digital transformation of education is largely based on the models of transformation, consisting in the background of modern high technology. A distinctive feature of transformational changes is their high speed, the inability of inertial institutions to match the changes taking place in society. Today, many education administrators, making decisions, believe that they are still in control of change. But this is far from being true; the situation has changed: changes in the surrounding world have accelerated, technology renewal takes years, not a decade, as it did half a century ago. New opportunities are constantly opening up. However, employees of the educational sphere do not have the resources and tools to promptly follow them, to plan research to study them, to assess the potential for updating educational practices.

As a result of this feature of the educational field, innovative schools and teacher innovators (“scouts of the future”) take the risk of mastering new digital technologies and testing their effectiveness in educational work. They share their successes with their colleagues, independently generating and disseminating new educational practices. Thus, modern educational institutions are losing their role as leaders of school renewal, leaving only the fixation and control of continuously occurring changes.

The purpose of this article is to analyze the main trends in the digital transformation of the educational and scientific sphere. Based on the purpose of the study, the following research objectives can be formulated:

nuevas áreas interdisciplinarias de trabajo de investigación. Importancia práctica: creación de recomendaciones sobre la aplicación de herramientas de adquisición de competencias digitales para la adaptación efectiva al nuevo entorno educativo digital en Ucrania y la divulgación de sus beneficios adicionales. En conclusión, se señala que este estudio abre un amplio debate sobre las perspectivas de cambio de los paradigmas educativos y científicos en Ucrania y en el mundo.

Palabras clave: tecnologías digitales de la educación, entorno educativo, actividades de investigación, educación innovadora, e-Learning.

- analysis of the current state of the study of the issue of digital transformation of the scientific and educational sphere in the world pedagogical science;
- the study of the features of the formation of digital transformation of education and science in Ukraine, highlighting the main features of this process, determining the national nature of the changes;
- the study of trends and prospects of development of digital transformation of scientific and educational spheres in accordance with the national strategy for reforming the educational sphere.

Theoretical Framework or Literature Review

The work was based on low academic research. Thus, the article by Abad-Segura, González-Zamar, Infante-Moro & Ruipérez García (2020) addresses the issue of reforming the management of educational institutions in a digital transformation. The authors point out that this process provides new opportunities for managing the quality of interaction of all participants in the educational process. Together with this study, the works of Balyer & Öz (2018) and Benavides, Tamayo Arias, Arango Serna, Branch Bedoya & Burgos (2020) address the digital transformation of the educational process in the academic environment. The authors of both studies identify issues that are specific to institutions of higher education and the academic research environment. For this study, the international experience of digitalization implementation is important. Bond, Marín, Dolch, Bedenlier & Zawacki-Richter (2018) study highlights the specifics of the digital transformation of education in Germany. The authors note that the field of education is still one of the most

conservative institutions, and despite the high technological development of the country, the introduction of innovative digital technologies into the educational process has been very sensitive. Studies highlighting the problems of a modern adaptation of educational institutions to current conditions remain interesting. Research by Diachkova, Tomyuk, Novgorodtseva, Avdeeva, & Belkevich, (2022) examines the state of digitalization of modern universities and the challenges that students and teachers face in their daily activities. The authors consider the strengths and weaknesses of the digital transformation of the educational process. The researchers have not overlooked the issues of organizing research work in the context of digital transformation. García-Peñalvo, (2021) in his article examines the practical mechanisms of implementing elements of digital transformation. Yes, the author considers the principle of e-Learning in higher education. The author reveals the goals and objectives of e-learning, points out the strengths and weaknesses of this educational technology. The author pays special attention to the problems faced by students in the digital educational environment. Jackson (2019) considers the problem of the formation of digital necessary for the successful implementation of digital transformation of education and science in the conditions of technological development. The author notes that basic ICT competencies play a special role in digital transformation today. Kapur, Byfield, Del Frate, Higgins & Jagannathan (2018) in their study point to important transformations in academia. The authors emphasize that with digital transformation, scientists gain new opportunities for their work. The study of Kazibekova, (2019) reveals the psychological features of the adaptation of teachers and students to the new digital environment. The study reveals the peculiarities of adaptation to new educational tools. Research Kulish, Radul, Haleta, Filonenko & Karikh (2020) aims to analyze the tools of digital transformation of the educational process in Ukraine. The study of Mhlanga & Moloi (2020) reveals the role of quarantine measures in relation to the COVID-19 epidemic in accelerating the digital transformation of educational and scientific institutions. Despite numerous studies on the digitalization of education and science, the issue is not lost on us. There are still low issues that have not been reflected in scientific research: effective tools to adapt students to the new pedagogical conditions, the transformation of scientific discourse in connection with the new digital realities, effective tools of digital transformation, etc.

Methodology

To analyze the organizational forms and infrastructure of digital transformation, the work applies interdisciplinary methods, allowing for a new quality of research, which ensures its perspective. Along with traditional sources and comparative historical methods, modern comparative methods of analysis of scientific literature and legal acts are used. Analysis of the integrity and completeness of information, analysis of spatial and temporal correspondence were used for comparative research. Applied methods of digital humanities - content analysis and visualization of research results - were used to present the results of the study. The work is based on the source analysis of Internet resources of periodicals and organizations, identification and comparison of qualitative and quantitative indicators of synchronicity and diachrony, scientometric analysis of publications in scientific journals and collections of conference materials, methods of information visualization, generalization of the results.

The key materials of the study were the official Ukrainian legislation: 1. The concept of digital transformation of education and science in Ukraine (Ministry of Education and Science of Ukraine, 2021). 2. Strategy for the development of higher education in Ukraine for 2021-2031 (Ministry of Education and Science of Ukraine, 2022). 3. Laws of Ukraine "On Higher Education" (Law № 1556-VII, 2014) The above legislative framework allowed to identify the current state, trends, and prospects for further development of digital transformation of the educational and scientific sphere in Ukraine at the present stage of development. The study was conducted in several stages: the first stage was an analysis of the scientific literature, the study of the legal framework, the goals and objectives of the study. The second stage characterized the state of digital transformation of education and science in Ukraine, highlighted the main features and trends of development, marked the most striking forms of the impact of digitalization on the development of these areas. At the last stage, the results of the study were summarized, conclusions were formed and the own point of view on the prospects of the development of digitalization of education and science in Ukraine was highlighted.

Results and Discussion

The intensive development of computer and, first and foremost, online educational technologies is radically changing the process and format of

education, both in terms of the content of the educational process itself and the means of its organization. These challenges require serious rethinking. It is not only about recording lectures and preparing electronic versions of textbooks. It is about the “depressurization” of education, moving beyond university classrooms and laboratories (Samoilovych, Garafonova, Popelo, Marhasova & Lazarenko, 2021).

The digital civilization of the 21st century has given rise to new forms of organization of socially important institutions, which are the educational and scientific spheres. Digitalization requires new, quite different competencies from those that Ukrainian university graduates have. There is a paradoxical situation - many necessary new competencies are acquired outside educational institutions (Tsekhmister, Kotyk, Matviienko, Rudenko & Ilchuk, 2021).

The main function of education becomes teaching how to learn, how to be ready for change, how to work with more complex projects, how to borrow advanced, foreign practices, how to broaden one's horizons by following trends in other industries and professions. Moreover, the digital competence of university graduates should not exceed the existing nomenclature of competencies in order to work ahead of the situation. The times when the lecturer was the primary source of discipline and learning was reduced to listening to lectures and discussing additional literature in seminars,

which was mostly reduced to fragments of primary sources, are rapidly disappearing, and in general have already gone into oblivion (Tanushev, 2022).

Students armed with gadgets, even during a traditional lecture, can repeatedly refer to primary sources, contemporary interpretations, often ahead of such awareness of the lecturer himself. And those teachers who demand the reproduction of the content of their lectures in exams and credits, those institutions of higher education that fight against the availability of information by prohibiting the use of electronic sources, fall out of professional activities, becoming uncompetitive and unclaimed (Bethencourt-Aguilar, Area-Moreira, Sosa-Al Castellano-Nieves, 2021).

Digital technology is radically changing both the content of disciplines and the way they are delivered. It is not only electronic presentations, which have already become a common practice, or the use of videos. It is possible to connect directly to electronic databases, news, and forums that are actively taking place all over the world. The use of social networks is possible in conducting practical classes. With the use of Skype, messengers possible participation in the session of the leading specialist, the expert (OECD (2018a)). The conceptual model for the implementation of digital transformation in Ukrainian universities is shown in Figure 1.

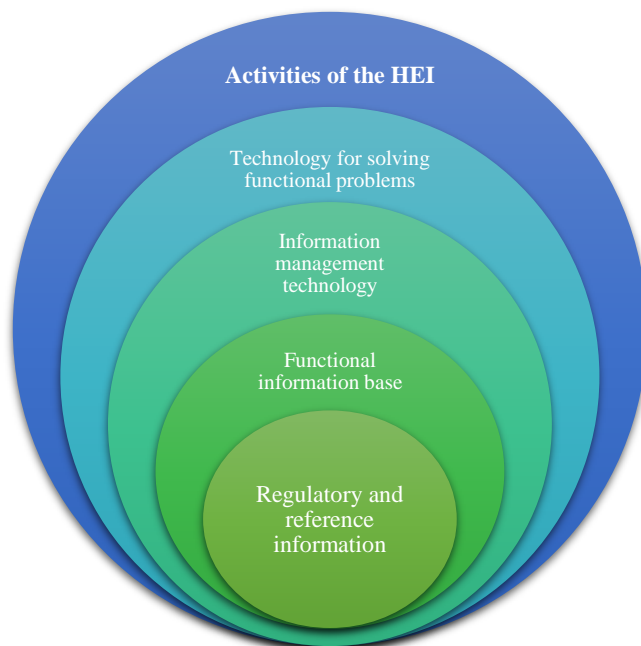


Figure 1. Conceptual model of concentric information technology of digital transformation of higher education institutions.

Developed by the authors of the article based on content analysis

Publishers specializing in educational literature are increasingly switching to electronic versions of textbooks and teaching aids. Mass online education is developing rapidly. Video recordings of lectures by educational institutions and individual teachers began to appear on the Internet as early as in the late 1990s. In the early 2010s, full-fledged interactive courses for taking tests and exams appeared. Currently, some popular courses have hundreds of thousands of students. And universities and individual instructors are actively entering the MOOC market, an international form of open-access online distance education (OECD (2018b)). The Coursera project alone now reaches almost 25 million users, who are offered more than 2,000 courses in 160 specializations from hundred and fifty educational institutions. Since the project collaborates with universities (among which are elite universities), students who complete courses and pass tests and exams receive full-fledged digital certificates. The technical platform is both the Coursera website and the iPhone and Android mobile app (Oliver & Jorre de St Jorre, 2018).

Since 2009, the Academic Earth website has been launched, featuring video lectures by professors at MIT, Berkeley, Harvard, Princeton, Stanford, and Yale on economics, political science, mathematics, physics, chemistry, history, philosophy, literature, psychology, etc. The Ukrainian web platform for schoolchildren (All-Ukrainian School Online) is also successful (Xiao, 2019).

Table 1.

The limits of digital competencies for students, teachers, and educational organizations

Limits and tools	Target audience	Content
Digital competencies for citizens	All citizens	Conceptualization of digital competence for citizens taking into account lifelong learning; Promotion model with all levels of digital competence
Digital competence of teachers	Teachers	Conceptualization of digital competence for educators; Promotion model with six levels of digital competence

Developed by the authors of the article based on content analysis

It is necessary for education to give confidence and readiness to change, to make a young person less dependent on facts and narrow knowledge, to teach how to develop together with technology. And this means that the university should teach: to solve problems quickly, to find the necessary information and knowledge, to be able to work in a team, to see the perspective and

If the listener does not have a goal to get a certificate, he or she can take the course for free. The development of free online education of advanced world-class universities is a serious challenge to small regional universities. However, if you intelligently combine online and offline education formats, regional universities can offer and implement high-quality, if not unique, educational programs. Students who attend traditional HEIs are increasingly supplementing their education with online courses as needed or desired-the format is not only convenient for gaining knowledge from top experts, but also for being able to study at any time (Ulas, 2019). Beginning in their sophomore year, most students begin working "on-the-job".

They are forced to do this both by financial circumstances (the need to pay tuition, living in another city, etc.) and by an understanding of life prospects. A graduate who graduates and only then enters the labor market loses out to a graduate who has already acquired skills while in a particular position. Thus, most universities will have to adapt to low attendance, more and more students switching to individual plans, rescheduling sessions, etc. (Ovchinnikova, Ovchinnikova & Kharlamov, 2020). It should be noted that the success of the implementation of digitalization of education depends on the formation of digital competencies of both students and teachers. Table 1 presents the content of the required digital competencies.

prepare for it, to be able to make decisions, to develop and implement projects, to respond to requests, to build communications and partnerships (Safonov, Uсыk & Bazhenkov, 2022).

Internet education, which is becoming increasingly popular, provides opportunities to

use electronic courses prepared by other universities in educational programs. A new educational field is forming, the purpose of which is the professional certification of specialists (Sousa & Rocha, 2019).

However, besides education, the traditional university plays another important role in the socialization of the most advanced part of the new generation, in its entry into the professional environment. The university forms a professional network-not only between generations-between faculty and students, but also horizontally-the graduates each year maintain a lasting relationship based on the memory of their shared years of study. Each university graduation not only adds to the professional network of formal and informal relationships but also triggers new network relationships already partially established within a generation during their studies. It has long been observed that personal relationships between classmates and even graduates of different years, but one university, one department, and one educational program lay quite a constructive foundation for partnerships and professional careers. These relationships persist in business and academia as well (Sinaga, Sahyar, Darwin & Rajagukguk, 2022).

But the role of the teacher, the very content of his work under digitalization changes significantly. His task becomes not so much the development of the course, the content of lectures and practical classes, their regular updating in accordance with new theoretical concepts and developments, as well as new technologies, practices, empirical data, publications of scientific and educational literature, as the tracking of electronic resources and databases, where all these materials are presented. This includes keeping abreast of educational programs and services offered by other universities. The teacher becomes not so much a source of knowledge as a navigator, offering the optimal trajectory for the purposes of this course to get acquainted with databases, develop practical tasks, cases for discussion, and, of course, testing the students' passing of this trajectory. And if the teacher or the head of an educational program wants to use the courses or their fragments presented on the web, he or she should take these courses to understand their capabilities (Stupak, 2021).

Speaking about interdisciplinary research from the perspective of instrumental interdisciplinarity, it should be noted that they are most effective if there is a common object, which the methods of different sciences are aimed at. Information, which has a complex

internal structure, can be considered as such an object. The methods of both natural and socio-humanitarian sciences must be used to study it. At the same time, it is becoming increasingly important not so much to expand the arsenal of scientific methods, as to search for universal general scientific foundations, the foundation that allows interdisciplinary research at the methodological level. The logic of development of the humanities today moves in the direction of methodological interdisciplinarity, the search for a general scientific methodology which would not simply allow to unite the tools of separate sciences, but also to work out some common grounds for humanitarian and natural research (Butschan, Heidenreich, Weber & Kraemer, 2019).

In the modern sciences, under the influence of digital transformation, methods have been created that allow us to investigate information from different perspectives. However, the study of information is still dominated by a technocratic approach, which narrows the understanding of the essence of information and its role in the development of society. The situation changed at the beginning of the 21st century when it became clear that interdisciplinary integrative research began to prevail in modern science. The humanities found themselves in a situation of searching for any general scientific foundations, a foundation that would provide interdisciplinary research. The response to this search was the attempts to synthesize the ideas about information, the ways of analyzing its life cycle, the role in the system of communications, which showed that such a synthesis of approaches to the study of information is possible only in the humanities on an interdisciplinary basis and is manifested today in the development of digital humanities (digital humanities – DH) (Núñez Valdés, Quiros Alpera & Cerdá Suárez, 2021).

The approach to humanitarian research from the standpoint of information theory leads to a change in the main object of research. If previously the source as a carrier of open information was considered as an object, now the main object of study becomes not the part of information fixed in the source in the sign form, but all information, including hidden information, latently present in the source. The spread of digital technologies leads to an extremely rapid birth of new information flows, the formation of new sources of information, which become the objects of DH. In turn, the study of new sources of information is accompanied by an increase in their number -

both primary sources, generated by the era and people, and secondary ones, arising already in the process of “digitalization”, in the process of applying various research methods. The development of digital technologies itself gives rise to new objects of humanities research - new texts in social networks and blogs, YouTube videos, etc., all at once in digital format, which requires computer processing of data and an informational approach to the analysis of sources (Marks & Al-Ali, 2022).

Digital Humanities (DH), a field that is rapidly growing and transforming humanities research through digital tools and resources, contributes to the emergence of new communications across academic boundaries. Breaking “disciplinary” boundaries in science leads at first to rejection but usually produces extraordinary results. Combining different technologies and methods, different expertise becomes key for the digital humanities, where not only “disciplinary” boundaries are raised, but also themes, meanings, searches, solutions are intertwined.

To analyze the organizational forms and infrastructure of DH, the paper applies interdisciplinary methods to obtain a new quality of research, which ensures its perspective. In addition to traditional source and comparative historical methods, modern sociological methods and tools based on questionnaires, focus groups, etc. are used. For data collection, automated environments were used, and for their processing - specialized software Statistica and MS Excel spreadsheet processor (Sumuer, 2018).

Reliability and credibility of found sources of information are ensured by their official character: reliability of sources is confirmed by the authority of the printed body, book, publisher, website; credibility is a guarantee of the authenticity of information fixation through a digital document or digital copy of the printed text of scientific publications with their filters of editorial selection, reviewing, the responsibility of the author and editor, reputation, etc. The materials obtained as a result of the information search are systematized and structured based on the relational data model and processed by statistical methods. Such analysis of initial empirical data allows to reveal organizational forms of scientific and educational centers working in the field of DH, to determine the infrastructure of researches in the field of DH in the leading world centers, to localize these centers in space, linking them to a world map. The study of the DH information environment is based on the analysis of the nature of information

interactions arising in the DH sphere and forming its information environment. The identified information interactions are classified as linear, interactive, and transactional structures of communication in the context of the process-information approach to communication.

The rapid spread and renewal of digital technologies over the past decade - broadband Internet, high-performance digital mobile devices (smartphones, tablets, etc.), Web 2.0 tools (blogs, wikis, social networks, etc.), cloud services (Google, Office 365, etc.), a new generation of virtual reality and artificial intelligence devices - offer virtually unlimited access to digital tools, materials, and services. Everyone's access to an unlimited library of online materials (which used to be the exclusive privilege of elites) gives unprecedented control over their information space and its sharing (Tsiuniak et al., 2020).

The opportunities for students and teachers for self- and mutual control, for the formation of interest in learning, for meaningful (accepted by the student) academic work have qualitatively increased. Today the main problem is the lack of a clear dynamically developing understanding (vision) of the ways to update the education system. Digital technologies in education - the nucleus around which pedagogical innovations can and should gather, there is a qualitative improvement of the educational process performance. However, so far the use of digital education has often been (and continues to be) considered in isolation from the transformation of goals, organizational forms, and methods of educational work. As a result, multimillion-dollar investments do not contribute to improving the quality of education. In advanced countries, this situation has now begun to change. The time has come for systemic transformation. Today, as never before, it is important that the ways and forms of introducing digital transformations in education be discussed and implemented based on an understanding of the possible place of these technologies in the educational process and the expected results (if any) of their use.

The goals of changing teaching methods, organization, and assessment should be considered along with the goals of developing a technology-rich learning environment. Solving these tasks is the only innovative process of education transformation. First of all, it is necessary to consider the issues of improving the efficiency of educational practices and, on this

basis, to address the issues of creating an appropriate digital information infrastructure.

Conclusions

Consequently, relentless scientific and technological progress has led to transformations in all spheres of social and political life. New digital technologies have affected not only the economy, but they could also not bypass the educational and scientific spheres, changing methods and approaches to their content and organization. The development of computer technology has prompted the creation of a new digital educational environment, which is the main trend in the development of modern education. The great role of digital and new communication technologies in the development and transformation of the scientific environment should be noted. The emergence of high digital technologies was the impetus for the creation of new interdisciplinary scientific directions, combining the humanities with the methods of mathematical and digital data processing. At present, the trend towards digital humanities (DH) persists in the global scientific discourse.

Digital technologies are evolving rapidly. The methodological developments that underlie them are constantly progressing. Consequently, the digital transformation of education and science does not seem to be a static statement of a certain level of development at a given stage, but a dynamic process of continuous development. Most of the curricula, simulators and learning assessment complexes are based on methodological solutions that were developed more than half a century ago while exploring the possibilities of programmed learning within the behavioral model of the learning process. Their advantage is that they use in most cases relatively uncomplicated technological solutions. The active model of the learning process requires for its computer support the creation of sufficiently developed learning environments of a new, digital type. Considering the above, it should be noted that further research on the digital transformation of education and science should focus on the analysis of educational environment transformation and the challenges it brings.

Bibliographic references

Abad-Segura, E., González-Zamar, M. D., Infante-Moro, J. C., & Ruipérez García, G. (2020). Sustainable management of digital transformation in higher education: Global research trends. *Sustainability*, 12(5), 2107. <https://doi.org/10.3390/su12052107>

- Balyer, A., & Öz, Ö. (2018). Academicians' Views on Digital Transformation in Education. *International Online Journal of Education and Teaching*, 5(4), 809-830. <http://iojet.org/index.php/IOJET/article/view/441/295>
- Benavides, L. M. C., Tamayo Arias, J. A., Arango Serna, M. D., Branch Bedoya, J. W., & Burgos, D. (2020). Digital transformation in higher education institutions: A systematic literature review. *Sensors*, 20(11), 3291. <http://dx.doi.org/10.3390/s20113291>
- Bethencourt-Aguilar, A., Area-Moreira, M., Sosa-Alonso, J. J., & Castellano-Nieves, D. (2021, September). The digital transformation of postgraduate degrees. A study on academic analytics at the University of La Laguna. In 2021 XI International Conference on Virtual Campus (JICV) (pp. 1-4). IEEE. <https://doi.org/10.1109/JICV53222.2021.9600311>
- Bond, M., Marín, V. I., Dolch, C., Bedenlier, S., & Zawacki-Richter, O. (2018). Digital transformation in German higher education: student and teacher perceptions and usage of digital media. *International Journal of Educational Technology in Higher Education*, 15(1), 1-20. <https://doi.org/10.1186/s41239-018-0130-1>
- Butschan, J., Heidenreich, S., Weber, B., & Kraemer, T. (2019). Tackling hurdles to digital transformation—The role of competencies for successful industrial internet of things (IIoT) implementation. *International Journal of Innovation Management*, 23(04), 1950036. <https://doi.org/10.1142/S1363919619500361>
- Diachkova, A., Tomyuk, O., Novgorodtseva, A., Avdeeva, O., & Belkevich, P. (2022). Digital transformation of a modern university in new reality (experience of top universities). In *INTED2022 Proceedings* (pp. 6999-7008). IATED. <https://doi.org/10.21125/inted.2022.1770>
- García-Peñalvo, F. J. (2021). Avoiding the dark side of digital transformation in teaching. An institutional reference framework for eLearning in higher education. *Sustainability*, 13(4), 2023. <https://doi.org/10.3390/su13042023>
- Jackson, N. C. (2019). Managing for competency with innovation change in higher education: Examining the pitfalls and pivots of digital transformation. *Business Horizons*, 62(6), 761-772. <https://doi.org/10.1016/j.bushor.2019.08.002>
- Kapur, R., Byfield, V., Del Frate, F., Higgins, M., & Jagannathan, S. (2018). The

- digital transformation of education. Earth observation open science and innovation [Internet]. ISSI Scientific Report Series, 15, 25-41. https://doi.org/10.1007/978-3-319-65633-5_2
- Kazibekova, V. F. (2019). Psychological features of communicative competence of future professionals. *Insight: the psychological dimensions of society*, 2, 64-71. <https://doi.org/10.32999/2663-970X/2019-2-9>
- Kulich, A., Radul, V., Haleta, Ya., Filonenko, O., & Karikh, I. (2020). The Newest Digital Technologies in Education and The Prospects of Their Implementation in Ukraine. *Propósitos y Representaciones*, 8(SPE2), e684. <https://doi.org/10.20511/pyr2020.v8nSPE2.684>
- Law No. 1556-VII. About higher education. Verkhovna Rada of Ukraine, December 2014. Retrieved from <https://zakon.rada.gov.ua/laws/show/1556-18#Text>
- Marks, A., & Al-Ali, M. (2022). Digital transformation in higher education: A framework for maturity assessment. In *COVID-19 Challenges to University Information Technology Governance* (pp. 61-81). Springer, Cham. https://doi.org/10.1007/978-3-031-13351-0_3
- Mhlanga, D., & Moloi, T. (2020). COVID-19 and the digital transformation of education: What are we learning on 4IR in South Africa? *Education sciences*, 10(7), 180. <https://doi.org/10.3390/educsci10070180>
- Ministry of Education and Science of Ukraine (2021, May 25) Concept of digital transformation of education and science: MES invites public discussion. Retrieved from <https://mon.gov.ua/ua/news/koncepciya-cifrovoyi-transformaciyi-osviti-i-nauki-mon-zaproshuye-do-gromadskogo-obgovorennya>
- Ministry of Education and Science of Ukraine (2022, April 15) The Strategy for the Development of Higher Education in Ukraine for 2022-2032. Retrieved from <https://mon.gov.ua/ua/news/opublikovano-strategiyu-rozvitku-vishoyi-osviti-v-ukrayini-na-2022-2032-roki>
- Núñez Valdés, K., Quiros Alpera, S., & Cerdá Suárez, L. M. (2021). An Institutional Perspective for Evaluating Digital Transformation in Higher Education: Insights from the Chilean Case. *Sustainability*, 13(17), 9850. <https://doi.org/10.3390/su13179850>
- OECD (2018a). Teaching for the future: Effective classroom practices to transform education. OECD. <https://doi.org/10.1787/9789264293243-en>
- OECD (2018b). The future of education and skills: Education 2030. OECD. Retrieved from <http://www.oecd.org/education/2030/OECD%20Education%202030%20Position%20Paper.pdf>. Accessed 21 Dec 2022
- Oliver, B., & Jorre de St Jorre, T. (2018). Graduate attributes for 2020 and beyond: Recommendations for Australian higher education providers. *Higher Education Research and Development*, 1–16. <https://doi.org/10.1080/07294360.2018.1446415>
- Ovchinnikova, N. E., Ovchinnikova, O. P., & Kharlamov, M. M. (2020). Analyzing Key Tools for Digital Transformation of Educational and Scientific Organizations. In *The International Scientific and Practical Forum “Industry. Science. Competence. Integration”* (pp. 728-735). Springer, Cham. https://doi.org/10.1007/978-3-030-40749-0_86
- Safonov, Y., Usyk, V., & Bazhenkov, I. (2022). Digital transformations of Education policy. *Baltic Journal of Economic Studies*, 8(2), 127-136. <https://doi.org/10.30525/2256-0742/2022-8-2-127-136>
- Samoilovych, A., Garafonova, O., Popelo, O., Marhasova, V., & Lazarenko, Y. (2021). World experience and ukrainian realities of digital transformation of regions in the context of the information economy development. *Financial and credit activity: problems of theory and practice*, 3(38), 316-325. <https://acortar.link/wFa8KZ>
- Sinaga, B., Sahyar, S., Darwin, D., & Rajagukguk, J. (2022, December). Academic Perspective for Digital Transformation of Higher Education in Postgraduate School of Universitas Negeri Medan. In *Proceedings of the 7th Annual International Seminar on Transformative Education and Educational Leadership, AISTEEL 2022*, 20 September 2022, Medan, North Sumatera Province, Indonesia. <http://dx.doi.org/10.4108/eai-20-9-2022.2324606>
- Sousa, M. J., & Rocha, Á. (2019). Digital learning: Developing skills for digital transformation of organizations. *Future Generation Computer Systems*, 91, 327-334. <https://doi.org/10.1016/j.future.2018.08.048>
- Stupak, O. Yu. (2021). Theory and Practice of Developing Youth Social Activity at Civil Society Institutions. (Doctor’s thesis). State Higher Educational Institution “Donbas State Pedagogical University”. Sloviansk.



- https://ddpu.edu.ua/images/stories/news/specrada/25260221/Stupak_dis.pdf
- Sumner, E. (2018). Factors related to college students' self-directed learning with technology. *Australasian Journal of Educational Technology*, 34(4), 29–43. <https://doi.org/10.14742/ajet.3142>.
- Tanushev, C. (2022). Digital Transformation: The Impact on Corporate Strategy. *Economic Alternatives*, 3, 383-404. <https://doi.org/10.37075/EA.2022.3.01>
- Tsekhmister, Y. V., Kotyk, T. M., Matviienko, Y. S., Rudenko, Y. A., & Ilchuk, V. V. (2021). La efectividad de la tecnología de realidad aumentada en la educación STEAM. *Apuntes Universitarios*, 12(1), 250–267. <https://doi.org/10.17162/au.v11i5.932>
- Tsiuniak, O., Pyslar, A., Lialiuk, G., Bondarenko, V., Kovtun, O., Los, O., & Popovych, I. (2020). Research of interdependence of variables and factor structure of masters' readiness for innovative pedagogical activity. *Revista Inclusiones*, 7(3), 427–452. <http://www.revistainclusiones.org/index.php/inclu/article/view/1645>
- Ulas, D. (2019). Digital transformation process and SMEs. *Procedia Computer Science*, 158, 662-671. <https://doi.org/10.1016/j.procs.2019.09.101>
- Xiao, J. (2019). Digital transformation in higher education: critiquing the five-year development plans (2016–2020) of 75 Chinese universities. *Distance Education*, 40(4), 515–533. <https://doi.org/10.1080/01587919.2019.1680272>