RESEARCH ARTICLE

Comprehensive Solution to the Problems of 5g Distance Education in the Context of Artificial Intelligence Challenges

Valentyna Voronkova[1], Vitalina Nikitenko[2], Roman Oleksenko[3*], Halina Harbar[4], Vladyslav Pyurko[5], Tetiana Khrystova[6], Olga Pyurko[7], Liudmyla Arabadzhy-Tipenko[8]

[1,2]Zaporizhzhia National University, Zaporizhzhia, Ukraine
[3*]Volodymyr Vynnychenko Central Ukrainian State University, Kropyvnytskyi, Ukraine
E-mail: roman.xdsl@ukr.net
[4]Mykolaiv National Agrarian University, Mykolaiv, Ukraine
[5,6,7,8]Bogdan Khmelnitsky Melitopol State Pedagogical University, Zaporizhzhia, Ukraine

ARTICLE INFO	ABSTRACT
	This research aims to examine the implications of 5G distance education on both society and individuals, presenting new avenues for cultivating skilled professionals. The focal point of this investigation lies in delineating the potential prospects and obstacles associated with 5G distance education, a multifaceted domain encompassing mobile communication, the Internet of Things, and virtual and augmented reality. The incorporation of mobile learning as a pivotal component within personalised 5G education holds promise in enhancing access to remote learning resources, including live-streamed lectures and virtual classrooms. Furthermore, the fusion of technologies such as the Internet of Things, artificial intelligence, and augmented/virtual reality within the educational sphere is revolutionising learning methodologies, fostering the development of critical thinking and problem-solving skills. By situating the implementation of 5G distance education within the broader context of globalization, digitalization, and the Fourth Industrial Revolution, this study elucidates the requisite conditions for its successful integration. Such contextualization not only enables adaptation to contemporary challenges and opportunities but also catalyzes ongoing refinement and evolution within educational paradigms.

INTRODUCTION

A comprehensive solution to the problems of 5g distance education in the context of artificial intelligence challenges opens up great opportunities for the development of education in the context of the rapid development of the 5G network and the spread of distance learning. The introduction of 5G distance education is associated with increased data transmission speeds, high bandwidth and improved quality of information transmission in the 5G network.

New artificial intelligence capabilities include the development of innovative teaching methods, such as the use of virtual and mixed reality, as well as 4K video lessons. The 5G network in the context of artificial intelligence development provides higher data transmission speeds and greater bandwidth. This opens up new opportunities for the development of distance education, with students and teachers being able to access large amounts of content in real time without delays. The 5G network is the fifth generation of mobile communication networks, which is characterised by high data rates, low latency and high bandwidth, and has significantly improved characteristics that allow data to be transmitted even faster and more efficiently.

The 5G network uses a variety of technologies, including the use of a wide range of radio frequencies, multiple input multiple output antennas (MIMO), frequency division multiplexing (OFDM) and other technologies to improve the speed and quality of data transmission. The 5G network has a wide range of applications, including mobile communications, the Internet of Things (IoT), virtual and

augmented reality, autonomous cars, medical technologies and much more. Its implementation opens up new opportunities for the development of various industries and accelerates the digitalisation of society. However, in today's environment, there are challenges related to accessibility, inclusiveness, data privacy and security, the need for infrastructure and equipment, and digital inequality. To successfully address these challenges, a comprehensive strategy covering technical, social, economic and legal aspects needs to be developed. 5G technologies enable extremely high internet speeds and minimal latency, which can greatly facilitate access to remote educational resources, streaming video lectures, and virtual classrooms.

Thanks to 5G, people in remote areas that previously had problems with access to fast internet can now access high-quality distance education. 5G allows for advanced technologies such as augmented reality (AR) and virtual reality (VR), which can improve the quality of learning and make it more engaging and effective; students can access learning material anytime and anywhere, provided they have a network connection. 5G networks provide extremely high data rates and high bandwidth, which opens up new opportunities for more interactive immersive distance learning environments. Personalised education using 5G aims to improve the accessibility, convenience and effectiveness of learning through advanced technologies. The study helps to find out how 5G technology affects the quality and effectiveness of distance learning, taking into account factors such as data transfer speed, connection stability and the possibility of using innovative methods. The 5G Personalised Education Study identifies new forms and methods of distance learning made possible by 5G technology, such as virtual reality, adaptive learning platforms and interactive lessons.

Personalised education using 5G allows to identify obstacles and challenges that arise in the process of implementing distance education based on 5G technology, such as network availability, digital security and psychological aspects. The 5G network in the context of artificial intelligence development can help improve teaching methods and stimulate active participation of students in the learning process. The use of 5G technology allows for the creation of interactive learning environments with greater student engagement and involvement. The development of 5G AI-powered distance education stimulates global knowledge sharing and cultural interaction, as it allows students and teachers from different countries to communicate and collaborate without boundaries and restrictions. Comprehensively addressing the challenges of 5g distance education in the context of artificial intelligence can contribute to economic development by training highly skilled workers, stimulating innovation and increasing productivity.

LITERATURE REVIEW

The literature analysis shows that the digital challenge is important and stimulating, requiring an analysis of the complex solution to the problems of 5g distance education in the context of artificial intelligence challenges for the formation of the digital economy. The digital challenge, especially in the context of fast-moving technologies such as 5G and artificial intelligence, has a significant impact on the development of modern education and the economy (Buhaichuk et al., 2023).

The formation of a digital education model in the digital economy (based on the example of EU countries) opens up new opportunities for distance education, providing high data transfer speeds and minimal latency. This allows teachers and students to communicate in real time, share video and audio materials, and use interactive learning platforms. the digital challenge in the context of 5G distance education requires a comprehensive approach that combines technological, pedagogical and organisational aspects. Through the effective use of digital tools and innovations in the learning process, it is possible to stimulate the development of a digital person and prepare competitive personnel for the future (Danilyan et al., 2023).

The key economic factors of 5G digital governance are that enterprises are being formed as complex socio-technological systems that need to be adapted to the new socio-economic conditions of the digital society. To verify the complexity of enterprises as complex socio-technological systems, we used the Agile methodology as a complexity methodology that develops on the basis of flexibility and self-organisation methods. This makes it possible to provide access to quality education for people in remote regions, which helps to reduce global inequalities in access to education, and promotes the development of flexible management structures in the context of the digital transformation of the 5G industry (Metelenko et al., 2023).

The development of digital transformation in education based on artificial intelligence has a significant impact on the quality of learning, access to knowledge and individual approach to each student, machine learning algorithms can adapt curricula to the needs of each student, analyse the current level of knowledge, interests, learning style, etc. to offer individualised tasks and materials, which contributes to the development of personalised education (Klopov et al., 2023).

A comprehensive solution to the problems of 5g distance education in the context of artificial intelligence challenges aims to conceptualise the cognitive development of society as a factor of digital transformation. The solution to this problem contributes to the formation of a new theory of 5G distance education, which requires the introduction of innovative technologies that play a very important role in the implementation of a digital model of education that requires a network connection, promotes the network effect, allows people to work in real time, and makes education more accessible to everyone, regardless of place of residence or social status (Nikitenko et al., 2022).

The analysis of articles showed that 5G distance education requires reliable infrastructure, digital literacy, digital competencies and skills for teachers, new approaches to assessment using digital technologies, artificial intelligence in education for personalisation and efficiency of learning (Shparyk, 2021; Shparyk, 2022).

The development of digital transformation in education based on artificial intelligence requires a great deal of effort in collecting and analysing data, developing appropriate algorithms and platforms, and ensuring compliance with security and privacy standards in the learning environment. However, it can bring significant benefits to students and teachers by improving the quality of education and expanding learning opportunities. (Firsova et al., 2024; Yekimov et al., 2023)

RESEARCH METHODOLOGY

A comprehensive solution to the problems of 5g distance education in the context of artificial intelligence challenges uses general philosophical and special scientific methods of cognition, in particular, analysis, synthesis, generalisation and modelling, structural and functional, Agile method, axiological, synergistic Using this methodology, the conceptual foundations of 5g distance education, its impact on society and the individual, which opens up new opportunities for training competitive specialists, are analysed.

5G distance education not only promotes technological progress, but also takes into account the challenges and opportunities of the Internet and artificial intelligence. The identified problems of 5G distance education and ways to overcome them are aimed at ensuring that the development of technology serves the well-being and improvement of the quality of life of society. The use of a systematic methodology can contribute to the development of theoretical models that explain the processes and relationships between different aspects of AI-based distance education.

The strategy of generative artificial intelligence (AI) and the overall digital strategy of education are of great value in the modern world in the context of applying the axiological method and identifying the values of distance education. Generative artificial intelligence can help develop new methods of instruction and learning that meet the individual needs of each student. This may include personalised learning, automated assessment and feedback, and other innovative approaches to learning. Digital education strategies backed by artificial intelligence can help improve the quality of learning and increase student competence.

Data analytics based on artificial intelligence can help identify the strengths and weaknesses of the learning process and respond to them more effectively using the SWOT analysis method. The growing influence of technology on the economy requires that the educational process be adaptive and responsive to the needs of the future workforce.

Artificial intelligence can help to adapt curricula and courses to modern labour market requirements, which can be identified using the Agile methodology. The use of generative artificial intelligence in education can contribute to research in the field of education and the development of new methods and approaches.

Overall, a generative AI strategy combined with a digital education strategy has the potential to change the way we learn, providing more effective, accessible and inclusive education for all. The

research methodology used consists of axiological, comparative, synergistic, structural and functional methods and approaches.

RESULTS AND DISCUSSION

4.1. Prospects and challenges of 5G distance education in the context of using the fifth generation of mobile networks

A comprehensive solution to the problems of 5g distance education in the context of artificial intelligence challenges includes the use of the fifth generation of mobile networks to provide access to learning resources and to deliver learning anywhere with 5G connectivity. This initiative has significant potential for transforming education, but it also faces challenges that need to be addressed in shaping the model of digital education in the digital economy (Buhaichuk et al., 2023). Successfully addressing these challenges requires a comprehensive strategy that includes technical, social, economic and legal aspects. Such an approach will make it possible to maximise the benefits of the 5G network for the development of distance education, ensuring its accessibility and quality for all users.

Table 1 - Prospects and challenges of 5G distance education

Criterion	Prospects	Challenges
Speed and capacity. Accessibility and inclusiveness	Improved data quality: The improved data quality of the 5G network makes it possible to deliver high quality and interactive learning experiences such as 4K video tutorials or virtual reality.	It is necessary to ensure that distance education on the 5G network is accessible and inclusive for all categories of users, including those living in rural and remote regions, as well as people with disabilities.
Development of innovative teaching methods	The speed and low latency of the 5G network stimulate the development of innovative teaching methods, such as collaborative virtual learning, the use of augmented and mixed reality, etc.	The development of distance education using 5G also faces a number of challenges, such as data security issues, uneven access to technology for different population groups, and the need to develop effective pedagogical approaches to using these technologies.
Speed and capacity. Infrastructure and equipment requirements	5G technology delivers fast data speeds and high bandwidth, enabling rapid downloads of large volumes of learning content, including video tutorials and interactive applications.	To be able to take advantage of the 5G network in distance education, the appropriate infrastructure and specialised equipment is required, which can be expensive and difficult to implement.
Virtual and augmented reality capabilities	5G distance education can use virtual and augmented reality to create immersive learning experiences that help learners better understand complex concepts.	Global access to education: Thanks to the mobility and wide coverage of the 5G network, students are able to receive quality education even remotely or in areas with low infrastructure development.
Data security. Data privacy and security	Transmitting sensitive educational information over a 5G network requires robust data security measures to prevent potential threats	Increased data transfer speeds and volumes may increase the threat to the privacy and security of personal information, requiring

	to the confidentiality and integrity of the information	improved data protection mechanisms. The shift to the massive use of distance education, especially through 5G networks, also raises issues with data security and privacy.
Performance and bandwidth Growing data volumes	5G technology provides significantly faster data speeds and higher bandwidths than previous generations of mobile networks. This will allow for more real-time content, including video streams, webinars and other learning resources, providing greater convenience and efficiency for students.	The increased bandwidth of 5G allows you to transmit more video and audio in high quality. This makes it possible to create and use more diverse and interactive learning materials.
Improved interactivity Low latency5 G	5G's enhanced interactivity allows for more interactive learning methods, such as real-time video conferencing, virtual and augmented reality, online project collaboration, and more.	Low latency5 G provides low latency for data transmission, which is especially important for real-time applications such as video conferencing and virtual reality. This enables more interactive learning and communication in online environments.
Increased accessibility Ensuring access to education in remote areas	5G technology provides much better internet access in remote and fragmented areas. This means that people who were previously unable to access quality education due to limited network access can now learn remotely.	Access to quality education is a challenge for many people, especially those living in rural areas or regions with limited access to educational institutions. Thanks to 5G technology, it is possible to provide high-quality distance education even in remote areas where it was previously problematic.
Personalised learning Digital inequality	With the help of data analytics and fast 5G connectivity, personalised learning programmes can be created that take into account the individual needs and learning behaviours of each student.	The introduction of new technologies may deepen the digital divide, as not all users will have access to 5G networks and devices.
Greater mobility Expanding the possibilities of virtual reality (VR) and augmented reality (AR)	Thanks to 5G technology, students can access learning resources and participate in lessons anywhere with network coverage, optimising learning time and space.	1. 5G technology has the potential to make learning in virtual and augmented environments more accessible and effective, as it provides sufficient speed and low latency to transmit large amounts of data in real time.
The need for infrastructure	The introduction of 5G technology requires significant investment in the	Deploying a 5G network and providing the relevant

| Financial costs | relevant infrastructure. This can be a challenge, especially in regions with limited financial resources. | infrastructure may require significant financial outlays for educational institutions and stakeholders. This may be an obstacle for countries or regions with limited budgetary resources |

Table 1 (compiled by the authors)

A comprehensive solution of the 5g distance education problems in the context of artificial intelligence challenges includes the use of the fifth generation of mobile networks to provide access to learning resources and learning in any place with a given connection, where digital human is formed as a product of the information society (Danilyan et al., 2023). This initiative has significant potential to transform education, but it also faces challenges that need to be addressed. A comprehensive strategy covering technical, social, economic and legal aspects is needed to successfully address these challenges.

4.2 Advantages of the 5G network for the development of distance education as a factor in the cognitive development of society

The advantages of the 5G network for the development of distance education as a factor of cognitive development of society are related to accessibility and quality for all users. The introduction of 5G technology in distance education opens up many new opportunities, but also creates a number of challenges that need to be addressed to maximise the digital potential of artificial intelligence (Klopov et al., 2023).

Through the use of advanced technologies such as virtual reality, augmented reality, and artificial intelligence, new learning formats are possible that may be more attractive and effective for students. In general, the use of 5G technology in distance education can lead to higher quality learning and increased student performance through more accessible, interactive and innovative teaching methods. Of course, there are also challenges, such as the need for infrastructure investment and data security, but the overall impact of 5G on distance education is expected to be very positive. Even with widespread 5G network coverage, there may be issues with the availability of modern devices or high-speed internet to all students, leading to a digital divide. It is important to ensure that 5G technologies facilitate the development of flexible governance structures in the context of the digital transformation of Industry 5.0 and are used to improve the quality of education, not just to provide access to content (Metelenko et al., 2023).

It is necessary to develop content that stimulates intellectual development and critical thinking. In general, 5G distance education offers great prospects for improving access to quality education, but it requires a comprehensive approach to addressing the challenges associated with technical, social and pedagogical aspects. One of the challenges of 5G distance education is to ensure an adequate level of interaction between teacher and student. Although 5G technology provides high data transfer speeds, poor audio or video quality can create barriers to effective communication.

There are some disproven or unclear claims about the health effects of high frequency rays emitted by 5G technology. For the successful implementation of 5G distance education, it is important to thoroughly research these aspects and take appropriate safety measures. The use of 5G distance education may lead to a growing sense of social isolation among learners as they interact less with peers and teachers in real time. The introduction of 5G distance education requires a rethinking of the role of the teacher and the introduction of new teaching methods. For this approach to be successful, it is important to provide adequate support and training for teaching staff. Although 5G technology can provide fast access to online resources, it is important to consider the diversity of content and its accessibility for all categories of learners, including those who may have limitations in using certain technologies. All in all, 5G distance education has great potential to transform the learning process, but its successful implementation requires consideration and resolution of various technical, social and organisational challenges. Taking these aspects into account, we can conclude that the development of the 5G network opens up great opportunities for improving distance

education, but at the same time poses new challenges that require the formation of education as a factor in the development of a cognitive society in the context of digital transformation (Nikitenko et al., 2022).

The rapid improvement and growing popularity of generative artificial intelligence capabilities have a significant impact on digital transformation efforts in education. As the main outputs of generative AI are digital, such as digital data, assets, and analytics, these outputs are applied and combined with existing digital tools, tasks, environments, educational processes, and datasets to maximise its impact on distance education. When the generative AI strategy and the overall digital strategy of education can be fully integrated, it will bring enormous benefits to society. On the other hand, given that generative artificial intelligence and its distributed nature are of great importance for scientific research, some experimental research will accelerate the creation of digital value for distance education.

Table 2. Advantages and disadvantages of the 5G network for the development of distance education as a factor of cognitive development of society

Criterion	Advantages	Disadvantages
High speed and minimal delay	The 5G network delivers significantly faster data speeds and low latency, enabling interactive learning content and high-quality video conferencing without interruption	Implementing 5G network infrastructure requires significant investment, which may be beyond the reach of some countries or regions
Greater accessibility	With its higher bandwidth and improved coverage, the 5G network can provide access to distance education to remote and hard-to-reach areas where it was previously a challenge.	Although the 5G network has the potential to provide a higher level of accessibility, in some cases there is a risk of widening the gap in access to education between different social groups.
Advanced virtual and augmented reality capabilities	The use of the 5G network allows for improved virtual and augmented realities, making the learning process more engaging and effective.	With high data rates, there may be security and privacy issues with educational data, which could be an obstacle to the adoption of 5G technology in distance education.
Flexibility	With improved 5G network mobility, students can study from anywhere, allowing for flexibility and convenience	Some people have expressed concern about the potential health effects of electromagnetic radiation from the 5G network
Innovative teaching methods	High data transfer speeds and minimal latency enable new interactive teaching methods such as virtual labs and group projects	In some regions or among certain social groups, there may be limited access to technologies such as 5G networks or related devices due to financial constraints or infrastructure issues

Table 2 (compiled by the authors)

So, while the 5G network has significant potential to improve distance education and the cognitive development of society, it is important to consider and address its shortcomings to maximise the use of this technology. Some educational institutions or educators may be resistant to change and remain within traditional teaching methods, refusing to use the latest technologies. Some educators may feel distrustful of new technologies, especially in relation to the health effects of electromagnetic

radiation or privacy and data security issues. In some cultures or among certain social groups, there may be a strong belief that traditional forms of learning are more effective or preferable to distance methods, and this may be opposed to change. Government policies or regulatory restrictions may slow or limit the development of new technologies in education, including the introduction of 5G networks. These opposing trends can make it difficult or difficult to implement 5G technology in the field of distance education and cognitive development of society. However, understanding these opposites can help to find ways to overcome obstacles and ensure wider inclusive access to education and technology.

4.3. Mobile education as a factor in the development of 5G personalised education

Mobile education and 5G personalised education allows for the access to large amounts of data and learning resources from mobile devices anywhere and anytime. This could spur the development of mobile learning applications and platforms that allow students to learn wherever they are. Some mobile applications may offer responsive programmes, but they are often limited by device and network capabilities. Mobile education and personalised learning can be greatly enhanced by the development of the 5G network. 5G provides high data speeds and low latency, making mobile education more accessible and convenient. Students can easily access learning material from their mobile devices anywhere and anytime. Thanks to mobile access to educational resources, students can study at a time and place convenient for them, which contributes to the flexibility of the learning process. The use of 5G-enabled mobile devices allows for interactive and multimedia teaching methods, such as video lectures, interactive lessons, and learning applications, contributing to digital transformation and secondary education (Shparyk, 2021).

A 5G-enabled mobile education platform. Thanks to the high bandwidth and low latency of the 5G network, mobile learning platforms can be developed that provide fast access to large amounts of video, audio, and other multimedia materials, even when on the move. It provides the ability to access learning materials through mobile devices, enabling learning anywhere there is access to a communication network. With 5G, students can access personalised learning materials that meet their individual needs and interests. The 5G network allows for the transfer of large amounts of data quickly and efficiently, enabling the creation of much-needed personalised learning experiences. Thanks to the low latency and high speed of 5G, students can video conference and communicate with experts and tutors in real time, making learning more efficient and interactive. 5G enables the development of mobile applications that help students learn anywhere and anytime. These applications can include interactive exercises, tests, video tutorials and other learning resources.

Personalised education using 5G includes individualised learning. With 5G, it is possible to deliver large amounts of personalised information to each learner, taking into account their needs, interests and learning style. Personalised 5G education allows large amounts of personalised information to be delivered to a large number of devices simultaneously. This can provide a learning experience tailored to each student's individual needs and pace. 5G-based personalised education systems can adapt to the individual needs of learners by providing materials and tasks that are appropriate to their level of knowledge and pace of learning. With 5G, it is possible to provide quick access to specialised learning resources that meet the specific needs of students.

Personalised education in the context of 5G involves creating a learning environment that adapts to the individual needs, interests, pace and style of each student. The high speeds and low latency of 5G networks allow students to access large volumes of personalised content, including video tutorials, interactive modules and individualised assignments. With a 5G network, it is possible to deliver more dynamic and personalised learning programmes that adapt to individual student needs and progress in real time. Thanks to the high bandwidth and low latency of the 5G network, students can receive feedback and interact with teachers in real time, even while completing assignments or watching videos. Thanks to the high speed of real-time data transmission, students can collaborate more effectively on learning tasks, even if they are located in different parts of the world. Personalised 5G education aims to create a more individualised and adaptive learning environment that takes advantage of high-speed and low-latency networks to optimise the learning experience for each

student, which generally fits into the discourse of digital transformation of European and American education (Shparyk, 2021).

Table 3 - New opportunities for distance education based on 5G technology

	Ways to use 5G technologies
	5G technology provides significantly higher data transfer speeds and low latency. This allows for smooth real-time video playback, seamless remote communication without noticeable lag, and interactive learning platforms without interruption
Virtual and augmented reality	With 5G, students can access virtual or augmented realities, which extends the possibilities of distance learning. For example, they can interact with three-dimensional models, visit virtual laboratories, or even take part in virtual tours.
Increased mobility	Thanks to 5G technology, students can be able to study from anywhere with network access. This allows for greater flexibility and increases the accessibility of education for those who cannot be tied to a specific location.
Improved communication	5G technology allows for better communication between students and teachers, using high quality video conferencing and other means of real-time communication
Innovative teaching methods	Using 5G technology, one can experiment with new teaching methods, such as group projects, collaborative work on virtual projects and other interactive forms of learning
Automation and data mining	Using 5G, it is possible to collect and analyse large amounts of data from learning processes, enabling course improvement, personalised learning and a better understanding of student performance

Table 3 (compiled by the authors)

New 5G-based distance education capabilities can significantly improve the distance education experience, providing a fast, interactive and accessible learning process for all. Generative AI has the potential to change the way all educational institutions compete, helping to democratise the information and skills of schoolchildren and students, and will be promoted in a wide range of roles and types of educational spaces; thanks to the natural textual model of generative artificial intelligence, educators will be able to effectively use huge data inside and outside the educational institution, because big data is the competitiveness of educational institutions and individuals. However, it is also important to consider challenges such as network availability and data privacy when using such technologies (Schwab Klaus, 2019).

CONCLUSIONS

The conceptual significance of the study includes the impact of artificial intelligence as a major progressive technological force on the development of pedagogical practice in general and 5G distance education. The results of the study can contribute to the improvement of curricula, methods and technologies used in distance education, which will lead to an improvement in the quality of learning. The development of distance education based on 5G technology can help ensure access to education for all segments of the population, including those living in remote or underdeveloped regions.

The use of advanced technologies in distance education can increase the competitiveness of educational institutions and help train qualified personnel to meet the needs of the Fourth Industrial Revolution. The research can contribute to the development of innovative potential in education, stimulate the development of new technologies and approaches, which contributes to the further development of society.

Distance education based on 5G technology creates unique opportunities for learning anytime and anywhere, which contributes to the development of the concept of lifelong learning and raising the level of education in society. The research and implementation of new technologies in the field of distance education can contribute to the development of this industry, which in turn stimulates investment, creates new jobs and promotes innovation in the sector. The development of modern

distance education based on 5G technology can increase the country's competitiveness in the international arena by creating conditions for training highly qualified personnel and attracting foreign students.

REFERENCES

Buhaichuk, O., Nikitenko, V., Voronkova, V. (2023). Formation of a digital education model in terms of the digital economy (based on the example of EU countries). *Baltic Journal of Economic Studies*, Vol. 9, Number 1, 53-60.

Danilyan, O., Dzeban, O., Kalynovskyi, Y. (2023). Digital man as a product of information society. *Cogito*. Vol. 15. Iss. 1. 142-159.

Yekimov, S., Salkova, D., Sharov, S., Belotserkovskaya, N., Oleksenko, R., Kompanets, E. (2023). Training of teachers for teaching in the conditions of distance education. In *E3S Web of Conferences* (Vol. 420, p. 10042). EDP Sciences.

Klopov, I., Shapurov, O., Voronkova, V., Nikitenko, V., Oleksenko, R., Khavina, I., Chebakova, Y. (2023). Digital Transformation of Education Based on Artificial Intelligence. *TEM Journal*, *12*(4), 2625. - 2634.

Metelenko, N., Klopov, I., Voronkova, V., Nikitenko, V., Oleksenko, R., Brytvienko, A., Runcheva, N. (2023). Development of Flexible Management Structures in the Context of Digital Transformation of INDUSTRY 5G. *[ref]: vol.21.2023. available at: https://refpress.org/ref-vol21-a221/.*

National report on the state and prospects of education development in Ukraine: monograph (2021) / National Academy of Pedagogical Sciences of Ukraine; [editors: V. Kremen (chairman), V. Luhovyi (deputy chairman), O. Topuzov (deputy chairman)]; edited by V. Kremen. Kyiv: CONVI PRINT. 384 p.

Nikitenko, V., Voronkova, V., Oleksenko, R., Andriukaitiene, R., Liudmyla, H. (2022). Education as a factor of cognitive society development in the conditions of digital transformation. *Revista de la universidad del zulia*. Núm. 38(13), 680-695

Shparyk, O. (2022). Digital transformation of secondary education: common strategic vectors of the USA and EU countries. *Ukrainian Pedagogical Journal*. (3). 33-43.

Shparyk, O. (2021). Conceptual foundations of digital transformation of education: European and American discourse. *Ukrainian Pedagogical Journal*. (4). 65-76.

Schwab, K. (2019). *The Fourth Industrial Revolution, Shaping the Fourth Industrial Revolution*. Kharkiv: Family Leisure Club. 426p.

Firsova, N., Bezkorovaina, O., Oleksenko, R., Chernenko, O., Tsukanova, N., Dubinka, M., Mykhailov, A. (2024). Improving the quality of education based on the system of continuing education. In *E3S Web of Conferences* (Vol. 538, p. 05002). EDP Sciences.