Informatization and digitization of the educational process in higher education: main directions, challenges of the time

Informatización y digitalización del proceso educativo en la enseñanza superior: principales orientaciones, retos de la epoch

Yaroslava Sikora
iaroslava.sikora@gmail.com
https://orcid.org/0000-0003-2621-6638
PhD in Pedagogy, Associate Professor at the Department of Computer Sciences and Information Technologies, Faculty of physics and mathematics, Zhytomyr Ivan Franko State University, Ukraine.
Oksana Skorobahatska
oksanaarttim@ukr.net
https://orcid.org/0000-0002-5072-5195
PhD in Pedagogy, Associate Professor of the Department of Educational Management and Pedagogy of the Higher School, Faculty of Pedagogy and Psychology, Sumy State Pedagogical University named after A.S. Makarenko, Sumy, Ukraine.
Hanna Lykhodieieva
annvl@ukr.net
https://orcid.org/0000-0002-2065-0217
PhD in Pedagogy, Associate Professor, Head of Department of Higher Mathematics, State University of Telecommunications, Kyiv, Ukraine.
Anatolii Maksymenko
maksimap@ukr.net
https://orcid.org/0000-0002-6892-4766
Doctor of Science in Pedagogy, Vice-Rector for International Relations,
Full Professor, Department for International Relations, Kyiv National Linguistic University, Kyiv, Ukraine.
Yaroslav Tsekhmister
info@naps.gov.ua
https://orcid.org/0000-0002-7959-3691
Scopus Author: https://www.scopus.com/authid/detail.uri?authorId=3574716590
Doctor of pedagogical sciences Professor, Ed. D, PhD National Academy of Educational Sciences of Ukraine, Kyiv, Ukraine.

Abstract

The relevance of the study is due to the need to rethink the educational paradigm in a rapidly developing digital environment. Given the creation of new information and digital learning technologies, scientific paradigms are changing towards the formation of an innovative educational infrastructure of HEIs. The article aims to investigate the main directions of the challenges of

implementing informatization and digitalization in order to form an ecosystem of an innovative educational environment. The article is based on the use of methods of theoretical pedagogical research: analysis, synthesis, induction, and deduction. The study of scientific literature showed that, despite the large number of scientific papers covering the issues of informatization and digitalization, the question of the need to bring modern educational standards to the realities of a digital society still remains unresolved. The results of the study were the actualization of the main challenges and directions of implementation of informatization and digitalization of higher education in order to improve its efficiency in the modern conditions of development of society. Practical significance: the study of the features of the practical implementation of the tools of the digital educational environment and the disclosure of their benefits.

Keywords: digital environment, educational technology, digital innovation, higher education, blockchain, MOOC.

Resumen

La pertinencia del estudio se debe a la necesidad de replantear el paradigma educativo en un entorno digital en rápido desarrollo. Dada la creación de nuevas tecnologías de la información y el aprendizaje digital, los paradigmas científicos están cambiando hacia la formación de una infraestructura educativa innovadora de las IES. El objetivo del artículo es investigar las principales direcciones de los retos de la aplicación de la informatización y la digitalización para formar un ecosistema de entorno educativo innovador. El artículo se basa en el uso de métodos de investigación teórica pedagógica: análisis, síntesis, inducción y deducción. El estudio de la literatura científica mostró que, a pesar del gran número de artículos científicos que abordan las cuestiones de la informatización y la digitalización, la cuestión de la necesidad de adaptar las normas educativas modernas a las realidades de una sociedad digital sigue sin resolverse. Los resultados del estudio fueron la actualización de los principales retos y direcciones de la aplicación de la informatización y la digitalización de la educación superior con el fin de mejorar su eficiencia en las condiciones modernas de desarrollo de la sociedad. Importancia práctica: el estudio de las características de la aplicación práctica de las herramientas del entorno educativo digital y la divulgación de sus beneficios.

Palabras clave: entorno digital, tecnología educativa, innovación digital, enseñanza superior, blockchain, MOOC.

1. Introduction

The modern world has entered the era of the fourth industrial revolution, Industry 4.0, which imposes special conditions on the implementation of most activities. First of all, the modifications have affected the industrial and economic sectors in general, but their transformation is not possible without the training of qualified personnel. Focusing on global informatization and digitalization, there is a need for more extensive training of subject matter specialists. It is no secret that in the realities of the XXI century, the key resource is relevant, reliable information, including the ability to search and analyze it. Professional perception and processing of the received information allows organizing the educational process more effectively and efficiently.

Despite the existing strategies of development in the field of education and the formation of modern methods and techniques of education, the issue of transition to distance learning is the

most acute. The COVID-19 pandemic has made significant adjustments, especially in terms of accelerating this transition. And the war in the center of Europe has shown the need for further development of the distance form of education. Of course, the formation of a clear and coherent system capable of seamless communication between educators and students within a few months is almost impossible. The main limitations arising in the process of adaptation to the forms of distance learning can be described by several characteristic aspects, namely the lack of equipment with digital means of communication, weak digital literacy, lack of self-organization, etc. It should be noted that these problems can still be attributed to both teachers and students.

There are also difficulties due to the rigid requirements for educational programs. The systems of educational standards do not have sufficient flexibility and only recently they began to be reconstructed to fit the new formats of education. It is quite obvious that the introduction of any changes in the standards is inert and unable to solve all the problematic issues instantly.

If we talk about higher education institutions, the degree of their readiness can be considered as a maximum. This is primarily due to the extramural and distance learning programs already being implemented, as well as part-time programs with partial or full use of e-learning. The situation in secondary vocational and secondary general education is less encouraging because, first, not all programs can be digitized, and second, this transition is complicated by technical unpreparedness for its implementation (Williamson, 2021).

The prospects of information and digital transformation of education are most logically considered on the example of higher education institutions, since this approach, as described earlier, has a positive experience of a real implementation. In addition, some global features characterize the digital environment of HEIs (Figure 1) and allow a segmented study of approaches to the formation of the new learning process in the field of distance learning.
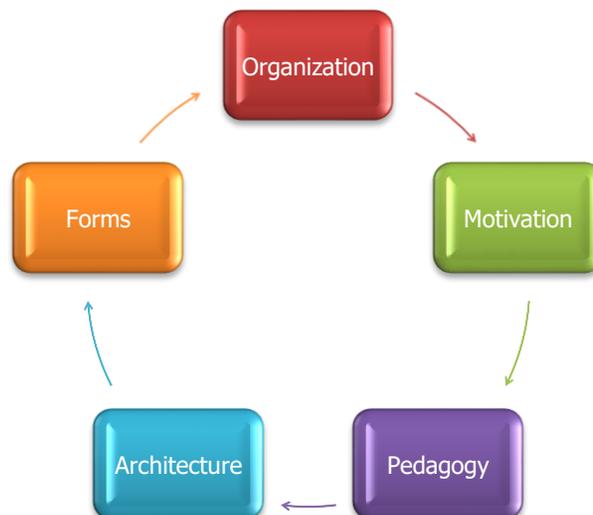
Figure 1. Conceptual model of the digital environment of higher education institutions
Developed by the authors of the article based on content analysis

Some of the blocks in the picture most clearly reflect the real picture of current digital learning. The transition from indivisible courses to microformats is already being actively implemented in many digital learning platforms. Obsolete approaches based on long-term fundamental disciplines are hardly implemented in a distance format due to the low level of audience coverage and high threshold of entry. Passive listening is now insufficient for rapid mastery of academic subjects.

Only active student action can lead to the greatest productivity and maximum learning impact. In a digital environment, the emphasis must be on personalizing the student and pushing back on personality traits, which precludes the use of single learning tools. This requires a larger pool of resources and more time (Selwyn, Pangrazio, Nemorin & Perrotta, 2020).

The aim is to investigate the main directions and challenges generated by the informatization and digitalization of the educational process in higher education.

2. Literature Review

Today the issue of informatization and digitalization of education in higher education is dealt with by a significant number of scientists from different scientific fields (pedagogy, psychology, computer science, sociology, etc.). The article by Kryvoshein, Vdovenko, Buriak, Saienko & Kolesnyk (2022) examines the implementation of informatization and digitalization in the professional training of future managers. The authors of the article cover the experience of EU countries. To study the peculiarities of the introduction of information technology in the educational process, it is important to rely on the study of the effectiveness of digital learning technologies. Thus, the article by Horytska (2022) examines the effectiveness of the index approach to learning. With the beginning of a large-scale military invasion of Ukraine, special attention is paid to the peculiarities of the functioning of the distance form of education. The article by Sherman, Puhovskiy, Kambalova, & Kdyrova (2022) examines the peculiarities of distance education organization in Ukraine during martial law. The authors draw attention to the high efficiency of this form of education using digital educational technologies and note that the future of education is associated with a comprehensive informatization of education. Wallin, Koro-Ljungberg, & Eskola (2019) discuss the use of digital technology in the study of history disciplines. The authors point out that informatization and digitalization methods open up new possibilities for the study of historical sciences. Prospects for the development of digitalization in education are discussed in Suoranta et al., (2022). The authors give a forecast of the development of digital education in the future. Also, the article by Mishchenko (2022) considers the prospects of digital education development in Ukraine. Particular attention is paid to the need to introduce innovative digital technologies in distance learning. The authors consider the most popular informatization and digital means of organizing the educational process. Particular attention is paid to the need to develop information and communication and digital competencies of both teachers and students HEA. Jandrić et al., (2019) consider the development of digital science in the future. The authors pay special attention to the transformation of the educational sphere under the influence of the development of future digital technologies. A significant role in this process, according to the authors, will play innovative learning technologies and the development of integrated digital educational devices. The article Wojciech, Sobczyk, Waldemar, & Pochopień (2021) examines the specifics of preparing teachers to implement innovative digital technologies in the educational process. The authors investigated the digital competencies necessary for HEA

workers to organize the educational process by means of informatization and digitalization. The article also considers the main didactic tools of digitalization of higher education. The authors highlighted popular innovative digital technologies, informatization tools, etc. Also, of particular interest for this study are the works devoted to the study of the experience of the educational process during the COVID-19 pandemic. Rosak-Szyrocka, Żywiołek, Zaborski, Chowdhury, & Hu (2022) discuss the main problems related to the educational process during the pandemic. Attention is also paid to the peculiarities of using digitalization tools for the educational process in a distance education setting. Rapanta, Botturi, Goodyear, Guàrdia, & Koole (2021) address the issue of the educational process after the pandemic. The authors explore the balance between digital innovation technologies and didactic teaching methods. Despite the large number of works devoted to informatization and certification of the educational process, there are still a low number of unresolved issues. The scientific literature does not cover the issue of creating a new educational paradigm, which would take into account the need to use digital tools during the organization and conduct of training in the HEIs.

3. Methodology

Using interdisciplinary methods, the organizational forms and features of the infrastructure of digital transformation were analyzed, which allowed to acquire a new quality of research, actualizing its perspective and relevance. The completeness of the study was ensured by the use of modern comparative methods, actualized in the context of source and comparative historical, analysis of scientific literature, legislative and other legal acts. Specific tools were also used for comparative-historical research: the integrity and completeness of information, spatial and temporal correspondence were analyzed. Visibility, representativeness of the results of scientific research provided the use of applied methods of digital humanities: content analysis, visualization of research results. The basis of scientific research was the source analysis of Internet resources, in particular - periodicals, of different types and kinds of organizations, analysis and comparison of their relevant indicators (quality, quantity, etc.), ranked by us in the synchronous and diachronic plane; scientometric analysis of articles in the above periodicals (journals, scientific collections, almanacs, and conference materials); visualization of results through methods of information data visualization (representation) and summarization of the results.

The core materials of our work were the Ukrainian legal framework, in particular: 1. The concept of digital transformation of education and science in Ukraine (Ministry of Education and Science of Ukraine, 2021). 2. Strategy for 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 No. 1556-VII, 2014). The above-mentioned normative legal acts helped to identify the current state, trends, and prospects of development of the process of digital transformation of education and science of the Ukrainian state. Scientific research had a number of stages: the first stage consisted in the analysis of the source base of research (scientific literature, regulatory framework) and the outline of goals and objectives of scientific work; the second - aimed at analyzing the state of digital transformation of the educational and scientific sphere of the Ukrainian state, highlighting the key features and trends of development, representation of the most representative forms of influence of the above process on the educational and scientific area of Ukraine; the third stage summarized the results of the study: it organized the conclusions

and highlighted his own vision of the prospects of digitalization of the educational and scientific sphere of the Ukrainian state.

4. Results and Discussion

The core of the learning process is intensive independent and interactive work of the student with the learning material, including video lectures, slides, methodological recommendations for the study of the discipline, and the implementation of control tasks, final testing, and final tests. E-learning is the implementation of educational programs using information and educational and digital resources, information and communication technologies, technical means, as well as information and telecommunication networks that ensure the interaction of participants in the educational space.

In today's information society, the main means of informatization and digitalization are a personal computer, an interactive whiteboard, software, etc. With the help of networked means of digitalization of education, it becomes possible to conduct virtual training sessions online, audio and video conferencing. A new generation of educational information technology has emerged that allows for more effective teacher-student interaction (Rahrouh, Taleb, & Mohamed, 2018).

Distance learning dates back to the 1920s. With the advent of information technology, e-learning is getting better. At the present stage, the problem of the gap between the possibilities of educational technologies and their actual application in educational institutions is evident. The situation is complicated by the rapid updating of ICTs (the emergence of artificial intelligence, multilingual interface, virtual reality, geoinformation systems). In addition, the informatization of education is slowed down by the relatively low competence and psychological unpreparedness of teachers and the administration of educational institutions (especially the older generation), as well as the insufficient equipment of educational institutions with information and communication technologies. The creation of organizational and methodological support in the field of educational technology is closely connected with the system of training and retraining of personnel in education, as well as with the material and normative base of ICTs (Jensen et al., 2022).

Informatization of education is often understood exclusively as the introduction of information and telecommunication technologies into the educational process. However, training only in the technical aspects of computer use does not cover all the activities of educational institutions. Students also need to know how to correctly select and use educational electronic resources.

The use of digital tools makes it possible to introduce new specialized computer-related curricula into educational programs, as well as to transform traditional programs not directly related to information technology. The processes of determining the qualifications of graduates, selection, and formation of the contingent of HEI students are increasingly informatized.

One of the main results of the informatization of education is total individualization, in which both positive and negative sides can be distinguished. Individual approach to a student positively influences the quality of education. However, "dialogue through the computer" significantly reduces the activity of language, which is the body of objectification of human thinking. The

widespread use of digital technology leads to a reduction in social interaction, the curtailment of social contacts (Ledger & Fischetti, 2020).

In recent years, the development of computer technology has led to the allocation of hardware group of multimedia. Their characteristic feature is the ability to process and provide information of different types. Multimedia tools are particularly important for education, because they stimulate cognitive aspects of learning, increase motivation, develop skills of collective cognition, and form a deep understanding of the material. Thus, further informatization levels out the shortcomings of the years of introduction of computer technology in education and allows the implementation of educational technology at a new level.

The educational process becomes more flexible with the appearance of great opportunities for modeling expensive or dangerous experiments ("virtual reality"), visualization of macro- and microcosm. The emergence of global telecommunication computer networks and their integration with multimedia and virtual reality technologies is called the sixth information revolution. At present, the total volume of knowledge in the world is doubling annually. Colossal volumes of information in electronic educational resources detach from the material, borrowing ready-made solutions and works do not contribute to the effectiveness of learning. In addition to technical and psychological, there are problems of a pedagogical nature associated with the lack of consistency in the development and use of disparate information resources. The effectiveness of the learning process is also reduced because of the impossibility of universal training of teaching staff in the conditions of modern informatization.

There is an urgent need to create a unified system of information resources and technologies supplemented by uniform methodological requirements and recommendations. Most of the information resources for use in the educational process are characterized by a low pedagogical level. The reason for this situation is that computer-based instructional programs are often created by experts in programming and not in a particular discipline. At the same time, teachers with extensive teaching experience are usually poorly versed in new information and telecommunication technologies. The goal of informatization of education is to train subject teachers who are capable not only of applying new technologies in their professional activities but also of developing ICT tools.

Currently, higher education is a process of teaching and scientific leadership, but soon there will be a transition from direct instruction to mentoring, and further to research coordination. Common trends in modern education can be considered to be:

– increasing its inclusiveness;
– individualization of education;
– "reduction" of educational trajectories (offering educational solutions in a compact form);
– opportunities for a student to master several modules (macro-courses) at once;
– application of interdisciplinary approaches in education, development of interdisciplinary cooperation in the design and implementation of relevant educational programs.

Digital trends in higher education include:

- application of virtual reality technology in addition to the existing distance technologies;
- The transition from the formation of hard skills to soft skills, which involve the development of creative thinking, the desire to develop, and the ability to organize themselves (especially for students of technical specialties);
- elimination of interference in related branches of knowledge (economics and law, etc.) based on digitalization;
- application of online technologies in the educational process, allowing "individualization" of students' learning trajectories, especially for people with disabilities;
- penetration of online education elements into the traditional system (offline) of education. For example, the use of the Skyeng educational environment for teaching English.

Digitalization of education today is built based on creative thinking, imagination, the desire to develop. The task of higher education is to promote the formation of creative skills, which today is more important than formal knowledge. The task of the teacher (tutor/mentor) is to give the student an impetus for development. The digitalization of the educational process also affects the organizational aspects of HEIs:

- increasing the efficiency of research management;
- automation of management processes at the university;
- application of distributed ledger technology (blockchain) for secure storage and rapid transfer of information. In many ways, virtual and augmented reality technologies, online management of the educational organization, big data technologies allow collecting information about the needs of students based on demand/supply, adapting educational programs (Saienko, Kurysh & Siliutina, 2022).

The digitalization of the higher education system is based on:

1) Digital transformation of the educational process itself as an environment for implementing the latest methods, techniques, and means of learning to ensure the training of highly qualified professionals with the skills and ability to confidently solve professional problems using modern software and information and communication technologies.
2) Digital transformation of higher education system management, including the introduction of advanced information technologies in the processes of implementation of management functions of educational institutions (the use of artificial intelligence in predicting the progress of students, the needs of the economy of young professionals in the context of specialties, etc.); organization of the use of educational resources of institutions (application of cloud technologies to form a unified educational network) and the promotion of their educational services at the international
3) Improvement of ICT competence of higher education teachers, as well as specialists of state administration bodies that implement policies in the field of education.

Digitalization in education offers many opportunities, but at the same time requires changes in methodology, approaches to student learning. In particular, we are talking about open access to electronic educational resources of universities, performed at a high level. For example, the use of educational platforms: Coursera, Alison, Prometeus, etc.

Mentioning mass online educational courses (MOOCs), it can be noted that they are built into professional and educational programs in different ways. Three scenarios can be distinguished:

1) MOOCs as web support for the traditional implementation of the educational process. To intensify the latter, up to 30% of resources are allowed using MOOCs.
2) Blended learning involves the partial replacement of classroom sessions (mostly lectures) with MOOC resources (up to 80% online).
3) Online learning, involving academic freedom, replacing traditional learning with MOOCs with a mentor/ tutor (up to 90 to 100% online) (Tsekhmister et al., 2021).

When it comes to MOOCs, universities are reluctant to use someone else's online education platforms and are not themselves ready to completely switch to an online format. In addition to university platforms, the corporate sector is also willing to offer its own educational platforms (Udemy, etc.). Table 1 compares the most popular distance education systems.

Table 1.
Comparison of distance education systems

Program product name/evaluation parameter	eLearning Server 4G	Moodle	WebTutor
License	Commercial	Open	Commercial
Architecture	Closed	Open	Closed
Number of users	Unlimited	Unlimited	Unlimited
Schedule control	+	+	+
Forum	+	+	+
Chat	+	+	+
Different types of verification	+	+	+
Mobile version	-	+	+

Developed by the authors of the article based on content analysis

The B2B and B2C education segment often experiences a shortage of personnel, particularly methodologists for the development and implementation of educational projects. Corporate educational services are characterized by the following specific features:

– practice-oriented, consumer-oriented;
– application of the "experts teach the experts" model;
– Evolution from online education to consulting, business coaching;
– online education is built into the business process, contributes to the long-term perspective of the business;
– active use of referral, adaptive, supportive services;
– Partnerships with other organizations implementing the concept of "B2B and B2C education" (Jarke & Breiter, 2019).

Blockchain is a distributed storage system where storage devices are not connected to a common server. This database stores an ever-growing list of ordered records called blocks, each block

contains a timestamp and a link to the previous block. Thanks to encryption, the user can only modify the part of the database that he owns, from which he has "private keys", without them it is impossible to write to the file. Encryption also ensures that all copies of the database are synchronized across all users so that if a blockchain is edited all changes are immediately visible to other users.

The security of blockchain technology is ensured through a time-stamping decentralized server and peer-to-peer connection networks. The result is a database that is managed autonomously, without a center. This makes blockchains very convenient for logging events and data transactions, identity management, and source authentication.

Blockchain technology is being seriously considered for use in education. The list of services provided by admissions committees and dean's offices is extensive, covering both primary work with applicants and organizational support of students, including academic trips. Depending on the size and structure of the HEA, the list can include traditional tasks as well as specific responsibilities (credit accounting for transfer students, escorts, time management training, financial aid, etc.) (Jarke & Breiter, 2019).

Blockchain, even at the admission stage of the HEA, will be able to make fraud related to falsification of grades, legitimacy of athletic and other achievements, grounds for benefits, misrepresentation of personal data, etc., impossible. In addition, blockchain will help popularize and legitimize online learning, which will greatly reduce unemployment worldwide: giving people who have no offline education a chance to get an online education (Rahardja, 2022).

Studies of the scientific literature have established that the key socio-psychological features of the formation and implementation of the digital model of higher education can include the following:

1) Changes in the social role of the teacher and approaches to its performance. Firstly, from a primary source, a carrier of knowledge and skills, he becomes a navigator, determining the optimal trajectory for the purposes of the course acquaintance with the knowledge bases. Secondly, the teacher must develop the ability to prepare educational products that deliver learning information to the audience in the form of an intense stream that includes simultaneously broadcast, text, graphics, video, and sound. In addition, his attitude to digital technologies should also change: from the means that complement traditional teaching approaches to new ways, technologies of training specialists with higher education.

2) Changing the motivation of learning and the approach to students' mastery of knowledge. Firstly, the dynamism of social processes and the shortage of time give rise to the desire to get the essence of events and problems in a short time, which leads to the formation of "clip" thinking. Secondly, frequent use of "on-demand" information search system from a multitude of simultaneously operating information sources creates conditions for consolidation of fragmentary type of perception of learning information. This approach allows us to study a certain aspect of the phenomenon under study, but it can make it difficult to form a unified view, cause-and-effect relationships, and the genesis of the development of the situation. Third, the desire to solve many problems simultaneously in a limited time allows you to develop problem-solving thinking. In such a situation, students do better with collaborative

projects than with individual tasks; they strive to get quick result, avoiding long-term planning of step-by-step work. Fourthly, the individualization of the learning process and the content of training sessions based on information educational resources contributes to the development of self-learning skills and self-monitoring of knowledge as elements of individual student manageability. Fifthly, the level of digital literacy of a student becomes a key factor ensuring academic success and success in various activities, as well as determines the nature of his communication in interaction with others.

3) Transformation of the system of requirements to specialists' competencies. Firstly, abilities and skills that are not available for full algorithmization and robotization (imagination, non-standard, initiative, leadership, etc.) become the most demanded. Secondly, there is a need to form "digital competencies of the future" (language mobility, cooperative-creative thinking, ability to work in interdisciplinary environments, understanding of global problems, health management skills, financial literacy, etc.) (Dumford & Miller, 2018).

In conclusion, we can identify the main advantages of digital learning using distance learning technologies:

1) Freedom of access. The student gets the opportunity to study almost anywhere without interruption of the main work. Distance learning using information and digital technologies allows teachers and students to be at a considerable distance from each other, including in different cities and countries. Access to learning materials is available at any time of the day or academic period.

2) Personalization of learning. Involvement of people with disabilities in learning, equal education opportunities regardless of financial security. New technologies allow making visual information alive and dynamic, building the learning process itself, taking into account the active interaction of the student with the learning system.

5. Conclusions

Education is a field that, in theory, and practice, cannot stand still. Through it passes a huge flow of people who are ready for the challenges of real life. And despite the fact that the system of digitalization of education is not ideal, we can offer several ways of solving this problem. In the next decade, digital technologies in education will help improve the work of educational organizations due to new developments in information and communication technologies.

One of the purposes of informatization of the educational process is the creation of a uniform information space of an education system on a national scale as a result of the integration of information environments of educational institutions. Pedagogical information technologies used for its functioning are based on the theory of pedagogy, psychology, computer science, management, as well as the possibilities of modern information and telecommunication technology. An educational portal is currently being developed at many ZHEs. In the future, the local informational educational space will become part of the world one. The introduction of information technology accelerates the transfer of knowledge and experience, increases the quality of education, helping people adapt quickly and successfully to the environment and social changes. Informatization has a positive impact on education, opening up new opportunities in improving the forms and methods of the educational process.

The value of knowledge as a foundation for personal growth in the era of computer networks and electronic reference books has significantly decreased. Most mental tasks today are taken over by computers. What is required from a modern person is not so much memorization, storage, and reproduction of information as the ability to navigate in information flows, be flexible in intellectual activity, learn new strategies of thinking, self-learn, search, and attract the missing resources to solve problems. That is why it is important for modern students not to get a ready-made set of knowledge, but to develop skills of self-development and self-education.

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