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OPPORTUNITIES FOR THE DEVELOPMENT OF HIGHER EDUCATION UNDER THE INFLUENCE OF DIGITAL TECHNOLOGY: PROSPECTS OF EDUCATION 4.0

OPORTUNIDADES PARA O DESENVOLVIMENTO DO ENSINO SUPERIOR SOB A INFLUÊNCIA DA TECNOLOGIA DIGITAL: PERSPECTIVAS DA EDUCAÇÃO 4.0

OPORTUNIDADES PARA EL DESARROLLO DE LA ENSEÑANZA SUPERIOR BAJO LA INFLUENCIA DE LA TECNOLOGÍA DIGITAL: PERSPECTIVAS DE LA EDUCACIÓN 4.0

Farida GAZIZOVA [1]
farida.gazizova@mymail.academy
Andrey CHUNIKHIN [2]
achunikhin@mymail.academy
Artemiy KOZACHEK [3]
kozachek@mymail.academy
Ekaterina MUSSAUI-ULIANISHCHEVA [4]
e.v.mussaui-ulianishcheva@mail.ru
Rustem SHICHIYAKH [5]
shichiyakh@mymail.academy
Natalia GUBANOVA [6]
gubanova@mymail.academy
Nadezhda KOL'COVA [7]
nkolcova@internet.ru

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[1] Kazan Federal University, Kazan - Russia. Associate Professor, Head of the Department of Theory and Methodology of Early Childhood and Primary Education at the Elabuga Institute.

[2] Russian Medical University, Moscow - Russia. Professor in the Department of Surgical Dentistry and Implantology.

[3] Tambov State Technical University, Tambov - Russia. Associate Professor in the Department of Nature Management and Environmental Protection.

[4] Russian Peoples' Friendship University (RUDN University), Moscow - Russia. Associate Professor in the Department of Foreign Languages.

[5] Kuban State Agrarian University named after I.T. Trubilin, Krasnodar - Russia. Associate Professor in the Department of Management.

[6] Moscow Polytechnic University, Moscow - Russia. Professor in the Department of Economics and Organization.

ABSTRACT: The article aims to present and characterize the leading and most popular digital technologies for supporting the educational process in higher education and to show the opportunities and prospective applications arising in the context of Industry 4.0, whose inextricable element is its relationship with technological progress. The paper outlines the current state of higher education didactics in light of advancements in information technology. It describes the principal aspects of teaching with a reliance on educational portals, mobile learning, and Web 2.0. Given the incremental advancement of scientific and technological progress, the authors examine the influence of Industry 4.0 technologies on higher education and the associated prospects of Education 4.0 in higher education. The

[7] Kuban State University, Krasnodar - Russia. Senior Lecturer in the Department of Business Economics, Regional Management and Human Resources.

study concludes that newly emerging professions require teaching new competencies, and introducing Industry 4.0 technologies in higher education necessitates profound changes, which becomes a challenge for the Russian education system.

KEYWORDS: Educational technologies. Industry 4.0. Education 4.0. E-Learning. Mobile learning.

RESUMO: *O objetivo deste artigo é apresentar e caracterizar as principais e mais populares tecnologias digitais de apoio ao processo educativo no ensino superior, além de explorar as oportunidades e aplicações futuras que surgem no contexto da Indústria 4.0, cuja característica fundamental é a relação intrínseca com o progresso tecnológico. O documento descreve o estado atual da didática no ensino superior à luz dos avanços das tecnologias da informação, abordando os principais aspectos da didática com base em portais educativos, aprendizagem móvel e Web 2.0. Dado o avanço gradual do progresso científico e tecnológico, os autores analisam a influência das tecnologias da Indústria 4.0 no ensino superior e as perspectivas associadas à Educação 4.0. O estudo conclui que as novas profissões emergentes exigem o ensino de novas competências, e que a introdução das tecnologias da Indústria 4.0 no ensino superior demanda mudanças profundas, representando um desafio significativo para o sistema educacional russo.*

PALAVRAS-CHAVE: *Tecnologias educativas. Indústria 4.0. Educação 4.0. E-Learning. Aprendizagem móvel.*

RESUMEN: *El artículo pretende presentar y caracterizar las principales y más populares tecnologías digitales de apoyo al proceso educativo en la enseñanza superior y mostrar las oportunidades y aplicaciones prospectivas que surgen en el contexto de la Industria 4.0, cuyo elemento inextricable es su relación con el progreso tecnológico. El artículo esboza el estado actual de la didáctica en la enseñanza superior a la luz de los avances en las tecnologías de la información. Describe los principales aspectos de la enseñanza con una dependencia de los portales educativos, el aprendizaje móvil y la Web 2.0. Dado el avance progresivo del progreso científico y tecnológico, los autores examinan la influencia de las tecnologías de la Industria 4.0 en la enseñanza superior y las perspectivas asociadas de la Educación 4.0 en la enseñanza superior. El estudio concluye que las nuevas profesiones emergentes requieren la enseñanza de nuevas competencias, y la introducción de las tecnologías de la Industria 4.0 en la enseñanza superior exige cambios profundos, lo que se convierte en un reto para el sistema educativo ruso.*

PALABRAS CLAVE: *Tecnologías educativas. Industria 4.0. Educación 4.0. Aprendizaje electrónico. Aprendizaje móvil.*

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INTRODUCTION

The dynamic development of technologies has significantly expanded their capabilities in practically every sphere of human life. Advanced technologies have also been incorporated into education, successfully improving the quality and practicality of learning (Novichkov et al., 2022; Shichkin et al., 2024b). The current discourse on the future of higher education must take into account the changes resulting from the advance of technologies associated with Industry 4.0, whose expectations for the labor market are linked to newly created sectors in the economy (Vasilev et al., 2020). Human beings' relationship with the products of modern technology can enrich their experience, allowing them to explore the real world from physically inaccessible perspectives (drones), expand their perception of the real world (augmented reality), replace it (virtual reality), or simulate it (Oztemel & Gursev, 2020). Today, technology physically connects to people, creating an integrated system, and the concept of computer-based education is gradually being replaced by enabling technologies (Akhmetshin et al., 2021; Lichtenthaler, 2021).

With the advance of communications and information networks, a global economy based on networks and information has emerged (Abdullayev et al., 2024; Kamble et al., 2018). We are living in a period of transformation and dynamic change driven by new technologies, especially the Internet (Carneiro et al., 2019), and the social consequences of network interaction (Abdullaev et al., 2023; Mamedova et al., 2019).

Progress in engineering and technology has substantially impacted the functioning of the modern human being (Filipova & Koroteev, 2023). Industry 4.0 is associated with the accelerated development of the Internet, mobile tools, and intelligent systems (Shumakova et al., 2023; Xu et al., 2019).

Modern solutions, including digital, information, and communication technologies, are driving changes in the education system. Studies highlight the importance of Education 4.0, based on various digital technologies (such as big data, network technologies, and the Internet of Things) (Dahdouh et al., 2019; Khan & Alqahtani, 2020) and new processes (such as artificial intelligence) (Sadiku et al., 2021). Technologies such as AI, machine learning (ML), digital doubles, and 5G play a key role (Vikhman & Romm, 2021; Vuta, 2021).

The implementation of Industry 4.0 technologies involves significant changes in the requirements for professionals who interact through networks with intelligent systems, machines, and their products (Koh et al., 2019; Pivneva et al., 2023). Industry 4.0 requires professionals qualified in the use of digital technologies, as well as specialists responsible for the design and development of these capabilities. (Shichkin et al., 2024a). Currently, the demand for qualified professionals has grown significantly, especially for programmers specialized in building AIs, analysts responsible for developing, interpreting, and managing

data, and specialists in cloud platforms. In addition, there is a growing demand for social media professionals, including content creators, authors, copywriters, and AI specialists such as business analysts and programmers using Python and JavaScript. Qualified e-commerce professionals are also in demand, covering areas such as e-commerce and digital marketing, as well as information recruiters, among others (Piccarozzi et al., 2024).

Education 4.0 needs to meet the demands of the labor market and the revolutionary changes underway (Guntur et al., 2020). The most relevant skills for professionals include digital skills, technological and computer knowledge, mastery of programming for robotics and automation solutions, and the ability to work with digital tools (Agaev et al., 2023). In addition, analytical thinking, innovation, learning ability, solving complex problems, creativity, originality, and initiative are essential, as are leadership skills, social influence, and mastery of the use of technology (Elmqaddem, 2019; Safiullin et al., 2024).

In 2018, the concept of T-shaped skills emerged, which refers to professional training that combines in-depth knowledge in a specific area with expanded competencies in related areas (Klochkova & Sadovnikova, 2019). With the growing interaction between workers and intelligent machines, the need for socio-emotional skills is also increasing (Vikhman, 2022). Research indicates a hybrid set of expectations in the modern job market, where the most valued professionals are highly motivated, intuitive, good listeners and familiar with management techniques. In the future, the ability to use ready-made software developed by third parties and manage information systems will be crucial (Gizatulina, 2024). The value of knowledge in manipulating and processing information has grown, with the aim of making it useful and accessible for analysis using computer programs. In this context, the use of specialized knowledge, the identification of interrelationships between information, and the ability to synthesize (Shatskaia, 2021) become essential.

Thus, higher education, in line with contemporary requirements, makes it easier to enter the job market, while the lack of such qualifications can lead to exclusion and marginalization (Appakova-Shogina et al., 2024).

In this sense, we have formulated the hypothesis that digitalization and Internet access will exert a growing influence on higher education, causing changes in the content of educational programs. However, these transformations are not restricted to the digital format or technological tools. The content itself is being reformulated to meet the demands of Industry 4.0, incorporating interdisciplinary approaches, challenges based on real-world problems, and the development of skills such as data analysis, programming, design thinking, and ethical reasoning in the use of technology. Educational programs are gradually shifting their focus from the static transmission of knowledge to the dynamic development of competencies, contextual learning, and the creation of personalized trajectories based on student performance. The theoretical modules are being enriched with case studies,

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simulations and collaborative digital projects, reflecting the evolution of the job market and digital society.

The study aimed to *objective* outline and characterize the main and most popular digital technologies used to support the learning process in higher education, as well as highlighting the possibilities and prospects for their application in the context of Industry 4.0, whose connection with technological progress is an essential element.

The *research objectives* were:

1. Analyze the current state of didactics in higher education in the light of advances in information technology;

2. Examine the impact of Industry 4.0 technologies on higher education and the prospects for Education 4.0 in this context.

METHODOLOGY

The use of digital technologies in Education 4.0 was analyzed through documentary research and the analysis of information sources using the methods of comparative analysis, synthesis, and abstract-logical generalization.

The study was based on bibliographical sources published in the last six years. The data analyzed included articles and reviews published in scientific journals indexed in the Scopus and Web of Science databases. The search was carried out using keywords and combinations of terms such as “educational technologies,” “Industry 4.0”, “Education 4.0”, “e-learning,” “mobile learning,” “Web 2.0 in education,” and “digital technologies,” in both English and Russian.

The purpose of the study was to synthesize the findings related to the following research questions: What is the current state of didactics in higher education in the face of advances in information technology? What impact will Industry 4.0 technologies have on higher education, and what are the prospects for Education 4.0 in this context?

The research was conducted in two stages. First, the sources of information needed to meet the study’s objectives were selected. In the second, based on an analysis of the selected scientific literature, we determined the current state of didactics in higher education in the face of the development of information technology, the impact of Industry 4.0 technologies on higher education, and the prospects for Education 4.0 in the university context.

RESULTS AND DISCUSSION

Didactics of higher education in the light of advances in IT: current situation

The current state of IT implementation in higher education is largely based on e-learning educational platforms, mobile learning technologies, and the Web 2.0 concept.

E-learning platforms can be understood as "broad Internet-based applications that facilitate the creation, delivery, and administration of educational courses" (Agaev et al., 2023, p. 5, our translation). In the IT market, various solutions and standards describe these platforms. From a technological point of view, the most common division is as follows (Gizatulina, 2024):

- LMS *(Learning Management System*): the main objective of this system is to automate the administration, management and reporting of all activities related to the training process;
- LCMS (*Learning Content Management System*): this system is designed to create, store and share learning resources, produced in the form of objects;
- LCS (*Life Communication System*): the main task of these systems is to ensure effective communication between all course participants.

One of the most popular and widely used e-learning platforms is Moodle (Borodina et al., 2022), which combines LMS and LCMS functions.

Technological advances have created new opportunities for accessing and sharing information (Togaibayeva et al., 2022). Mobile technologies have revolutionized the perception and understanding of various spheres of modern life. Modern *smartphones* are communication devices and multimedia tools, that offer many functions that were previously inaccessible (Bozhkova et al., 2024).

The application of technological achievements in various areas of life, including education, was a natural evolution. According to Klochkova and Sadovnikova (2019), mobile learning is carried out and supported through portable devices (*handheld*) and mobile technologies, such as *smartphones* or devices with access to wireless networks.

There are two main ways in which mobile learning systems are perceived and implemented. The first is mobile learning, which is seen as a form of distance learning technology implemented on the basis of specialized means of communication.

In the second approach, this solution is seen as a component of the hybrid learning model, i.e. face-to-face training enriched with additional forms of e-learning.

By analyzing various examples of these solutions, we concluded that mobile learning systems are often considered aids in the learning process. Mobile learning puts technological and hardware solutions at the center of its operation. This form of learning should not be

treated in isolation or independently of other didactic elements. On the contrary, the recommended approach allows the solution to be integrated with other systems used in education.

The development of Internet technology has opened up new possibilities for the construction and use of learning support systems. From solutions based on fixed text and possibly graphics, the Internet has evolved into an interactive space, with the user at the center, becoming not only a consumer but also a creator of information (Kabzhanova et al., 2024).

A new chapter in the history of Internet technologies is the creation and dissemination of the Web 2.0 concept, which relates to sites where content created and edited by users plays a central role. The community online platforms are an ideal extension of one of the pillars of education: learning to live together and interact with others. (Carneiro et al., 2019). To meet this requirement, the student must have teamwork skills, be able to collaborate, and be interdependent. These elements represent the closest approximation to the vision of 21st century education, based on Internet technologies (Berdibaev et al., 2024).

Web 2.0 now underpins many educational platforms and is widely used in the educational process (Polozhentseva et al., 2024). Among the most common and widely used elements are social networking sites, collaborative work sites (Wiki), and live broadcasts.

Social networking sites are used to collect and catalog data and information, as well as offer opportunities to meet people with similar interests, including professionals. A common feature of social networking sites is that they are free to use and allow the cataloging and sharing of resources based on permissions. These networks have great educational and creative potential, promoting community building, collaboration, and access to sources of knowledge.

Group work sites (wikis) are platforms that allow multiple users to collaborate in the creation of content. A Wiki system is a Content Management System that facilitates the publication of content in a simple way. It offers various features derived from the open source ideology, allowing people to collaborate with permissions, editing articles or entries. Wiki's main educational objective is to support learning through collaboration in the creation of educational resources.

Live broadcasts (webcasts) are Internet-based multimedia transmissions that take place in real-time, allowing interaction between the participants and the presenter. The viewer can influence the form and amount of information presented.

Web 2.0 has several consequences for education (Mamedova et al., 2019). It changes the way the participants in the educational process communicate and interact. The wide range of applications and systems available makes it possible to adapt solutions to users' specific needs. As a result of using Web 2.0, the teaching and learning paradigm is changing (Akhmetshin et al., 2024). The learner becomes the central element, directly impacting the way education is delivered. This, in turn, affects the ability to provide personalized content, adapted to the specific needs of each student.

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Web 2.0 has given rise to new forms of distance learning and expanded the possibilities for applying advanced technologies in the educational process.

New technologies in Education 4.0 and trends in Education 4.0 in higher education

The educational capabilities of AI have been described in many studies (Sadiku et al., 2021). Some applications of AI in the educational environment include data collection and analysis, control over the learning process, AI-generated student performance predictions, implementation of *adaptive* software, real-time performance analysis, as well as learning management systems (LMS), *learning bots* (virtual teachers), and cognitive tutors. These solutions make it possible to reduce the exclusive dependence of educational institutions on the teaching process.

One example of the use of AI in education is learning supported by *learning* bots. Communication between humans and *bots* is a complex system with interactive characteristics. Studies on *bots* in foreign language learning have shown their effectiveness in improving vocabulary and increasing interest in learning (Piccarozzi et al., 2018). Research also indicates that learning supported by this technology speeds up the resolution of cognitive tasks and promotes a positive perception of learning (Guntur et al., 2020).

New inventions are opening up previously unknown possibilities for application in education. Augmented reality, virtual reality, drones, computer modeling, robots, and AI-based learning programs allow us to see the world and knowledge from a new perspective (including physics).

The changes in education caused by global digitalization can correct the existing education system, fundamentally reorganize it, or offer multiple solutions. These changes have the potential to address several long-standing limitations of the current education system. Corrections involve increasing flexibility, promoting learner-centered approaches, and ensuring that educational content and formats reflect the skills needed in the digital economy. Thus, digitalization not only offers a technological improvement, but also an opportunity to review and modernize the fundamental structures of education, which no longer meet contemporary social and professional needs.

The correction of the educational system, which implies the introduction of new technologies into the traditional learning model, has not yet had an impact on the modernization of education at all levels. The discrepancy between science, technology, its dynamic development, the actual state of education and the level of knowledge of teachers is difficult to overcome. New technologies require changes in teaching methods and forms, and this facet of change is being implemented in educational institutions.

With regard to the fundamental reorganization of the higher education system, we know that this process cannot be carried out without changes to the programs, contents, methods, and forms of education, taking into account social and cultural needs and focusing on the use of new technologies in the educational process.

Change, understood as multiple solutions, presupposes the adoption of attitudes based on different educational models. This perspective leads to the abandonment of the traditional classroom system in favor of teaching and learning based on the network society, with the Internet playing a central role in the acquisition of knowledge and interaction between individuals.

Digitalization and Internet access have a growing influence on higher education, directly impacting the content of educational programs. Today, it is already possible to describe the trends that will be increasingly present in higher education:

- Education will be geared towards the needs of Industry 4.0, with a focus on developing vocational training in line with the demands of the labor market (Trubitsyna et al., 2024; Akhmetshin et al., 2021);
- We can expect a shift from the traditional classroom system to the wider use of cyberspace, which will require special attention to the characteristics of the students, also taking into account the social environment (Guntur et al., 2020);
- Subject-based education will be softened and eventually abandoned in favor of interdisciplinary and problem-based learning (Gizatulina, 2024);
- A greater focus is expected on the frequent use of gamification and on classes that rely on new technologies such as the Internet and VR (Vikhman & Romm, 2021);
- An important aspect will be the combination of interpersonal and group communication with the development of intellectual and psychomotor skills;
- The importance and accessibility of AR and VR-based learning tools and software, as well as interactive learning, is set to increase;
- Learning will be based on the meaning and context of the information, with the construction of knowledge based on this principle (Sadiku et al., 2021);
- There will be an emphasis on student activities aimed at creating knowledge and resources, such as carrying out independent projects and creating portfolios using information from the Internet (Kabzhanova et al., 2024);
- Teaching and learning processes will focus on solving the problems of using the Internet and its resources, including social tools (Mamedova et al., 2019);
- Self-education skills will be developed through new educational technologies (Agaev et al., 2023);
- There will be a focus on individualization and the use of AI-based tools to analyze

students' academic performance, such as data mining in education and considering teaching styles in didactic design (Polozhentseva et al., 2024).

These anticipated developments reflect a paradigm shift in higher education away from rigid structures and towards more flexible, personalized, and technology-integrated models of teaching and learning. Although these projections are based on current literature and observed practices, future empirical research will be essential to validate and evaluate the impact of these changes in different educational contexts. Many of these trends involve a transformation in the design of educational spaces and the creation of classrooms in which students will work more freely in teams.

FINAL CONSIDERATIONS

The development of the information society and changes in lifestyles, as well as the perception of many everyday issues, have imposed a change in the approach to education. The potential of contemporary technologies opens up a wide range of opportunities for their implementation in modern education. The miniaturization and increased efficiency of mobile devices are creating new possibilities for their use in the learning process, providing unlimited access to knowledge, regardless of time and place. Today, educational portals form the backbone of education at many Russian universities. The development of communities around these portals, in addition to modern technical achievements such as Web 2.0, has been fundamental. Web 2.0 is based mainly on social networking sites, group work sites (Wiki), and webcasts, and the changes brought about by Web 3.0 are awaited with even more interest, as they could change the current methods of using the Internet in the learning process.

Today's students need knowledge that combines theory, skills, and practical application. Adapting education to the changes taking place under the influence of cutting-edge digital technologies and Industry 4.0 requires significant transformations in educational policies. These transformations involve the allocation of public financial resources for new computer equipment, educational software, updated textbooks, and extensive teacher training in the use of technology in academic subjects. Special attention should be paid to educational technologies (methodologies) and the introduction of AI-based tools and software into the educational process.

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