

UDC 37.09

JEL I21; I29; J20

PROCESSES OF DEVELOPMENT OF INTELLECTUAL SYSTEMS IN EDUCATION

Roman Soviak, Vasyl Antoniv

*Ivan Franko National University of Lviv,
18 Svobody Ave., Lviv, 79008,*

e-mail: Roman.Soviak@lnu.edu.ua; ORCID: <https://orcid.org/0009-0008-7776-7839>

e-mail: Vasyl.Antoniv@lnu.edu.ua; ORCID: <https://orcid.org/0000-0003-4259-4129>

Abstract. *The purpose of the study is to reveal new possibilities, that can be used during the development of intelligent systems in education. The objectives of the article are: to clarify the essence of AI in education, to reveal its role in education processes, especially in online studying, determine methods and ways, that could be applied for more effective studying. The study's findings showed that AI technologies offer significant opportunities for the education field, but their adoption in educational institutions is still limited. Prospects for further research on this issue are the study of the last scientific results, which referred to the using AI in education and determining new ways of integrating new technologies in studying. All of that should have a significant positive impact on studying results and the education system.*

Keywords: *studying, online education, Artificial intelligence, Learning Analytics, Machine learning, Data mining.*

Introduction. Throughout the years online studying becomes more and more popular and important. Technologies, that provided online studying are rapidly increased in the last few years. Covid-19 was one of the most important factors that affected on the development of online studying. Teachers and students met with different problems and collisions during pandemic period. We can use the last achievements in artificial Intelligence such as virtual and augmented reality, the Internet of things, etc. for improving this situation and make studying more effective. We should know how to use these technologies effectively and it is necessary to ensure the availability of these technologies for all schools and teachers and teach them how to use it in the educational process. Development of distance education, online courses, libraries with online access, and its implementation in the educational process are important as well.

Analysis of recent research and publications. A significant number of scientific works of foreign and domestic researchers are devoted to the problems of the development of educational intelligent systems, using AI for increasing students' performance and improving studying by using new technologies.

In particular, Muhammad Ali Chaudhry & Emre Kazim's research describes the Revolutionizing of using AI in the education sphere [1].

The article of Asmat Ara Shaikh a, Anuj Kumar b, Kruti Jani c, Saloni Mitra d, Diego A. García-Tadeo e, Agilandeswari Devarajan [21] shows the Role of Machine Learning and Artificial Intelligence in education and its impact on Education during Covid-19. The review of Lijia Chen; Pingping Chen; Zhijian Lin [2] provides information about new approaches that could be obtained in the context of using AI.

Noting the significant results of scientific achievements, it should be noted that several theoretical and practical issues of adopting AI in education need further study and analysis. This applies, first of all, to clarify the problems of integration of AI in the studying process and using AI technologies for improving the acquirement of knowledge for students, and better interaction between teachers and learners.

Methods. In the article, the following scientific methods were used: systematization, generalization, analysis, and leveraging literature review as a research design. These methods were used to investigate the processes of development of intellectual systems in education mainly focused on AI.

Results. In recent decades, technological progress has completely revolutionized the world we live in. Industry experts assert that the next significant digital transformation in our way of life, communication, occupation, business, and learning will be driven by Artificial Intelligence (AI) [24]. The advancements made in computing and information communication technologies have significantly evolved over time, ultimately resulting in the emergence and development of artificial intelligence. Many scientists gave AI different determinations. Coppin defines Artificial Intelligence as the ability of machines to adapt to new situations, deal with emerging situations, solve problems, answer questions, devise plans, and perform various other functions that require some level of intelligence typically evident in human beings[3]. AI can also be determined as a computer-based system that can accomplish specific tasks through a set of capabilities (such as speech or vision) and intelligent actions that were once believed to be exclusive to humans[16]. Devedžić noted that research and development efforts in Web Intelligence (WI) and Artificial Intelligence (AI) are concentrated on various factors. These include implementing machine learning to establish distributed intelligence, achieving equilibrium between Web technology and intelligent agent technology, promoting agent self-organization, and enabling learning and adaptation, among other aspects. These WI and AI characteristics can be harnessed to facilitate advancements in the education sector [22].

Certainly, artificial intelligence has been adopted and has penetrated numerous departments within the education sector. The use of artificial intelligence in education ('AIEd') has resulted in significant effects such as enhanced efficiency, globalized learning, individualized and tailored learning, intelligent content, and amplified effectiveness and efficiency in the administration of education, among other benefits [11].

When we mention artificial intelligence in education, it often conjures up images of a supercomputer possessing immense processing capabilities that incorporate adaptive behavior and sensory inputs. This enables the computer to emulate human-like cognition and functionality, which in turn enhances its interaction with human beings. In the education

sector, there has been increasing use of artificial intelligence beyond the traditional view of AI as a supercomputer, to encompass embedded computer systems. Artificial intelligence (AI) will have a significant role in shaping the way we teach and learn new skills. One aspect of AIED is its potential to automate and monitor learners' progress in these skills and identify areas where a human teacher's intervention is necessary. For educators, AIED can help identify the most effective teaching methods based on students' learning backgrounds and contexts. It can automate repetitive tasks, create assessments, and automatically grade and provide feedback. AI not only impacts what students learn through recommendations but also how they learn, identifying learning gaps, determining the most effective pedagogies, and improving learner engagement.

In these cases, teachers act as the 'human-in-the-loop,' and AI's role is only to support teachers in making informed decisions by providing predictions about students' performance and recommending relevant content with teachers' approval.

We can consider a system named SAGLET developed by Segal [18]. SAGLET uses an approach that is employed to display and simulate students' actions to educators in real time, allowing them to intervene more efficiently and promptly. The main goal of using AI here is to equip teachers with the ability to improve students' learning results. In a similar vein, Rodriguez and colleagues have demonstrated how teachers as the 'human-in-the-loop' can personalize multimodal learning analytics, making them more efficient in blended learning settings [15].

Use of these systems is rapidly increasing, especially after Covid 19. People generate tons of data for ed-tech companies on which they can build AI systems. So, we can say that the pandemic had an impact on introducing innovations in the learning process, online studying, and interaction between students and teachers.

AI is used in an intelligent tutoring system, that can be considered as a computer program that tries to mimic a human teacher to provide personalized learning to students [12, 9].

There has been a longstanding anticipation for Intelligent Tutoring Systems (ITS) to effectively facilitate learning. However, over time, it has become apparent that there is a notable discrepancy between the initial expectations of ITS and their actual capabilities in practice [4].

ITS in contemporary times have primarily been designed to cater to specific subjects or topics, with examples including ASSISTments, iTalk2Learn, and Aida Calculus.

Despite the constraints of their specific subject domains, individual Intelligent Tutoring Systems have demonstrated their efficacy in delivering appropriate content, engaging with students, and ultimately enhancing academic performance [5].

AI has promoted the efficiency of teaching and learning by improving the quality of instructional methods. Learner-centric programs like DeepTutor and AutoTutor utilize AI to provide personalized content that is tailored to the unique needs and abilities of individual learners. By doing so, they enhance the learning experience and promote the attainment of learning goals. Moreover, AI plays a significant role in disseminating course content throughout the entire process, including curriculum development and the delivery of instructional materials in online and web-based learning platforms.

In modern times, the study of AI and machine learning has largely focused on their applications in mobile devices, to improve computational quality and create prospects for new functions such as speech recognition, facial unlocking, virtual reality, and natural language translation. However, the implementation of machine learning mandates substantial computation capability to facilitate complex training and learning processes. As a solution to this obstacle, certain frameworks have been suggested to support computationally efficient operations. We should mention the Snapdragon Neural Processing Engine, to hasten the execution of neural networks utilizing their GPU processors launched in 2016 by Qualcomm. Also, the HiAI platform for running neural networks was proposed by HiSilicon. Regarding the learning network associated with AI, SqueezeNet, MobileNet, and Shufflenet have been extensively developed for mobile phones [8].

The technological advancement of AI in mobile devices has brought mobile education to new heights, offering greater convenience by enabling students to learn more quickly and achieve interactive and personalized learning experiences. Virtual reality is one example of this, as it allows the learning process to extend beyond the traditional classroom and creates a global learning environment by connecting students to virtual classrooms. Additionally, AI-powered chatbots provide personalized online learning, turning instructors into chat conversations that can assess students' comprehension levels. AI-facilitated education encompasses intelligent education, inventive virtual learning, and data analysis and prediction. The primary scenarios of AI in education and the critical technologies that underpin them are outlined in Table 1. Intelligent education systems provide prompt and customized guidance and feedback for both instructors and learners, designed to improve the value and efficiency of learning through various computing technologies, particularly those related to machine learning that are closely tied to statistical models and cognitive learning theory [7].

Table 1

Techniques for Scenarios of AI Education [2]

Scenarios of AI education	AI-related techniques
Assessment of students and schools	Adaptive learning method and personalized learning approach, academic analytics
Grading and valuation of paper and exams	Image recognition, computer-vision, prediction system
Personalized intelligent teaching	Data mining or Bayesian knowledge interference, intelligent teaching systems, learning analytics
Smart school	Face recognition, speech recognition, virtual labs, A/R, V/R, hearing and sensing technologies
Online and mobile remote education	Edge computing, virtual personalized assistants, real-time analysis

Incorporated into AI systems for learning analysis, recommendation, and knowledge acquisition are diverse techniques, including machine learning, data mining, and knowledge modeling[17]. As shown in Figure 1 the AI education system is generally composed of instructional content, data, and intelligent algorithms that can be bifurcated into two sections: the system model (comprising of the learner model, teaching model, and knowledge model) and intelligent technologies [23].

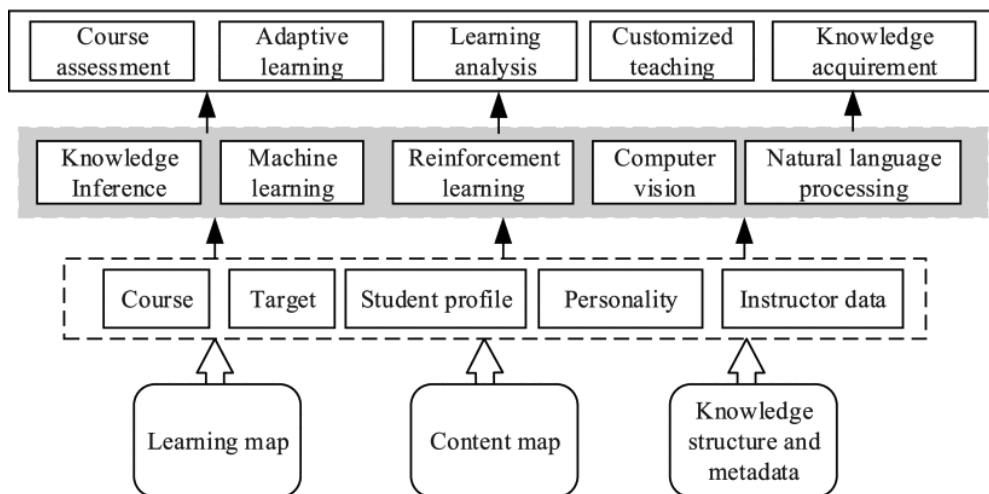


Fig. 1. Technological structure of AI education

In an AI learning system, the learner model plays a pivotal role in enhancing independent learning skills. It is created using behavioral data generated by learners throughout the learning process. Learners' thought processes and capabilities are analyzed to evaluate their learning abilities, and knowledge analyses are mapped to determine the learners' knowledge mastery. The learner model establishes a connection between learning outcomes and various factors, including learning materials, resources, and teaching approaches [17].

Machine learning, learning analytics, and data mining are interrelated technologies in the field of education.

The essence of machine learning lies in knowledge discovery, which entails analyzing a sampled data set, referred to as the «training data», to generate structured knowledge and meaningful patterns. One of the key applications of machine learning in education is to assist students in selecting courses and universities by providing personalized recommendations. This technology makes use of data on students' achievements, preferences, and aspirations to «match» them with institutions that can best foster their development. By utilizing machine learning techniques, instructors can tailor their teaching methods based on students' cumulative records, leading to a better understanding of course material. Moreover, machine learning can be employed for student assessment, where image recognition and predictive analytics can help to grade assignments and exams more quickly and accurately than human graders. Some widely used techniques in machine learning include decision tree learning, inductive logic programming, clustering, reinforcement learning, and Bayesian networks.

The aim of learning analytics is to customize educational approaches to the unique requirements and skills of individual learners. This includes taking action with students who are at risk and providing personalized feedback and instructional materials [20]. AI-based competency learning can extract valuable data from students, allowing institutions to make proactive decisions about the critical competencies that students should pursue. In addition,

learning analytics can leverage AI's ability to learn, using various parameters to predict the likelihood of student drop-out and provide early warning systems for institutions. However, the challenge for learning analytics is to extend beyond academic skills and assess a broader range of competencies, such as interpersonal skills and the arts, which presents a new level of complexity in terms of measurement and assessment. Another challenge is to apply learning analytics to specific learning contexts while maintaining enough generality to be used across different courses and institutions. Learning analytics will continue to be used more widely and incorporate advanced techniques to support students, instructors, administrators, and institutions.

Data mining is a valuable tool for enhancing the learning process and mastery of knowledge by revealing hidden patterns and allowing for predictive modeling. This results in a greater understanding of the educational environment and learners, enabling educators to make improvements to curriculum development. Data mining can be applied to extract insights from knowledge field data, allowing for personalized learning experiences for students who can learn at their own pace and according to their preferred learning style, with the assistance of AI. Personalized learning allows students to choose what interests them, while educators adjust their teaching methods and course material to align with their students' interests. Through data mining and the use of machine learning, AI can enhance its intelligence, resulting in more reliable outcomes[23].

AI has been integrated into educational institutions in diverse approaches such as automation of administrative processes, content development, curriculum creation, and students learning processes. AI helps teachers with reviewing students' work, grading, and providing feedback on assignments through automation using web-based platforms or computer programs. Virtual and Augmented reality, robotics, web-based platforms, video conferencing, and 3-D technologies are used for students to learn better. It creates a more efficient and effective educational experience. Students break physical barriers posed by national and international borders because learning materials could be found on the Internet and the World Wide Web. Nowadays learning resources are available globally, and the use of other AI tools such as language translation technologies enables students to learn more effectively within the context of their individual skills and capabilities.

AI is also widespread in online education. In the research of Kahraman, Colak, and Sagirolu, the authors explored the evolution and utilization of AI in education, specifically in the form of adaptive and intelligent web-based educational systems (AIWBES). These systems are increasingly taking the place of the basic use of the internet and the world wide web, which they refer to as the simple «just-put-it-on-the-web» approach[7]. AIWBES refers to the integration of AI principles and technology into web-based learning platforms to improve learners' experiences. Peredo et al. also discuss the integration of AI into web-based platforms, which they describe as intelligent web-based education (IWBE). They note that IWBE is a significant component of education, particularly with the increasing popularity of online education, and that it leverages the power of the platform as a pedagogical tool that incorporates AI into web-based education (WBE) and other intelligent methods, tools, and theories for modeling engineering agent-based systems and technologies [14].

According to their research, IWBE takes into account a range of factors, such as the learner's knowledge and skills, learning style, performance capabilities, and compatibilities, to create and implement a platform that enhances the teaching and learning experience.

AI can function as an evaluation tool to assess and grade papers and exams, which in turn saves teachers time. Additionally, it can assist students in navigating through various content paths and tailor learning experiences to their individual strengths and weaknesses. Table 2 illustrates the various roles that AI can fulfill in educational settings, including administration, instruction, and learning.

Table 2

The Functions AI Provides in Educational Scenarios

	The work AI can do in education
Administration	<ul style="list-style-type: none"> ● Perform administrative tasks faster that consume much of instructors' time, such as ● grading exams and providing feedback. ● Identify the Teaming styles and preferences of each of their students, helping them build personalized learning plan. ● Assist instructors in decision support and data-driven work. ● Give feedback and work with students timely and directly.
Instruction	<ul style="list-style-type: none"> ● Anticipate how well a student exceed expectations in projects and exercises and the odds of ● dropping out of school. ● Analyze the syllabus and course material to propose customized content. ● Allow instruction beyond the classroom and into higher-level education, supporting ● collaboration. ● Tailor teaching method for each student based on their personal data. ● Help instructors create personalized learning plans for each student.
Learning	<ul style="list-style-type: none"> ● Uncover learning shortcomings of student and address them early in education. ● Customize the university course selection for students. ● Predict the career path for each student by gathering studying data ● Detect learning state and apply intelligent adaptive intervention to students.

One of the key areas in education, identified as likely to be impacted by AI, is the performance of different administrative tasks. students' assignments and papers reviews, grading, and providing feedback to students are the most important of them. According to Sharma et al. AI in education, particularly in the distance and online education, where AI has enhanced efficiencies in institutional and administrative services. Indeed, specific programs, such as Knewton, ease the burden on instructors because they provide a platform for feedback to students premised on the interaction on the platforms. Similar positions are evident in other studies and publications, which discuss systems that make administrative tasks easier [13].

Teaching or instruction is one of the main areas, where we can use AI. In the work «Letting artificial intelligence in education out of the box: Educational cobots and smart classrooms», Timms explores the different ways that AI can be used in education, specifically as a pedagogical tool or instructional platform. One of these applications involves simulation-based instruction,

which utilizes various technologies, such as virtual reality, to visually illustrate concepts or provide practical demonstrations, allowing students to gain experiential and hands-on learning experiences [11]. Mikropoulos and Natsis in their work draw attention to the educational benefits of utilizing virtual reality, 3-D technology, and interactive simulations as pedagogical tools. These tools can provide students with a clearer understanding of complex concepts by allowing for immersive and interactive demonstrations [19]. Incorporating AI technology into machines or robots has been the focus of various studies, which have emphasized the development of effective instructional tools and the enhancement of pedagogical approaches. The use of robots as teacher assistants and collaborators, known as cobots, has the potential to assist with basic to advanced teaching tasks, including teaching students how to read and properly pronounce words [11]. Artificial Intelligence (AI) enables humanoids and other robots to possess cognitive and decision-making capabilities, as well as the ability to engage in dialogue and conversation. Consequently, these machines can be utilized as educational and instructional tools.

The study also encompasses the topic of learning, which is another fundamental aspect of education. The use of AI in education has addressed the challenge of limited access to learning opportunities caused by factors such as national or international boundaries. Through online and web-based platforms, AI has made it possible for learners across the globe to access education and learning opportunities without being hindered by geographical limitations [13]. A significant contribution of AI to enhancing students' learning experiences is through the customization and personalization of curriculum and content that aligns with their individual needs, abilities, and capabilities [19].

As an intelligent system, it would be intriguing to examine the impact of AI on the effectiveness of educators and learners. With the growth in student enrollment at educational institutions, AI technology can alleviate the workload of instructors. AI systems can aid educators in scrutinizing the course outline and curriculum to suggest tailored course material [10]. These intelligent systems can also produce and assess tests by scrutinizing data. Consequently, this would relieve instructors to deal with more urgent concerns, such as evaluating student performance. In personalized teaching and self-directed learning, AI solutions can analyze learning data more effectively, ultimately enabling instructors to develop individualized learning plans for each student. An emerging issue for AI in education is human partiality. AI solutions can appraise papers and exams using predetermined criteria and standards to combat partiality. This can be accomplished through AI systems that are based on computer vision, which can read and recognize handwritten documents. Apart from reducing partiality, such systems can also prevent students from engaging in cheating and plagiarism [10].

Through the analysis of student data, AI systems have identified areas where students are struggling and can address these issues at an early stage of their education. Traditional educational systems tend to treat all students in a similar fashion [6]. Therefore, using the same teaching approach for all students is unlikely to yield optimal results. With the help of AI, the most effective teaching methods for each student can be determined based on their individual traits, strengths, and complementary abilities. In doing so, all students can improve

and experience more enjoyable learning outcomes. Furthermore, AI systems can enhance students' learning capacity, habits, and creativity while also expanding their knowledge base. By collecting studying data, AI systems can predict each student's career path and, as a result, customize their university course selection. By taking into account each student's unique abilities and career aspirations, this approach can help students earn better grades and acquire skills that are more applicable to the real world.

Conclusions. The main target of this study was to assess the impact of AI on education, which affects students' development and determines the ways of further development of education. The problem of adopting AI is one of the keys to modern education. This study focuses on the adoption and use of artificial intelligence (AI) in the education sector, specifically within educational institutions.

The primary focus of the analysis was to assess how artificial intelligence (AI) has been utilized and the effects on administrative, instructional, and learning aspects of education. Artificial intelligence (AI) has had a significant influence on the education sector, beginning with the introduction of computers and computer-related systems, followed by web-based and online education platforms. Today, embedded systems allow for the use of robots such as cobots and humanoid robots as teacher colleagues or independent instructors, as well as chatbots that can perform teacher-like functions. These platforms and tools have enhanced teacher effectiveness and efficiency, resulting in improved instructional quality. In addition, AI has enabled the customization and personalization of learning materials to suit the unique needs and capabilities of students, resulting in richer learning experiences. As a result, AI has had a major impact on education in areas such as administration, instruction, and learning within the context of individual institutions. Further researches require more detailed investigations of applying AI to the educational process and fetching more useful data and optimizing processes for better performance of education acquirers.

References

1. Chaudhry, M.A., & Kazim, E. (2022) Artificial Intelligence in Education (AIEd): a high-level academic and industry note 2021. Retrieved from: <https://link.springer.com/article/10.1007/s43681-021-00074-z>
2. Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018) Artificial intelligence trends in education: A narrative overview, *Procedia Comput. Sci.*, 136, 16–24.
3. Timms, M.J. (2016) Letting artificial intelligence in education out of the box: Educational cobots and smart classrooms, *Int. J. Artif. Intell. Edu.*, 26 (2), 701–712.
4. Mohamed, H., & Lamia, M. (2018) Implementing flipped classroom that used an intelligent tutoring system into learning process. *Comput. Educ.* 124, 62–76. Retrieved from: <https://doi.org/10.1016/j.compedu.2018.05.011>.
5. Sharma, R.C., Kawachi, P., & Bozkurt, A. (2019) The landscape of artificial intelligence in open online and distance education: Promises and concerns, *Asian J. Distance Educ.*, 14 (2), 1–2.
6. Peredo, R., Canales, A., Menchaca, A. & Peredo, I. (2011) Intelligent Web-based education system for adaptive learning, *Expert Syst. Appl.*, 38 (12), 14690–14702.
7. Rodríguez-Triana, M.J., Prieto, L.P., Martínez-Monés, A., Asensio-Pérez, J.I. & Dimitriadis, Y. (2018) The teacher in the loop: Customizing multimodal learning analytics for blended

- learning. *Proceedings of the 8th international conference on learning analytics and knowledge* (pp 417–426).
8. Russell, S.J., Norvig, P., & Davis, E. (2010) Artificial intelligence: a modern approach. *Prentice Hall, Upper Saddle River*.
 9. Nunn, S., Avella, J.T., Kanai, T., & Kebritchi, M. (2016) Learning analytics methods benefits and challenges in higher education: A systematic literature review, *Online Learn.*, 20 (2), 1-17.
 10. Segal, A., Hindi, S., Prusak, N., Swidan, O., Livni, A., Palatnic, A., & Schwarz, B. (2017) Keeping the teacher in the loop: Technologies for monitoring group learning in real-time. *In International Conference on Artificial Intelligence in Education*. (pp. 64–76).
 11. Mikropoulos, T.A. & Natsis, A. (2011) Educational virtual environments: A ten-year review of empirical research (1999–2009), *Comput. Edu.*, 56 (3), 769-780.
 12. Baker, R.S. (2016) Stupid tutoring systems, intelligent humans. *Int. J. Artif. Intell. Educ.* 26 (2), 600–614.
 13. Yi-Shan, T., & Gasevic, D. (2017) Learning analytics in higher education – Challenges and policies: A review of eight learning analytics policies, *7th Int. Learn. Anal. Knowl. Conf.*, (pp. 233–242).
 14. Chen, L., Chen, P., & Zhijian Lin, Z. (2020) The Role of Machine Learning and Artificial Intelligence for making a Digital Classroom and its sustainable Impact on Education during Covid-19. Retrieved from: <https://ieeexplore.ieee.org/abstract/document/9069875/>
 15. Devedžić, V. (2004) Web intelligence and artificial intelligence in education, *Educ. Technol. Soc.*, 7, 29–39.
 16. Kim, Y., Soyata, T., & Behnagh, R.F. (2018) Towards emotionally aware AI smart classroom: Current issues and directions for engineering and education, *IEEE Access*, 6, 5308-5331.
 17. Fang, Y., Ren, Z., Hu, X., & Graesser, A.C. (2019) A meta-analysis of the effectiveness of ALEKS on learning. *Educ. Psychol.* 39 (10), 1278–1292.
 18. Global Development of AI-Based Education, Deloitte China (2019) Deloitte Company, 1.
 19. Kahraman, H.T., Sagioglu S., & Colak, I. (2010) Development of adaptive and intelligent Web-based educational systems, *4th Int. Conf. Appl. Inf. Commun. Technol.* (pp. 1–5).
 20. Hu, J., Shen, L., & Sun, G. (2018) Squeeze-and-excitation networks, *Conf. Comput. Vis. Pattern Recognit. (CVPR)* (pp. 7132–7141).
 21. Jiménez, S., Juárez-Ramírez, R., Castillo, V.H., Licea, G., Ramírez-Noriega, A., & Inzunza, S. (2018) A feedback system to provide affective support to students. *Comput. Appl. Eng. Educ.* 26 (3), 473–483.
 22. Zemel, R., Wu Y., Swersky, K., Pitassi, T., & Dwork, C. (2013) Learning fair representations. *International Conference on Machine Learning* (pp. 325–333).

ПРОЦЕСИ РОЗВИТКУ ІНТЕЛЕКТУАЛЬНИХ СИСТЕМ В ОСВІТІ

Роман Сов'як, Василь Антонів

*Львівський національний університет імені Івана Франка,
79008, м. Львів, просп. Свободи, 18,*

e-mail: Roman.Soviak@lnu.edu.ua; ORCID: <https://orcid.org/0009-0008-7776-7839>

e-mail: Vasyl.Antoniv@lnu.edu.ua; ORCID: <https://orcid.org/0000-0003-4259-4129>

Анотація. Метою дослідження є виявлення нових можливостей, які можуть бути використані під час розробки інтелектуальних систем в освіті. Завданнями статті є наступними: з'ясувати сутність штучного інтелекту в освіті, розкрити його роль в освітніх процесах, особливо в онлайн-навчанні, визначити методи та шляхи, які можна застосувати для більш ефективного навчання. Результати дослідження показали, що технології штучного інтелекту відіграють важливу роль у розвитку навчання та роблять освіту більш гнучкою, інноваційною та ефективною. Перспективи подальших досліджень з цього питання полягають у вивченні останніх наукових результатів, які стосувалися використання штучного інтелекту в освіті та визначення нових шляхів інтеграції нових технологій у навчання. Усе це має суттєво вплинути на результати навчання та систему освіти.

Ключові слова: навчання, онлайн-освіта, штучний інтелект, аналітика навчання, машинне навчання, інтелектуальний аналіз даних.

Стаття надійшла до редакції 30.11.2022

Прийнята до друку 02.02.2023