



## IMPACT OF NEURAL NETWORKS ON ADAPTATION TO LEARNERS' EDUCATIONAL NEEDS AND THE IMPROVEMENT OF TEACHING METHODS

## IMPACTO DAS REDES NEURAS NA ADAPTAÇÃO ÀS NECESSIDADES EDUCACIONAIS DOS ALUNOS E NO APRIMORAMENTO DOS MÉTODOS DE ENSINO

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### ABSTRACT

**Objective:** This article explores the dynamic technological development of modern society with a focus on the application of neural networks in education.

**Methods:** Utilizing an integrated research approach that combines descriptive and comparative analytical methods, this study examines the role and potential of neural networks in enhancing the adaptability and effectiveness of higher education. A review of existing scientific literature provides a comprehensive overview of current trends.

**Results:** The study concludes that neural networks hold significant potential to revolutionize both teaching and learning processes. Education systems thus need to rapidly adapt to technological advancements and modify current educational practices to shape the future of teaching.

**Conclusion:** The article highlights the modern tools for applying neural networks in education and outlines their potential to significantly influence the education of future generations. It





discusses how neural networks can transform educational processes into more accessible, flexible, and efficient experiences, although it also acknowledges the challenges and ethical concerns of integrating these technologies into higher education settings.

**Keywords:** Neural networks in education. Educational technology. Adaptive learning. Future of education. Educational innovation

## RESUMO

**Objetivo:** Este artigo explora o desenvolvimento tecnológico dinâmico da sociedade moderna, com foco na aplicação de redes neurais na educação.

**Métodos:** Utilizando uma abordagem de pesquisa integrada que combina métodos analíticos descritivos e comparativos, este estudo examina o papel e o potencial das redes neurais em aprimorar a adaptabilidade e a eficácia do ensino superior. Uma revisão da literatura científica existente fornece uma visão abrangente das tendências atuais.

**Resultados:** O estudo conclui que as redes neurais possuem um potencial significativo para revolucionar os processos de ensino e aprendizagem. Assim, os sistemas educacionais precisam se adaptar rapidamente aos avanços tecnológicos e modificar as práticas educacionais atuais para moldar o futuro do ensino.

**Conclusão:** O artigo destaca as ferramentas modernas para a aplicação de redes neurais na educação e delinea seu potencial para influenciar significativamente a educação das futuras gerações. Discute como as redes neurais podem transformar os processos educacionais em experiências mais acessíveis, flexíveis e eficientes, embora também reconheça os desafios e preocupações éticas da integração dessas tecnologias nos ambientes de ensino superior.

**Palavras-chave:** Redes neurais na educação. Tecnologia educacional. Aprendizagem adaptativa. Futuro da educação. Inovação educacional.

## 1 INTRODUCTION

The traditional role of education is to prepare learners for the future. Today, this role manifests in constant changes in the educational environment, which is increasingly saturated with technology replacing routine work with automated procedures and devices. Knowledge and its acquisition, distribution, and application are vital factors in economic development and social welfare. They allow individuals and entire organizations to succeed by increasing their value and competitiveness in the market. Therefore, these factors are of fundamental importance to society, and technological advances, particularly neural networks, can significantly improve this process (Auyelbek et al., 2022; Koriakova & Sudakova, 2023; Ukolova & Afanasyev, 2023).

In a world of dynamically changing technologies, neural networks have become not





only a subject of research but also a key element in shaping future generations. Over the past decade, their development has revolutionized many aspects of everyday life, including education. Neural networks are a powerful educational tool that can dramatically change how we teach and learn (Ilin, 2024; Kazachenok, 2020).

Introducing neural networks into the educational process affects all students but is particularly important for Generation Alpha and Generation Z, pursuing higher education. Generation Z is experiencing the benefits of neural networks in education. Generation Alpha is growing up in an environment where neural networks will be further integrated into their everyday learning process, inside and outside formal education (Abdullayev et al., 2024a, 2024b; Luo & Yang, 2022; Sakenov et al., 2022).

Studies by O.M. Bakunova et al. (2018) and O.N. Filatova et al. (2022) suggest that neural networks revolutionize learning and teaching. The need to rapidly adapt to dynamically changing technologies will change existing educational practices. Understanding the impact of neural networks on these aspects will become crucial. Education systems centered around the requirements of the industrial age will recognize some of their features as obsolete under the influence of neural networks, while others will be emphasized. Neural networks will pave the way for new teaching and learning methods.

However, integrating neural networks into education raises concerns about the limitations of natural interpersonal relationships, which are important in learning and socialization (Kurbanova & Ismailova, 2023; Novichkov et al., 2022; Shurygin et al., 2024). Therefore, there is an urgent need to study the specifics of applying neural networks in education as a new and not yet fully explored area that requires further research and analysis.

I.R. Khabibullin et al. (2023) note that neural networks are transforming education by offering new opportunities for teaching and learning. Neural networks make education more personalized through adaptation to individual needs and learning styles (Bosov, 2022; Chumaceiro Hernández et al., 2022). Neural network-based tools provide a more efficient and interactive learning experience and simplify access to knowledge (Kasatkina, 2021; Saprykina, 2023). The application of neural networks in education facilitates faster acquisition of knowledge and skills by offering flexibility in the place and time of study (Onufrieva & Sukhova, 2020; Polovchenko, 2024).

Neural networks can be useful in analyzing educational data, automating learning processes, consolidating learning skills, planning and designing educational programs, and



adapting teaching materials and methods to learners' features and goals (Fiore, 2019).

The clear integration of neural networks into educational programs is of decisive importance because neural networks prepare students for a future in which this technology plays a central role (Bobkov et al., 2020; Matvienko et al., 2022; Shamsutdinova, 2022). Introducing innovations based on neural networks into education facilitates the development of such skills as problem-solving, critical thinking, and adaptation to rapidly changing technology. By learning to use neural networks and understanding their application, students gain technical knowledge and the skills vital for living in an increasingly automated and technologically advanced world (Akhmetshin, 2023; Ilyushin & Martirosyan, 2024; Podzorova, 2022).

The topic of using neural networks in education is gaining popularity among educators. The year 2022 was marked by the creation of two new prominent tools: ChatGPT by Open AI and Bing by Microsoft. ChatGPT and Bing are advanced neural network language models capable of generating content on various topics. Importantly, both tools can interact with humans, meaning they can play a key part in interpersonal communication, supporting individuals and businesses alike (Abdullaev et al., 2023; Hernández García de Velazco, 2022; Polegoshko, 2023; Ybyraimzhanov et al., 2022).

E. Okewu et al. (2021) demonstrate that in the short time since its launch, ChatGPT has garnered widespread interest in the education sector. A significant proportion of the surveyed teaching staff (51%) started using the tool, with 40% using it weekly. Forecasts on the further use of ChatGPT are optimistic, as more than half of the teachers (53%) plan to use it more intensively. Among the students, 22% of whom use ChatGPT weekly, there is a popular belief (63%) shared by most teachers (72%) that this instrument symbolizes the need to change traditional approaches to teaching. This agrees with students' conviction (68 and 75%, respectively) that ChatGPT can improve their academic performance and learning effectiveness and with the opinion of 73% of teachers that ChatGPT helps improve learning outcomes and catalyze students' learning. These findings allow one to conclude that ChatGPT is a major factor in the evolution of pedagogical methods and techniques.

The study aims to present neural networks as a key element in contemporary education and to emphasize their role in the renewal of teaching methods.

In line with the set research goal, the study seeks to answer the following research questions:

- (1) What tools based on neural networks can be used in the higher education process?

(2) What advantages and threats arise from neural networks in education?

## 2 METHODS

The study uses a comprehensive methodological approach combining descriptive and comparative analysis to thoroughly investigate the influence of neural networks on the education sector.

Descriptive analysis provided a detailed description of the application of neural networks in education focusing on fundamental characteristics and trends in the data. This method outlined the key areas of interest and potential patterns, advancing the understanding of the current state of the use of neural networks in educational contexts. The application of descriptive analysis enabled an in-depth study of specific cases of neural networks' application in education, which contributed to a more intuitive understanding of its impact on the learning process.

The method of comparative analysis was used to conduct a comparative assessment of the various aspects of neural network implementation in education in relation to other teaching methods, education systems, and technological applications. This analysis showed the properties and benefits of incorporating neural networks into the higher education process, providing a more complete understanding of their impact on a broader scale.

Desk research was conducted to review current knowledge about neural networks in education. This method provided an opportunity to analyze existing data, including statistical data, and scientific literature, supplemented by the results of selected reports and studies. This provided a comprehensive review of current trends and research in the field.

Moreover, the analysis relied on inductive reasoning to draw general conclusions based on detailed observations and analysis. This approach was crucial for conclusions about the future direction and impact of neural networks on education.

The described multidimensional combination of methodologies ensured an in-depth understanding of the dynamically evolving potential of neural networks in education, which is imperative due to constant change and innovation in educational technologies.

## 3 RESULTS

Table 1 shows neural network-based tools revolutionizing education by offering new



methods and paths of learning.

**Table 1.** Neural network-based tools in the higher education process

Instruments	Characteristic	Example
Intelligent assistants and chatbots	Used to quickly answer questions, help solve problems, or explain complex concepts	Duolingo (language learning chatbot) Engati (chatbot platform) ChatGPT
Grading and analysis systems	Can automatically grade responses and analyze results to identify areas that require additional attention. These systems can assess multiple-choice and descriptive responses	Turnitin (analysis and assessment of written assignments) Gradescope (automated grading of assignments) Knewton (academic performance analysis)
Developmental games and simulators	Neural network-based games and simulations that offer interactive and engaging ways to learn through hands-on experience and experimentation	DragonBox (mathematical games) CodeCombat (a game for learning programming)
Natural language processing (NLP) instruments	Help analyze texts and support the development of language and literary skills. They can be used to automatically summarize texts or to support language learning	Grammarly (an instrument to improve grammar and writing style) QuillBot (a paraphrasing instrument) Rosetta Stone (a language-learning instrument)
Analysis of emotions and commitments	Can monitor and analyze students' reactions to learning material, adapting the approach to increase engagement and the effectiveness of learning	GoReact (a tool for analyzing presentations and speech)
Voice recognition and voice assistants	Provide interactive learning through voice commands, which is especially useful in language learning or for people with disabilities	Google Assistant (voice assistant) Amazon Alexa (voice assistant) Dragon NaturallySpeaking (voice recognition)

Source: own research based on (Kazachenok, 2019; Kozlova & Protasova, 2021; Kravtsova, 2023).

Thus, neural networks contribute to transforming the education sector by offering various tools (Table 1). They improve teaching and learning methodologies and contribute to a more effective, accessible, and flexible learning environment.

Table 2 presents an analysis of the benefits and threats associated with neural networks in education. Analysis of this data will help to understand both the potential and challenges of integrating neural networks into the educational environment.

**Table 2.** Advantages and threats arising from the use of neural networks in education

Advantages	Individualization of learning	Neural networks analyze data such as test scores, learning progress, learning preferences, and learning styles to tailor learning materials and methods to each student's individual needs
	Support for teachers	Teachers can use neural networks to create personalized learning plans tailored to students' individual goals and needs and to adapt materials and lessons in real time
	Automatic assessment	Neural networks help teachers automatically grade tests, assignments, and homework, thus saving time and making grading more objective
	Identification of learning difficulties	By analyzing data, neural networks can help teachers identify students' learning difficulties early on, allowing for faster remedial intervention
	Interactive learning	Neural networks can act as interactive tutors to help students understand the material, answer questions, and provide additional practice
	Development of soft skills	Neural networks can be used as simulators to develop soft skills such as emotion management and problem-solving
	Foreign language learning	Advanced neural network-based language translation systems can facilitate foreign language learning
	Information search	Search engines based on neural networks provide more precise results
	Help with academic assignments	Neural networks help solve mathematical problems, analyze data and graphs, and create graphics and animations
Threats	Elimination of critical thinking	Students may rely too heavily on neural networks as a source of information, which limits the development of critical thinking and independent problem-solving skills
	Distrust of neural networks	There is a risk that students will uncritically trust the answers provided by neural networks without checking them with other sources, which could lead to the dissemination of false information
	Lack of social interaction	Overuse of neural networks in education may limit social interaction between students and teachers, which is important for the development of social skills
	Dependence on technology	Students may develop a reliance on neural networks as a primary educational tool, which will compromise their ability to think independently and solve problems
	Lack of compassion and understanding	Although neural networks can imitate conversations and interactions, they are incapable of empathy or deep understanding, which are critical to the learning process and providing students with emotional support

Source: own research based on: (Mitsel et al., 2013; Repkina, 2016; Vai, 2017).

## 4 DISCUSSION

The obtained findings demonstrate that neural networks offer innovative solutions in education that can potentially affect the development of future generations. The benefits of their implementation are invaluable for adapting the educational process to the needs of each learner.

The application of neural networks in education positively impacts the educational

process (Table 1) by individualizing learning, supporting teachers, automating grading, identifying learning difficulties, providing interactive learning, developing soft skills, facilitating foreign language learning, improving information search, and assisting with assignments. Neural networks allow one to adapt learning materials and teaching methods to individual needs, facilitating more effective and engaging learning. Teachers have the tools to create personalized learning plans, making education more effective. Automated grading saves teachers' time and ensures greater objectivity in assessment. Neural networks help identify learning difficulties early so that appropriate support measures can be implemented quickly. Interactive tutorials, soft skills development, language learning, and accurate information search enrich the learning process, making it more interactive, engaging, and adapted to the needs of the modern world.

It is important to consider potential threats from excessive reliance on neural networks. Considering the development of future generations, it is crucial to find a balance between taking advantage of neural networks and preserving important aspects of traditional education that cultivate social skills, empathy, and critical thinking. Responsible and conscious implementation of neural networks will have a critical impact on the development and preparation of young people for future challenges.

The global market for neural networks in education, estimated at approximately 2.126 billion USD in 2022, is dynamically increasing. Between now and 2030, this market is expected to grow at an impressive rate of 36.6% per year, reaching 25.772 billion USD by the end of the decade (Luo & Yang, 2022). This surge is driven by significant investments, the rising demand for neural network-based personalized education, and the increasing need for the automation of administrative tasks. This growth rate demonstrates the transformation of the education sector and the rising role of neural networks in shaping future learning methods and environments.

The development of neural networks is becoming increasingly influential and requires close attention to ethics to ensure their responsible and safe use (Kurbanova & Ismailova, 2023; Tolegen et al., 2016). The ethics of neural networks explore the moral aspects associated with their design, implementation, and use. The advancement of technology, especially in neural networks, gives rise to ethical issues (Aitimov et al., 2015; Okewu et al., 2021; Vasyukov & Khisamova, 2021). The scale of the problems goes beyond the direct impact of neural networks on people. Neural networks can influence the processes and structures that form the foundation of society (Abdullayev et al., 2025; Babaskin et al., 2024;





Polegoshko, 2023).

Drawing on historical data, neural network algorithms tend to view the future as an extension of the past, which raises ethical dilemmas. The important thing is the need for genuine human choice, not a repetition of the past. Despite the advances neural networks have made in creativity, interaction with people with unique creative qualities remains challenging (Kasatkina, 2021; Potapov, 2021).

In 2017, UNESCO published a report of the World Commission on the Ethics of Scientific Knowledge and Technology, aimed to establish an ethical framework and support global dialogue. The report emphasizes that robots blur the line between man and machine, which affects their moral status. The development of intelligent autonomous robots based on neural networks raises questions about their moral classification comparable to those arising in the context of the animal rights movement. It may also affect current ideas about the moral status of humans (Koriakova & Sudakova, 2023).

Thus, the importance of neural networks in higher education is growing, and educators must be prepared to use neural networks ethically and responsibly. Ethics is key in making morally sound decisions and developing rules for social coexistence, essential for developing and applying neural networks in education.

## 5 CONCLUSIONS

Neural networks become particularly important in the context of modern educational challenges, such as adaptation to the diverse needs of learners, effective knowledge transfer, and continuous improvement of teaching methods. Considering these challenges, neural networks become a tool to facilitate the learning process and a dynamic partner capable of adapting to learners' characteristics.

Incorporating neural networks into higher education is transforming learning by making it more accessible through language translation and personalized learning plans that allow one to tailor the pace and style of learning to students' needs. Learning is also becoming more flexible with the ability to access educational materials and resources from any place at any time. The effectiveness of education is boosted using neural network-based systems that analyze learning outcomes in real time, identify gaps in knowledge, and provide personalized recommendations to help students achieve educational goals faster and more efficiently.



## REFERENCES

Abdullaev, I., Prodanova, N., Bhaskar, K.A., Lydia, E.L., Kadry, S., & Kim, J. (2023). Task offloading and resource allocation in IoT based mobile edge computing using deep learning. *Computers, Materials & Continua*, 76(2), 1463-1477. <https://doi.org/10.32604/cmc.2023.038417>

Abdullayev, I., Akhmetshin, E., Nayanov, E., Otcheskiy, I., & Lyubanenko, A. (2024a). Possibilities of using online network communities in the educational process to develop professional skills in students. *Revista Conrado*, 20(98), 395-401.

Abdullayev, I., Osadchy, E., Shcherbakova, N., Kosorukova, I. (2025). An innovative approach to financial distress prediction using relative weighted neutrosophic valued distances. *International Journal of Neutrosophic Science*, 25(1), 370-381. <https://doi.org/10.54216/IJNS.250133>

Abdullayev, I.S., Akhmetshin, E.M., Krasnovskiy, E.E., Tuguz, N.S., & Mashentseva, G. (2024b). Soliton solutions to the DS and generalized DS system via an analytical method. *Computational Methods for Differential Equations*. <https://doi.org/10.22034/cmde.2024.60337.2576>

Aitimov, B.Z., Seriev, B.A., & Kopbasarova, G.K. (2015). Interaction of non-profit organizations with government bodies in the fight against corruption as a basis for citizens' economic rights protection. *Actual Problems of Economics*, 167(5), 95-102.

Akhmetshin, E. (2023). Enhancing advanced mathematical proficiency in economics students through software integration. *Multidisciplinary Science Journal*, 5, e2023064. <https://doi.org/10.31893/multiscience.2023064>

Auyelbek, M., Ybyraimzhanov, K., Andasbayev, E., Abdykerimova, E., & Turkmenbayev, A. (2022). Analysis of studies in the literature on educational robotics. *Journal of Turkish Education*, 19(4), 1267-1290.

Babaskin, D., Masharipov, F., Savinkova, O., Shustikova, N., & Volkova, N. (2024). Functional state of team sports athletes in the annual training cycle. *Retos*, 54, 106-113. <http://dx.doi.org/10.47197/retos.v54.99620>

Bakunova, O.M., Kalitenia, I.L., Bakunov, A.M., Paluiko, A.F., Antonov, E.D., & Grechko, I.S. (2018). Ispolzovanie neironnykh setei v obrazovanii [The use of neural networks in education]. *Web of Scholar*, 1(1(19)), 8-10.

Bobkov, V.N., Simonova, M.V., Loktyuhina, N.V., & Shichkin, I.A. (2020). Peculiarities of unstable employment in the era of a digital economy from data of social media of Russia. In S. Ashmarina, A. Mesquita, & M. Vochozka (Eds.), *Digital transformation of the economy: Challenges, trends and new opportunities* (pp. 235-243). Cham: Springer. [https://doi.org/10.1007/978-3-030-11367-4\\_22](https://doi.org/10.1007/978-3-030-11367-4_22)

Bosov, A.V. (2022). Primenenie samoorganizuiushchikhsia neuronnykh setei k protsessu formirovaniia individualnoi traektorii obucheniiia [Application of self-organizing neural networks to the process of forming an individual learning path]. *Informatics and Applications*, 16(3), 7-15. <https://doi.org/10.14357/19922264220302>

Chumaceiro Hernández, A.C., Hernández García De Vela, J., Velazco Hernández, J., Lagusev, Y., & Rogozhina, A. (2022). The impact of sustainable development and social responsibility on quality education. *Journal of Environmental Management and Tourism*, 13(1), 51-62. [https://doi.org/10.14505/jemt.v13.1\(57\).05](https://doi.org/10.14505/jemt.v13.1(57).05)

Filatova, O.N., Bulaeva, M.N., & Gushchin, A.V. (2022). Primenenie neurosetei v professionalnom obrazovanii [Application of neural networks in vocational education]. *Problemy sovremennogo pedagogicheskogo obrazovaniya*, 77-3, 243-245.

Fiore, U. (2019). Neural networks in the educational sector: Challenges and opportunities. *Balkan Region Conference on Engineering and Business Education*, 1(1), 332-337.

Hernández García de Velazco, J.J. (2022). Sociedades del conocimiento y ciencia abierta en la nueva normalidad. *Jurídicas CUC*, 18(1), 1-4.

Ilin, I.G. (2024). Personal data in artificial intelligence systems: Natural language processing technology. *Journal of Digital Technologies and Law*, 2(1), 123-140. <https://doi.org/10.21202/jdtl.2024.7>

Ilyushin, Y., & Martirosyan, A. (2024). The development of the soderberg electrolyzer electromagnetic field's state monitoring system. *Scientific Reports*, 14, 3501. <https://doi.org/10.1038/s41598-024-52002-w>

Kasatkina, T.I. (2021). Matematicheskoe modelirovanie obrazovatel'nogo portala vuza na osnove tekhnologii neuronnykh setei [Mathematical modeling of the university educational portal based on neural network technology]. *Modeling, Optimization and Information Technology*, 9(4), 1-12.

Kazachenok, V.V. (2019). Primenenie neuronnykh setei dlia avtomatizatsii individualizirovannogo obucheniiia [The usage of neural networks for the automatization of individualized learning]. In M.V. Noskov (Ed.), *Informatizatsiia obrazovaniia i metodika elektron'nogo obucheniiia: Proceedings of the III International scientific conference (Part 3, pp. 244-250)*. Krasnoyarsk: Siberian Federal University.

Kazachenok, V.V. (2020). Primenenie neuronnykh setei v obuchenii [Application of neural networks in training]. *Informatics and Education*, 2, 41-47. <https://doi.org/10.32517/0234-0453-2020-35-2-41-47>

Khabibullin, I.R., Azovtseva, O.V., & Gareev, A.D. (2023). Aktualnost ispolzovaniia neurosetei v obrazovatelnykh tseliakh [The relevance of applying neural networks for educational purposes]. *Young Scientist*, 13(460), 176-178.

Koriakova, K.A., & Sudakova, O.V. (2023). Neuroseti kak novye instrumenty v obrazovanii [Neural networks as a new instrument in education]. *Informatsionnyye tekhnologii v obrazovanii*, 6, 180-186.

Kozlova, O.A., & Protasova, A.A. (2021). Ispolzovanie neironnykh setei v distantsionnykh obrazovatelnykh tekhnologiiakh dlia identifikatsii obuchaiushchikhsia [The use of neural networks in distance education technologies for the identification of students]. *Open Education*, 25(3), 26-35. <https://doi.org/10.21686/1818-4243-2021-3-26-35>

Kravtsova, A.G. (2023). Chatgpt-3: Perspektivy ispolzovaniia v obuchenii inostrannomu iazyku [CHATGPT-3: Perspectives of application to foreign language teaching]. *Mir nauki, kultury, obrazovaniya*, 3(100), 33-35. <https://doi.org/10.24412/1991-5497-2023-3100-33-35>

Kurbanova, Z.S., & Ismailova, N.P. (2023). Neuroseti v kontekste tsifrovizatsii obrazovaniia i nauki [Neural networks in the context of digitalization of education and science]. *Mir nauki, kultury, obrazovaniya*, 3(100), 309-311. <https://doi.org/10.24412/1991-5497-2023-3100-309-311>

Luo, Q., & Yang, J. (2022). The artificial intelligence and neural network in teaching. *Computational Intelligence and Neuroscience*, 2022, 1778562. <https://doi.org/10.1155/2022/1778562>

Matvienko, E., Zolkin, A., Suchkov, D., Shichkin, I., & Pomazanov, V. (2022). Applying of smart, robotic systems and big data processing in agro-industrial complex. *IOP Conference Series: Earth and Environmental Science*, 981, 032002. <https://doi.org/10.1088/1755-1315/981/3/032002>

Mitsel, A.A., Poguda, A.A., Semenov, K.A., & Utesheva, A.E. (2013). Metody testirovaniia znaniia na osnove primeneniia apparata neironnoi seti [Testing methods of knowledge on the basis of neural network]. *Open Education*, 2(97), 34-41.

Novichkov, V.B., Ilyichyova, I.V., & Potapov, D.A. (2022). Principles of constructing the content of general secondary education. *Anthropological Didactics and Upbringing*, 5(4), 10-26.

Okewu, E., Adewole, P., Misra, S., Maskeliunas, R., & Damasevicius, R. (2021). Artificial neural networks for educational data mining in higher education: A systematic literature review. *Applied Artificial Intelligence*, 35(13), 983-1021. <http://dx.doi.org/10.1080/08839514.2021.1922847>

Onufrieva, T.A., & Sukhova, A.S. (2020). Primenenie neironnykh setei v razrabotke elektronnykh obuchaiushchikh resursov [Application of neural networks in the development of e-learning resources]. *South-Siberian Scientific Bulletin*, 6(34), 194-197.

Podzorova, M.I. (2022). Neironnaia set kak odno iz perspektivnykh napravlenii iskusstvennogo intellekta [Neural network as one of the promising directions of artificial intelligence]. *Modern European Researches*, 1(3), 169-176.

Polegoshko, K.R. (2023). Ispolzovanie chat-bota GPT v pedagogike: Preimushchestva, osobennosti i riski [Using GPT Chat bot in pedagogy: Advantages, features and risks]. *Bulletin of Perm State Humanitarian and Pedagogical University*, 19, 128-133.

Polovchenko, K. (2024). Interactive methodology for teaching legal disciplines: Theory and practice. *Revista Juridica*, 1(77), 117-140.





Potapov, D.A. (2021). Personal creativity study: Structure, levels, indicators. *Anthropological Didactics and Upbringing*, 4(4), 92-101.

Repkina, N.G. (2016). Prognozirovaniye uspeshnosti obrazovaniia studentov tekhnicheskikh napravlenii podgotovki s ispolzovaniem iskusstvennykh neuronnykh setei [Predicting educational success of technical students using artificial neural networks]. *Almanakh mirovoi nauki*, 5-1(8), 92-95.

Sakenov, D.Z., Zhaparova, B.M., Kenzhebeyeva, T.B., & Mambetalina, A.S. (2022). Model of socialization in an orphanage. *European Journal of Contemporary Education*, 11(2), 483-490. <https://doi.org/10.13187/ejced.2022.2.483>

Saprykina, O.A. (2023). Yazykovaya politika v stranakh portugal'skoy rechi: Institutsional'nyy aspect [Language policy in Portuguese-speaking countries: Institutional aspect]. *Litera*, 12, 1-14. <https://doi.org/10.25136/2409-8698.2023.12.68932>

Shamsutdinova, T.M. (2022). Problemy i perspektivy primeneniia neuronnykh setei v sfere obrazovaniia [Problems and prospects for the application of neural networks for the sphere of education]. *Open Education*, 26(6), 4-10. <https://doi.org/10.21686/1818-4243-2022-6-4-10>

Shurygin, V., Abdullayev, I., Hajiyev, H., Yakutina, M., Kozachek, A., & Zakieva, R. (2024). Blended learning: The effect on students' self-regulation and academic achievements. *Novitas-ROYAL*, 18(1), 137-154. <https://doi.org/10.5281/zenodo.11057892>

Tolegen, M.A., Seriev, B.A., Akhatov, U.A., Taubayev, B.R., & Balashov, T.T. (2016). Social and legal aspects of the educational support of adolescents with deviant behavior. *International Journal of Environmental and Science Education*, 11(11), 4768-4781.

Ukolova, L.I., & Afanasyev, V.V. (2023). Pedagogical potential of the application of computer educational programs in the lessons of fine arts. *Anthropological Didactics and Upbringing*, 6(1), 21-30.

Vai, I.M. (2017). Primenenie neuronnykh setei dlia kontrolya i prognozirovaniia rezultatov uchebnogo protsessa v vuze [Neural network application to control and prediction of educational process results in the university]. *Economical and Social-Humanitarian Research*, 4(16), 130-132.

Vasyukov, V.F., & Khisamova, Z.I. (2021). Investigation and seizure of electronic media in the production of investigative actions. *Revista de Direito, Estado e Telecomunicacoes*, 13(2), 78-88. <https://doi.org/10.26512/lstr.v13i2.25920>

Ybyraimzhanov, K., Baimyrzayev, K., Taurbekova, A., Gulden, Y., & Tynyskhanova, A. (2022). Formation of speech activity of primary school students in foreign language teaching technology integration. *World Journal on Educational Technology: Current Issues*, 14(2), 507-519. <http://dx.doi.org/10.18844/wjet.v14i2.7023>

