DOI: 10.63550/ICEIP.2025.12.29.072

Neural Networks as a Tool for Developing It Competencies in Students of Special Education (Defectology)

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Keywords: neural network, teacher training, IT competencies of students, independent student work.

Abstract: The article explores the use of neural networks as an innovative tool for supporting students' independent work at pedagogical universities. The authors outline key principles and strategies for integrating neural network technologies into the educational process, while also addressing potential challenges and proposing solutions. The article presents findings from an empirical study that assessed the IT competencies of students in the Special Education ("Defectology") program who use neural networks to complete academic and professional tasks. Additionally, it offers examples of practical assignments that can be incorporated into the curriculum. The authors emphasize the importance of developing specific methodological guidelines to improve the effectiveness of neural network applications in students' independent learning.

1 INTRODUCTION

Modern information technologies have a significant impact on various aspects of public life, including education. Among these technologies, neural networks have emerged as a particularly promising tool. From a pedagogical perspective, neural networks—computational systems inspired by the functioning of the human brain—offer considerable potential for the automation and optimization of educational processes. In educational contexts, they are employed for tasks such as data analysis, forecasting academic performance, personalizing learning trajectories, developing adaptive instructional materials, and supporting educators in the assessment of student achievement [Bengio, Courville, & Vincent, 2017]. In recent years, scholarly and practical interest in the integration of neural networks into educational settings has grown markedly. However, the specific ways in which these technologies can support students' independent work remain underexplored.

Neural networks present a powerful tool for automating a wide range of processes related to data processing and analysis. While their potential has been widely recognized and effectively applied in such fields as business, media communication, and science, its implementation in education remains underexplored. According to some researchers, neural networks can perform the following functions within the educational process:

1. Automated assessment and feedback. Neural networks can be used for the automatic evaluation of student work, tests, and essays. They can also provide instant feedback, enhancing the effectiveness of students' independent work and helping them improve their professional skills [Khan, Ali, Ahmed, 2019].

2. Personalized learning. Neural networks allow for the development of personalized learning paths by adapting the content and pace of learning to each student's cognitive processes. [Park, Kim, 2020].

3. Support for teachers and mentors. Neural networks assist educators in analyzing student performance, identifying existing educational gaps and their possible causes, and suggesting corrective measures [Gligorea, Ilie & Cioca, 2023].

4. Predicting academic performance. The use of neural networks allows for predicting student success based on previous achievements and behavior [Kanatyev, Filatova, Zinovyeva, 2024].

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5. Creating interactive educational materials. Neural networks facilitate the creation of interactive and multimedia resources, improving student engagement in learning activities [Yufei, Liu & Saleh, Salmiza & Jiahui, Huang & Abdullah, Syed, 2020].

6. Supporting inclusive education. Neural networks can help create conditions for inclusive education by providing adapted materials and technologies for individuals with diverse needs [Heinrich, Milne, Grout, 2019].

7. Analyzing emotional states. Neural networks can analyze facial expressions, vocal intonation, and other non-verbal signals, helping educators better understand students' emotional states and respond flexibly by adjusting teaching tactics [Ivanova, 2016].

These functions make neural networks a promising tool for the educational activities of students in any field of study, as they significantly expand the opportunities for learners' self-preparation and self-development. Neural networks are especially valuable when working with individuals who have special educational needs, as these cases require the highest level of individualization in the learning process. Therefore, educators who are being trained to work with such individuals shall be well-versed in using neural networks for their educational and professional activities.

However, despite their many benefits, the authors also note certain challenges associated with the implementation of neural networks in the educational process. These include:

1. Technical difficulties. Implementing neural networks requires access to appropriate technical resources and infrastructure, which can pose a challenge for educational institutions with limited financial resources [Kuznetsov, 2020].

2. Ethical issues. The use of neural networks in education raises questions of data privacy and ethics, especially when processing students' personal data [Kusuma, 2022].

3. Lack of qualified personnel. The implementation of neural networks requires specialists with the necessary knowledge and skills in artificial intelligence and machine learning [Sidorova, 2022].

4. Resistance to change. Educators and students may experience psychological resistance to new technologies, which can slow down the process of integrating neural networks into the educational process [Smirnov, Ivanov, 2019].

5. Limited data availability. Successful training of neural networks requires high-quality databases, which are not always available in the field of education and upbringing of individuals with special educational needs [Sysoev, 2025].

In addition to the points mentioned above, we believe that in order to use neural networks in the training of future teachers, it is essential to rely on students' existing skills with digital technologies. To assess these skills among students, we organized and conducted a special study in 2025.

2 MATERIALS AND METHODS

The study included 66 students from full-time and part-time programs in the fields of "Speech Therapy" and "Preschool Defectology." A questionnaire was developed to assess the following parameters: knowledge about neural networks, the use of neural networks in educational/professional activities, the use of neural networks for data analysis in corrective work, and the use of neural networks for creating educational content.

The knowledge component of the questionnaire included questions designed to assess the basic principles behind networks, methods for integrating neural networks with other technologies within the defectological approach, and awareness of the ethical issues associated with using neural networks in specific fields such as special education.

Skills were assessed through a series of questions designed to identify the practical skills students possess in working with neural networks. The questions focused on identifying the applications of neural networks in various real-life situations, assessing the ability to independently learn and configure neural networks using data sets, and selecting the most suitable architecture and network for specific tasks. Additionally, participant were evaluated on their experience with popular models, their ability to effectively process data for corrective purposes, analyze the results of neural network operations, and apply these insights to solve medical and corrective tasks. Responses were scored on a scale from 1 to 4 based on specially developed criteria.

The study was conducted using remote Google survey forms, which allowed for the rapid collection of a substantial amount of data. Participants were asked to evaluate their skills in several key areas. First, the questions addressed digital literacy, including the use of neural networks in educational and professional practice, training neural networks based on data, selecting appropriate architectures for specific tasks, and working with popular pre-trained

models. Second, significant attention was given to the application of neural networks in corrective work, which was reflected in the ability to analyze data, interpret results, and automate the diagnosis or correction of speech disorders. The third area focused on creation of educational content, where participants demonstrated skills in developing interactive educational applications using neural networks. Finally, the individual proposals for future professional experience emphasized creative potential and strategic thinking regarding the application of neural networks, indicating a high level of readiness for innovation in the professional environment.

We hypothesized that part-time students, who engage in a higher proportion of independent work, would be more active in utilizing the capabilities of neural networks compared to full-time students. We also expected to see a higher level of proficiency with neural networks among students in the Speech Therapy program, given the widespread adoption of remote speech therapy services in the post-pandemic period.

The data obtained during the study were subjected to mathematical analysis using statistical methods: normality testing using the Shapiro-Wilk method and testing for significant differences using the non-parametric Mann-Whitney test.

3 RESULTS AND DISCUSSION

The results obtained are presented in Table 1.

Table 1: Results obtained students.

	Knowledge about neural networks	Use of neural network in educational/professional activities	Use of neural networks in correctional work	Using neural networks to develop educational content
Preschool defectology	1,84	1,97	1,54	1,67
Logopedics	1,94	2,12	1,64	1,59
Full-time courses	2,15	2,52	1,84	1,79
Extramural studies	1,71	1,72	1,42	1,51
Total by sample	1,89	2,05	1,59	1,63

For clarity, we present the obtained data in Figure 1.

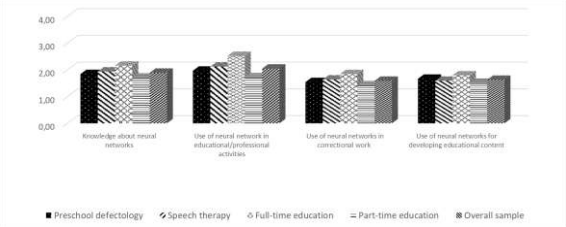

Figure 1: Visual representation of survey results

The analysis of the data revealed several key findings regarding the level of knowledge and skills in the field of neural networks among the surveyed student group. The results showed that the vast majority of respondents have a general understanding of the concept of "neural network" and are familiar with certain types of neural networks. However, 11% of students indicated that they have never used neural networks in their educational or professional activities. When examining specific aspects of proficiency with neural networks, it became evident that many respondents experience difficulties with tasks requiring a deep understanding of how neural networks function. For instance, only 3% of students were able to confirm that they had trained a neural network using data, integrated it into the educational process, or had selected an appropriate architecture for solving specific tasks. Affirmative responses regarding the use of neural networks in corrective work or for individualizing learning were extremely rare, with only 7% of respondents reporting such experience. Notably, a significant portion of respondents acknowledged their lack of competence in IT technologies and expresses a desire and

readiness to improve their skills in the future. This highlights the need for additional training and practice in this area, as students recognize the potential benefits and opportunities provided by neural network technologies for both their own educational activities and for organizing corrective work in their future professional roles.

The results of the validity testing of differences between students of different profiles and forms of study are presented in Tables 2 and 3.

Table 2: Validity Testing of Differences Between Students of Different Educational Profiles in Terms of Proficiency with Neural Networks.

Independent Samples T-Test (educations profile)		
	W	p
knowledge of neural networks	477.500	0.389
use of neural networks in educational/professional activities	476.500	0.386
using neural networks to analyze data in correctional work	484.000	0.430
using neural networks to create educational content	557.000	0.866
Mann-Whitney U test		

Table 3: Validity Testing of Differences Between Students of Different Educational Formats in Terms of Proficiency with Neural Networks.

Independent Samples T-Test (form of education)		
	W	p
knowledge of neural networks	713.500	0.013
use of neural networks in educational/professional activities	866.000	<0.001
using neural networks to analyze data in correctional work	742.000	0.004
using neural networks to create educational content	648.500	0.095
Mann-Whitney U test		

The data indicate that there are no statistically significant differences between students of different educational profiles. However, the format of study (full-time or part-time) does have an impact on the level of proficiency with neural networks, though not in the way we initially hypothesized. Full-time students demonstrated higher levels of competence in using neural networks compared to part-time students. The most significant differences were observed in skills related to the use of neural networks in educational activities.

In the course of the mathematical processing, we aimed to analyze the relationships between the studied components of IT competence. The results of the correlation analysis using Spearman's Correlation are presented in Table 4 and Figure 2.

Table 4: Correlation Analysis of IT Competence Components.

IT Competence Components			Spearman's rho		p
knowledge of neural networks	-	use of neural networks in educational/ professional activities	0.597	***	<0.001
knowledge of neural networks	-	using neural networks to analyze data in correctional work	0.836	***	< 0.001

knowledge of neural networks	-	using neural networks to create educational content	0.844	***	< 0.001
use of neural networks in educational/professional activities	-	using neural networks to analyze data in correctional work	0.669	***	< 0.001
use of neural networks in educational/professional activities	-	using neural networks to create educational content	0.419	***	< 0.001
using neural networks to analyze data in correctional work	-	using neural networks to create educational content	0.490	***	< 0.001
* p < .05, ** p < .01, *** p < .001					

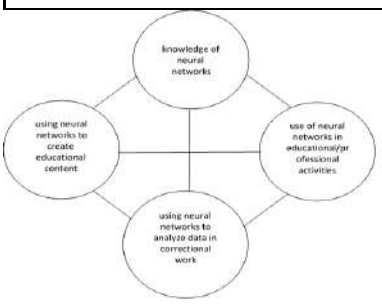

Figure 2: Structural Diagram of Correlation Relationships Among IT Competence Components.

A significant positive correlation was found between various aspects of using neural networks in educational and professional activities. Knowledge about neural networks is positively associated with their use in educational and professional contexts. Therefore, by expanding students' understanding of the mechanisms of neural networks and establishing ethical norms for their use, we can expect that graduates will be more actively engaged in applying neural networks for the individualization of corrective work, as well as involving parents in collaborative efforts to assist children with special needs.

We discovered a strong positive correlation between knowledge of neural networks and their use for data analysis in corrective work, indicating the potential for using neural networks for diagnosing and monitoring the results of corrective work, both with individual children with disabilities and with groups of children. In turn, the ability to analyze data sets obtained during monitoring assessments allows for timely adjustments to corrective work based on the progress and dynamics observed in each specific child.

A positive correlation was also found in relation to the creation of educational content using neural networks. This is especially important for defectologists, as finding readyt-made methodological materials that align with the developmental level of a specific child is often difficult. Currently, defectologists often have to prepare a significant amount of methodological, didactic, and handout materials for each corrective session, which are often used only once due to various constraints. Utilizing neural network resources to create such educational content (didactic and methodological materials) would significantly enhance the effectiveness and efficiency of corrective work by diversifying the handout materials.

4 CONCLUSION

Based on the results of our theoretical and practical research, we have developed the following recommendations for educators on integrating neural networks into the educational process for defectology students:

1. Integrate neural networks into the curriculum by including topics related to neural networks in the main training program. This could be a separate course, or a series of lectures dedicated to the fundamentals of neural networks, their architecture, and applications in defectology.

2. Organize practical workshops work where students can independently build and test simple neural networks, using ready-made platforms such as Google Colab or Kaggle for simplified access to computational resources.

3. Engage students in working with real data by assigning tasks such as analyzing medical documentation, diagnosing speech disorders, and

building neural networks to solve specific practical problems.

4. Assign group projects in which students collaboratively develop neural network solutions for specific special education challenges, such as creating software for speech analysis or developing an educational course with adaptive content.

5. Provide regular feedback and assessment, discussing the work done and offering students constructive criticism and advice for improving their projects. The evaluation should include not only technical aspects but also the ability to apply neural networks in the context of special education.

6. Ensure access to tools and libraries for working with neural networks, such as TensorFlow, PyTorch, or Keras; this will simplify the learning process and allow students to work with modern technologies.

7. Conduct seminars and workshops with specialists in neural networks, to enable students to learn about the latest developments and trends in this field.

8. Encourage self-directed learning by motivating students to engage in online courses, read specialized literature, and attend conferences.

It is also recommended to use the following types of assignments in educational and research work with students:

1. Exploring the Capabilities of Neural Networks for Professional Tasks in Defectology: Study the literature and analyze existing neural network solutions in defectology, then compile a report summarizing their functions and capabilities.

2. Creating a Classifier for Analyzing Speech Disorders: Using available libraries (e.g., TensorFlow or PyTorch), build a simple neural network that classifies types of speech disorders based on short audio recordings, using training data from open resources.

3. Analyzing the Effectiveness of Neural Networks for Diagnostics: Conduct research aimed at comparing the effectiveness of traditional diagnostics for speech and motor disorders with the use of neural networks; present the results in a presentation format.

4. Developing an Adaptive Educational Course Using Neural Networks: Create an adaptive educational course for children with special educational needs based on a neural network approach. Ensure that the course takes into account the individual characteristics of learners and adapts to their knowledge levels and pace of learning.

5. Integrating Neural Networks into the Diagnostic Process: Develop software that integrates neural networks into the processes of diagnosing and correcting speech and motor disorders, allowing special educators to conduct automated diagnostics and generate correction recommendations.

6. Research on the Application of Neural Networks for Predicting Outcomes of Corrective Work: Conduct scientific research to explore the potential of neural networks in predicting the effectiveness of corrective work; the results can be formatted as a chapter in an academic paper or a research article.

In today's world, where information technology is rapidly developing and permeating all areas of life, the formation of IT competence becomes an important task for specialists in various fields, including defectology. Neural networks, as advanced tools for data analysis and process automation, open new prospects for enhancing the qualifications of future special needs educators.

The use of neural networks significantly improves diagnostic quality, individualizes teaching approaches for children with disabilities, and automates routine tasks, allowing educators more time for creative work. Integrating neural network technologies into educational programs for special education students helps develop essential professional competencies, such as the ability to work with large data sets, apply modern analytical methods, and create personalized educational trajectories.

Thus, the implementation of neural networks in the education of special education students is an important step toward preparing highly qualified specialists, who can effectively use modern technologies to enhance the quality of education and rehabilitation for children with disabilities.

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