



The impact of neuropedagogical teaching technologies on the effectiveness of the learning process of future education managers

Vira Lyashchenko*

PhD, Associate Professor

H.S. Skovoroda Kharkiv National Pedagogical University

61002, 29 Alchevskyh Str., Kharkiv, Ukraine

<https://orcid.org/0000-0002-1698-8557>

Iryna Dobroskok

Doctor of Pedagogical Sciences, Professor

Hryhorii Skovoroda University in Pereiaslav

08401, 30 Sukhomlynskyi Str., Pereiaslav, Ukraine

<https://orcid.org/0000-0002-3937-8428>

Alina Zarva

Postgraduate Student

Hryhorii Skovoroda University in Pereiaslav

08401, 30 Sukhomlynskyi Str., Pereiaslav, Ukraine

<https://orcid.org/0009-0000-3542-4813>

■ **Abstract.** The purpose of the study was to determine the impact of neuropedagogical technologies on the effectiveness of the training process of future education managers. The research methodology included the use of the Emotional Intelligence Scale to assess the level of students' emotional intelligence before and after the introduction of neuropedagogical technologies, methods for assessing cognitive learning strategies, and a questionnaire for evaluating pedagogical effectiveness. The study involved 120 higher education students – future education managers and teachers. They were assessed on their ability to understand and manage their own emotions, as well as evaluated the impact of new pedagogical technologies on their learning process. The research focused on methods such as multimodal learning, action learning, emotional intelligence development, brainstorming with neuropedagogical techniques, as well as reflection and self-regulation techniques. The results of the study have shown that neuropedagogical technologies affect the cognitive development, emotional intelligence and motivation of students of vocational educational institutions. It was found that after their introduction into the educational process, there was a significant increase in the level of students' emotional intelligence. Teachers who used modern neuropedagogical technologies created favourable conditions for learning, which led to increased motivation, better learning and increased cognitive activity of students. It was noted that methods of reflection and self-regulation significantly improved students' ability to manage their own learning, reduced stress and increased their interest in learning. It has been found that teachers should use reflection, self-regulation and multimodal learning technologies to improve the learning process and manage students' emotions. It is also important to take into account individual characteristics and develop social and communication skills through teamwork. These findings emphasised the importance of integrating neuropedagogical techniques into the vocational education system to improve the effectiveness of the learning process

■ **Keywords:** professional training; vocational education; innovative technologies; emotional intelligence; cognitive activity; teaching strategies; educational practices

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*Corresponding author

■ Introduction

Vocational education is undergoing constant change due to the rapid development of technology, changing labour market needs and new approaches to learning. There is a need to update teaching methods in vocational education to improve the quality of learning and adapt to the individual characteristics of students. Learning processes need to be more flexible and personalised. Neuropedagogy offers new approaches that promote the development of critical thinking, creativity and adaptability of students, which are important skills in professional life.

Teaching methods are based on outdated pedagogical approaches and do not take into account the latest scientific discoveries in the field of neuroscience. This leads to the fact that learning can be less effective than it could be if the individual cognitive characteristics of students were considered. Despite the growing popularity of neuropedagogy in the world, its implementation in the vocational education system remains insufficiently researched. Many teachers do not have a clear understanding of how to use neuroscientific data to improve teaching methods. Most vocational education institutions have not yet implemented the principles of neuropedagogy in practice, which reduces the effectiveness of learning processes. There is a need to study how neuropedagogy technologies can be adapted to improve teaching methods in vocational education. A significant number of researchers have studied neuropedagogy, revealing unique aspects of how the application of knowledge about brain function, cognitive functions and emotional development can improve learning experience and performance, in particular, H. Kravchenko *et al.* (2024) studied the relationship between neuropedagogy and learning processes. They explored how knowledge about the brain can be applied in educational practice to improve student outcomes. N. Rombaoa Tanaka *et al.* (2020) found that learning through play, using active attention, and stimulating different cognitive processes help students to better remember and absorb information. Their research highlighted how important it is to take into account the neuroplasticity of the brain in curricula.

A. Petter *et al.* (2021) specialised in the emotional and social aspects of neuroeducation. They proved that learning is related not only to cognitive processes, but also to the emotional state of participants in the educational process. Their research has shown that emotional stimuli play a key role in motivation and deep learning. The use of methods that promote the development of emotional intelligence can improve academic performance and satisfaction with learning. The role of neuropedagogy was studied by M. Fragkaki *et al.* (2022). This study was aimed at developing methods for teachers to help optimise the learning process, taking into account the cognitive characteristics of students. They found that the use of active learning, where

different sensory channels are involved, helps students better understand complex topics and increases overall learning performance. Z. Wen *et al.* (2023) studied the practical application of brain knowledge in schools and universities. Their research shows that an approach based on understanding cognitive processes increases student engagement in the learning process. They also found that methods that support emotional interaction between teacher and student help reduce stress during learning and facilitate learning.

Researchers O. Sviertniev & Y. Shostak (2022) noted that the process of training education managers should be targeted at developing managers of a new generation who can think and act methodically, make appropriate management decisions in crisis situations, and use existing resources efficiently. A. Hernández Fernández (2022) found that the use of neuroeducational approaches, such as alternating concentration and relaxation, can improve long-term memory and learning of complex concepts. This, in turn, helps students to reduce anxiety during learning and improve their academic performance. A. Alam & A. Mohanty (2024) have conducted research in the field of neuropedagogy and its impact on student motivation. Their work focused on how interactive technologies and methods of stimulating cognitive activity can help students with different types of learning abilities. Despite significant achievements in the study of neuropedagogy, the issue of its impact in the context of vocational education has not been sufficiently considered. Most of the research is related to general education or higher education, but the specifics of vocational education remain insufficiently researched. The aim of the study was to investigate the impact of neuropedagogical technologies on the cognitive development, emotional intelligence and motivation of vocational education students.

■ Materials and Methods

The study was conducted on the basis of a quantitative approach, which helped to assess the impact of modern pedagogical technologies and methods of neuropedagogy on the learning process of students of vocational education institutions in Ukraine. The sample consisted of 120 participants, including 60 women and 60 men, aged 19 to 21 years. All participants were students of vocational educational institutions from different regions of Ukraine and had previous experience with innovative pedagogical technologies. This sample ensured the representativeness of the study and made it possible to analyse the impact of neuropedagogical methods in different contexts and regions.

Three methods were used to collect data after the application of new neuropedagogical pedagogical technologies in the educational process among vocational education students: multimodal learning, action learning, development of emotional intelligence, application

of brainstorming technology using neuropedagogical techniques, technology of reflection and self-regulation. The first methodology was the emotional intelligence scale. This scale allowed to measure the level of students' emotional intelligence, namely their ability to understand and manage their own emotions before and after using neuropedagogical pedagogical technologies. The next methodology was to assess cognitive learning strategies. This tool allowed to assess the level of cognitive activity of students, their ability to learn independently, as well as their use of various strategies in solving educational tasks. The questionnaire included questions related to aspects such as organisation of learning activities, memorisation strategies, metacognitive skills and self-regulation:

1. How often do you use plans or task lists to organise your learning process?
2. What memorisation strategies do you use when preparing for exams or learning new material?
3. Do you analyse your mistakes after completing learning tasks to improve your understanding of the material?
4. To what extent can you control your attention and focus on a task even in the presence of distractions?

The data obtained from this questionnaire made it possible to assess the extent to which students are actively involved in the learning process and the extent to which they are able to organise their own learning. The last method used was the questionnaire for assessing pedagogical effectiveness, which is aimed at assessing the effectiveness of teachers' use of modern methods of neuropedagogy in their work and included the following questions: Does the teacher use different teaching methods (visual, auditory, kinetic) to stimulate different types of cognitive activity? To what extent does the teacher adapt teaching methods to the individual characteristics of students? Does the teacher use methods that promote the development of critical thinking (discussions, case studies, problem-based learning)? Does the teacher provide constructive feedback during the learning process? How do you assess the teacher's ability to maintain your attention and motivation during classes? Does the teacher use methods that take into account the principles of neuropedagogy (e.g., taking into account the peculiarities of brain functioning at different times of the day, working with students' emotions, etc.)? How do you assess the overall effectiveness of the teacher in using modern neuropedagogy methods?

The students evaluated the teachers according to various criteria, including their ability to adapt teaching materials to the needs of students, use of interactive technologies, emotional support and stimulation of cognitive activity. The data on the following questions helped to determine which teaching methods are most effective within the neuropedagogical approach. The study was organised in such a way that all students filled out the questionnaires in an electronic format.

This made it possible to attract participants from different regions of Ukraine, ensuring the geographical diversity of the sample. The participants were provided with an explanation of the purpose of the study, as well as guarantees of confidentiality and anonymity of their answers in accordance with the American Sociological Association's Code of Ethics (1997). The data collection procedure lasted about two weeks to ensure that all respondents had adequate time to participate. The data were analysed using statistical methods, including descriptive statistics. The analysis focused on the relationship between cognitive activity, emotional intelligence, and the effectiveness of neuroeducational methods. This comprehensive approach to data collection and analysis helped to gain a broad understanding of how neuropedagogy affects teaching methods in vocational education, as well as which aspects are most effective in improving the quality of learning.

■ Results

Theoretical foundations of neuropedagogy and analysis of the main pedagogical technologies in this field that affect the educational process in vocational education

Neuroeducation combines knowledge of neuroscience, psychology, and pedagogy to improve educational processes. This field helps to study how the brain works during learning, how cognitive processes occur, and how emotions affect the acquisition of new knowledge. By applying this scientific approach, educators can develop learning strategies that meet the individual developmental characteristics of students.

One of the main aspects of neuropedagogy is understanding how the brain processes information. It has been found that different areas of the brain are activated during different tasks, such as reading, solving maths problems or listening to music. Neuroeducation also takes into account the development of the brain at different stages of life. For example, younger learners have a different structure of cognitive processes than teenagers or adults, so teaching methods should be appropriate to these age-specific characteristics. Another important aspect of neuropedagogy is the role of emotions in the learning process. Scientific research shows that positive emotions can contribute to better learning, while stress or anxiety can block learning. It is important for teachers to create a positive emotional environment in the classroom where students feel safe and supported. The use of neuropedagogy allows teachers to use a variety of approaches that promote active engagement of students in the learning process. These can include methods that develop critical thinking, stimulate creativity, or improve memory. The use of multimedia, interactive tasks or game-based learning can stimulate the brain and make learning more effective.

The above science helps teachers to better understand how individual student characteristics affect

their learning. These may include differences in information processing speed, attention span, or learning style. Taking these factors into account, teachers can create differentiated tasks that meet the needs of each student. The main principles of neuropedagogy include active learning, individualisation, emotional engagement and metacognition. Taking into account different types of thinking, learning styles and learning rates allows to focus on each student individually. Use methods that stimulate cognitive activity, such as interactive technologies, problem-solving and practical tasks. This promotes better memorisation and deeper understanding of the material.

There are several different neuropedagogical technologies that are important to introduce to vocational students and apply in the learning process. Multimodal learning involves using different sensory perception channels, such as sight, hearing, and touch, to absorb information. This means combining audio and video materials, interactive simulations, and practical exercises to stimulate different areas of the brain, contributing to a deeper understanding of professional knowledge. Action learning is based on physical activity during training, which stimulates various parts of the brain and enhances memory and concentration. This can include coordination exercises while solving practical problems. The development of emotional intelligence involves incorporating emotional components into the learning process to help students improve their ability to interact and collaborate. Students can model real-life situations of professional communication, requiring them to show empathy, regulate emotions, and make decisions under pressure. The application of brainstorming technology with neuropedagogical techniques helps activate creative and analytical processes in the brain. This includes using interactive whiteboards or software to visualise thoughts and ideas during group discussions, stimulating both hemispheres of the brain and enhancing creativity. Reflection and self-regulation technology teach students these skills to improve their cognitive and emotional performance. Students can keep learning diaries, where they analyse their successes, challenges, and emotions during tasks and independently determine strategies for further learning.

Neuropedagogy emphasises the importance of emotions for learning, as positive emotions contribute to better memory and motivation. Creating a friendly and supportive environment helps students to engage more actively in the process. Developing self-reflection and self-regulation skills in learning allows students to better understand their own cognitive processes, which helps them to learn new knowledge more effectively. Applying the principles of neuropedagogy in education allows teachers to better understand how students learn information and create teaching methods that contribute not only to academic success but also to the development of cognitive and emotional skills.

Analysis of the research results after getting acquainted with new pedagogical technologies of neuropedagogy in the educational process of vocational education students

During the academic semester, teachers used a number of neuropedagogical technologies in the learning process. Students took part in classes that combined multimodal approaches, active learning, brainstorming and reflective practices. Students were encouraged to work with different formats of information – texts, audio and video materials, interactive presentations – which activated different sensory channels of information perception. This contributed to better knowledge acquisition and the development of skills related to emotional self-regulation, as students learned to manage their emotional state while processing large amounts of information. The curricula included many practical tasks that required students to actively participate, react quickly and solve real professional situations. This allowed students to experience their own emotions in stressful situations and learn how to manage them effectively. Students were also offered a series of special exercises to develop emotional self-awareness, empathy and emotional self-regulation. For example, exercises to determine the emotional state of themselves and other people, as well as techniques to control emotional reactions during conflicts or learning challenges.

Brainstorming sessions using neuropedagogical techniques helped to engage students in active idea generation in teamwork. It helped to develop communication and empathy skills as students learnt to express their thoughts, listen to others and respond to the emotions of their partners. Future education managers also regularly performed reflection exercises, which allowed them to analyse their emotional states after completing challenging tasks. This practice contributed to the development of self-regulation and self-control skills, which are important elements of emotional intelligence. At the initial stage of the study, students were tested using the Emotional Intelligence Scale, which allowed to assess their basic level of emotional competence. The average value of the level of emotional intelligence for all students was 62.4 points out of a possible 100, which indicates an average level of students' ability to manage emotions at the beginning of the educational process. At the start of the study, vocational education students with a higher level of emotional intelligence showed higher motivation to learn and a better understanding of their emotions when performing complex tasks. Students with a lower level of emotional intelligence more often had difficulty managing emotions during stressful situations and demonstrated lower performance.

After the introduction of pedagogical technologies during the academic semester, the Emotional Intelligence Scale was re-tested, which revealed significant changes in students' emotional competence. The majority

of students showed an increase in the level of emotional self-awareness. Students noted that they had become better able to understand their emotional reactions in stressful situations, especially when performing practical tasks requiring quick decision-making. It turned out that 65% of respondents showed a significant improvement in their emotional awareness, which is a key component of emotional intelligence. This improvement was attributed to the effectiveness of reflection and self-regulation, which helped students analyse their emotions after completing difficult tasks. During practical classes, students were encouraged to take notes on their emotional reactions and analyse their impact on the task. This allowed them to better control stress and maintain concentration during subsequent classes.

The ability to manage one's emotions, especially in times of stress or conflict, is an important aspect of emotional intelligence. After using brainstorming and active learning techniques, 70% of students showed significant improvement in managing their emotions. They became better able to control their reactions to difficulties and failures, particularly when working in teams or completing complex tasks. Students who participated in brainstorming sessions learned how to interact with others, listen better and understand the emotions of their classmates. This helped them to develop empathy and more successfully resolve conflicts that arose during teamwork.

55% of students said that after the introduction of neuropedagogical technologies, they became more sensitive to the emotions of other people. This was especially noticeable among students who worked in groups while completing their learning tasks. Teachers used multimodal learning methods, where students had to interact with different types of information and look for common solutions, taking into account the emotional state of each team member. This result suggests that the use of neuropedagogy contributes to the development of empathy, which is an important aspect for successful learning and professional activity. Students with a higher level of empathy adapted better to different learning environments and were able to interact more effectively with both teachers and classmates.

Improved emotional intelligence also had a positive impact on students' academic achievements. 80% of respondents reported that their motivation to learn had increased significantly after the introduction of neuropedagogical technologies. They felt more satisfied with the learning process and began to learn the material better. Emotional support from teachers, which became possible due to the development of emotional competence, allowed students to feel more confident when completing tasks. This increased their academic productivity and helped them to cope better with stressful situations that could have previously had a negative impact on their performance. The data analysis also showed a certain difference in the impact of pedagog-

ical technologies on men and women. Women showed a greater tendency to develop empathy and emotional awareness, while men showed better results in managing stress and emotions in stressful situations. This indicates that teachers should take into account gender peculiarities when implementing neuropedagogy methods in order to develop students' emotional intelligence as effectively as possible.

The results of the study using the Emotional Intelligence Scale methodology showed that the introduction of neuropedagogical technologies significantly improved the emotional and cognitive abilities of vocational education students. An important conclusion was that technologies aimed at developing emotional self-awareness, emotion management and empathy have a great impact on student performance. In particular, after the introduction of such technologies as multimodal learning, action learning, brainstorming using neuropedagogical techniques, and technologies for reflection and self-regulation, 80% of students showed an increase in motivation to learn, increased self-confidence, and reduced stress during academic tasks. The greatest impact was observed in students with initially average and low levels of emotional intelligence. They showed significant improvements in such aspects as emotional self-regulation, the ability to reflect and interact with other students during group tasks. This demonstrated the effectiveness of neuropedagogical pedagogical technologies in promoting the development of emotional competence even in students who initially had a low level of emotional intelligence.

The second methodology was aimed at studying the level of students' cognitive activity and their ability to learn independently using the methodology of assessing cognitive learning strategies. The study involved 120 students from different vocational education institutions, which allowed to collect a variety of data and draw objective conclusions about the use of cognitive strategies in learning. The level of cognitive activity of the respondents was assessed on a scale from low to high, which allowed to identify how effectively students use cognitive strategies to process information and assimilate it. Three main levels of cognitive activity were identified: high, medium and low (Fig. 1).

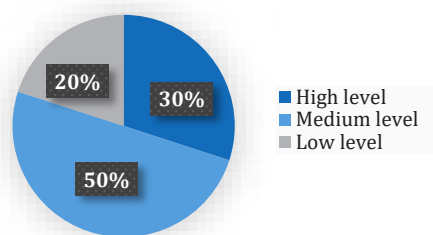


Figure 1. Assessment of the level of cognitive activity of students after familiarisation with pedagogical technologies of neuropedagogy

Source: compiled by the authors

The high-level group of students demonstrated positive indicators of the use of cognitive strategies aimed at deep understanding of the educational material. They actively used such strategies as analysis, synthesis, critical thinking, and also have the ability to systematise information. They did not just memorise the material, but understood it on a deeper level, which allowed them to apply knowledge in new situations. Students in this group were more likely to use reflection when necessary and to reflect on the results of their learning activities.

The largest group of students showed an average level of cognitive activity. They used basic cognitive strategies, such as memorisation and superficial understanding of the material, which allowed them to cope with the tasks provided that the teacher explained them properly. However, their strategies tended to be less systematic and less effective for learning complex concepts or solving problems. This group often used simple methods of memorisation, but did not often engage in critical thinking. The smallest group demonstrated a low level of cognitive activity. These students had difficulties in organising their learning and found it difficult to apply cognitive strategies for effective learning. They did not often use strategies such as analysis or critical thinking, and resorted to rote memorisation. This approach led to a superficial understanding of the material and limited opportunities for further use of knowledge in practical situations. The students' ability to learn independently was also divided into three levels, which allowed to assess how well students can organise their learning activities, plan tasks and effectively monitor their own progress (Fig. 2).

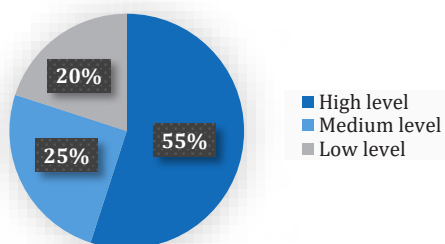


Figure 2. Assessment of the ability of vocational education students to learn independently

Source: compiled by the authors

The group of high-level students accounted for more than half of all those involved in the study, which was a positive indicator. These individuals are able to organise their learning independently. They plan time effectively, distribute tasks and are highly motivated to achieve their goals. These students used a variety of information sources and critically analysed the data. They can find solutions to problems independently. They have developed skills of self-organisation and self-control, which helps them to achieve significant academic success without constant support from teachers. A quarter of all participants have an average level of independent learning ability. They are able to complete learning tasks with instructions or guidance from teachers. They need some support in the form of clear guidance on how to organise their studies. Their ability to plan and control their own activities is not yet sufficiently developed, but they show potential for further development of these skills. The smallest group still has a low level of independent learning ability. These students demonstrated difficulties in organising the learning process and need constant guidance and assistance from teachers. They are usually unable to plan their own learning tasks or analyse their progress, which often leads to delays in completing tasks and poor academic performance.

The results of the analysis showed that there is a positive correlation between the level of cognitive activity and the ability to learn independently. This indicates that students with a higher level of cognitive activity also demonstrate a higher ability to learn independently. Students who use complex cognitive strategies, such as critical thinking, analysis and synthesis of information, are more likely to organise their learning effectively and achieve high results. At the same time, vocational students with low cognitive activity have significant difficulties in independent learning, as they do not have sufficiently developed strategies for processing information and planning their activities. They need additional support from teachers and clear instructions to complete tasks successfully. The survey participants assessed the effectiveness of teachers' use of neuropsychology technologies in the educational process. The results of the survey are presented in Table 1.

Table 1. Results of assessment by vocational education applicants of the effectiveness of teachers' use of modern neuropsychological technologies

Question number	% of participants	Results of the survey participants' responses
1	90%	It was noted that teachers actively use various forms of presenting material, stimulating different channels of perception (visual, auditory, kinetic).
	10%	It was believed that teachers mostly use one method without adapting it to different cognitive styles.
2	75%	Teachers' ability to change their teaching approach depending on the individual needs and level of training of students was positively assessed.
	25%	It was noted that adaptation of methods occurs infrequently, and the teachers' approach is more standard.
3	85%	Teachers noted the frequent use of critical thinking development methods, such as case analysis, discussions, and problem-based learning.
	15%	They pointed out the insufficient integration of such methods into the educational process.

Table 1. Continued

Question number	% of participants	Results of the survey participants' responses
4	80%	Teachers were believed to provide constructive feedback that helps to understand mistakes and improve subsequent results.
	20%	Feedback was felt to be insufficiently specific or infrequent.
5	70%	Teachers' ability to maintain attention and motivation was rated as high, noting the interesting nature of the material and interactive approaches.
	30%	It was pointed out that teachers do not always use motivational tools, and students' attention during classes decreases.
6	65%	Confirmed that teachers use methods that take into account the peculiarities of brain function, such as planning classes taking into account daily rhythms and working with the emotional state of students.
	35%	Teachers did not notice the active use of such approaches in the educational process.
7	90%	Teachers' effectiveness in applying modern neuropedagogical methods was highly appreciated.
	10%	It was noted that teachers could integrate more innovative approaches to improve the quality of teaching.

Source: compiled by the authors based on their own research

According to the above information, it was found that 55% of students rated the work of their teachers as very effective. These teachers actively use neuropedagogical approaches focused on stimulating students' cognitive activity, developing critical thinking and interactive teaching methods. Students noted that such teachers adapt teaching methods to meet individual student needs, apply multimodal approaches, and use various forms of feedback to enhance understanding of the material. At the same time, 35% of the survey participants rated their teachers as moderately effective. They found that teachers use some neuropedagogical methods, but their implementation is not always consistent or systematic. Students noted that these teachers introduce new methods, but often return to traditional teaching methods, such as lectures and tests, without integrating modern cognitive approaches. 15% of students assessed the work of their teachers as ineffective in terms of the use of neuropedagogical technologies. Students in this group noted that teachers mostly rely on traditional teaching methods that do not take into account the peculiarities of students' neurocognitive processes. These teachers rarely used active or interactive teaching methods and almost never apply approaches that would improve students' memory, attention or cognitive activity.

Vocational education students were quite positive about teachers who demonstrated an understanding of neuropedagogical approaches and the ability to adapt their teaching methods depending on the type of material or the needs of the group. Such teachers provided a variety of options for presenting information, using both visual and auditory teaching methods. However, 40% of respondents indicated that they did not always consider the individual cognitive characteristics of students. Teachers who effectively used neuropedagogical methods contributed to the improvement of students' academic results. Vocational students reported that such teachers helped them to better understand the material and stimulated the development of cognitive skills such as critical thinking

and problem-based learning. In groups with a low level of neuropedagogy, students often felt a decrease in motivation and interest in the subject. Active teachers, according to students, provided constructive feedback, which helped them to better understand their own mistakes and adjust their learning process. Students noted that regular and well-structured feedback had a positive impact on their understanding of the course material. The study showed that the introduction of neuropedagogy into the educational process can significantly improve learning efficiency and student motivation, but this requires providing teachers with the necessary knowledge and skills.

Neuropedagogy has a significant impact on teaching in vocational education and learning outcomes, as it considers the peculiarities of brain functioning to optimise the learning process. Its principles have helped teachers to better understand how students perceive, process and learn information, which is important for training specialists in various fields. It turned out that using knowledge of brain functions, teachers can better adapt curricula to the needs of individual students, taking into account their cognitive characteristics and level of training. Teachers who have developed an emotional connection with students are able to increase motivation and create a favourable learning environment. By understanding how students absorb information, neuropedagogy promotes interactive teaching methods that engage students in active learning through digital platforms, simulations, or game-based methods.

Teachers should actively use reflection and self-regulation technologies so that students can be aware of their emotional reactions during the learning process. This will help them to better manage emotions in stressful situations. It is also worth continuing to use various forms of multimodal learning, as it allows for the use of different sensory channels and promotes better absorption of information. Teamwork, which stimulates the development of empathy and communication skills, should be actively implemented, as it contributes to the development of students' social and emotional competences.

At the same time, it is important for teachers to take into account the individual characteristics of students, including gender differences in the development of emotional intelligence, to ensure the most effective learning for all groups of students. Since professional education is often associated with high levels of stress (especially in medical or technical specialities), neuro-education helps to develop methods to improve stress management, which contributes to a more effective learning process. Neuropedagogy provides scientifically based approaches to the development of teaching methods, which increases the effectiveness of learning in vocational education, making it more adapted to the needs of modern students.

■ Discussion

The results of the study showed that neuropedagogy is gaining widespread use in vocational education every year due to its ability to ensure more effective learning and development of students' cognitive abilities. The study of the brain and neuroscience allows teachers to better understand how learning affects neural processes and adapt teaching methods to improve learning outcomes. Research shows that neuropedagogical approaches contribute to the development of critical thinking, concentration and the ability to solve complex problems in students of professional educational institutions, as noted by L. Werner & D. Koering (2020), D.E. Nurmakanova *et al.* (2021), S.-C. Kong & Y.-Q. Wang (2024). This study also found that the use of neuropedagogical techniques, such as adaptive learning strategies, content personalisation, and cognitive training, increased student achievement. These results are in line with the research of other authors, such as R. Shaw & B. Patra (2022), R. Shaw *et al.* (2023), where the emphasis is on the connection between emotions and the learning process, and this allows for a deeper understanding of how motivation and emotional states affect academic achievement. The study by S. Mystakidis *et al.* (2023) emphasises the importance of integrating emotions into learning processes, which contributes to the activation of certain neural pathways responsible for the storage and processing of information. This study also noted that the emotional engagement of students caused by teachers through the use of multimedia materials and interactive tools improved their understanding of complex material and its long-term retention. The findings on the importance of integrating emotional factors are consistent with previous research and highlight the need for emotional stimulation to improve learning outcomes.

It has been found that individualisation of educational processes based on neurobiological differences between students is considered one of the key topics of neuropedagogy. According to research by D. Marchak & I. Shvarts-Serebro (2021), I. Shvarts-Serebro *et al.* (2024), the adaptation of teaching methods to the

individual cognitive needs of the participants in the educational process is an important aspect to achieve maximum results. In this study, it was found that the use of adaptive methods, in particular testing the cognitive profile of students before the start of the educational process, allows teachers to select the most effective tools and approaches for each student. This makes it possible to adjust the learning process to consider the neuroplasticity of the brain, which further increases the level of knowledge acquisition. These results correlate with the findings of A. Rakhmetova *et al.* (2024), which emphasised that teachers should use teaching methods that correspond to the natural learning cycles of the brain. In particular, these results showed that the use of interactive simulators and simulations that take into account individual cognitive characteristics significantly increases the level of student interest and promotes deeper learning.

The findings also revealed that it is important to take into account the neuroplasticity of the brain, i.e., its ability to change its structure and functions in response to experience and learning. Studies have shown that techniques that stimulate neuroplasticity, such as practical application of knowledge, problem-based learning, and cognitive training, can significantly improve learning outcomes (Izaguirre *et al.*, 2023; Álvarez de Andrés, 2023). These studies confirmed that curricula based on the integration of practical tasks and simulation training help vocational students to better learn the material and develop professional skills. These results are also consistent with the study by V. Richard *et al.* (2018), which noted that practice and repetition are key factors that stimulate neuroplasticity. In the present study, students who went through intensive practical training and worked with simulation tools demonstrated significantly higher results on final tests, which confirms the importance of using practical methods for the development of neuroplasticity.

Innovative technologies such as virtual reality, augmented reality, and artificial intelligence are important tools in neuropedagogy, as they can provide unique opportunities for interactive learning and adaptation to the individual needs of students (Cobos Reina & Silva, 2022). In this study, it was noted that the use of such simulations and interactive platforms allows vocational students to immerse themselves in real-life situations that stimulate cognitive activity and promote more effective learning. This approach is consistent with the research of S. Ismail Adham & N. Al-Zuhairi (2022), which emphasised that multimedia learning promotes the active involvement of neural networks responsible for cognitive perception. The works by O.O. Adesope *et al.* (2019), S. Gates (2021), R. Recio (2024) also support the idea that technologies that allow students to interact with learning material contribute to better understanding and assimilation of knowledge. In the present study, it was noted that vocational students who used

interactive simulators and technology performed better on final tests and demonstrated a better understanding of professional skills. This once again underlines the importance of using the latest technologies to stimulate cognitive activity and develop neuroplasticity.

Neuropedagogy has demonstrated significant results in improving learning effectiveness, but its application in vocational education faces certain challenges and limitations. Researchers such as A. Kumar *et al.* (2021), B. Mohammadi Orangi *et al.* (2021) note that there is a risk of misinterpreting neuroscientific data and transferring untested concepts to practice. This can lead to ineffective use of methods, as incorrect interpretations may not be relevant to real-world learning environments. In this context, it has been found that some teachers have difficulty adapting the latest neuropedagogical methods due to a lack of training and resources, which limits their ability to implement new approaches effectively. An essential step in overcoming these difficulties is the development and implementation of systematic professional development programmes for teachers. Such programmes can help to better understand the foundations of neuroeducation and to use them appropriately in practice. This is in line with the work of E. Bottero (2022), who emphasised the need to prepare teachers to use neuroscientific knowledge to improve learning outcomes. The introduction of new technologies and methods can also require significant financial costs and resources. This can be a limitation for some educational institutions, especially those facing funding issues or insufficient technical equipment. The effective implementation of neuropedagogical approaches requires a comprehensive approach to training and resourcing.

The introduction of neuropedagogy in vocational education demonstrates significant potential for improving learning outcomes. This study confirms that the use of neuropedagogical techniques, such as adaptive learning strategies, interactive technologies and practical tasks, contributes to the improvement of learning outcomes and the development of professional skills. These results are consistent with previous research confirming the importance of integrating emotional and cognitive aspects into the learning process. The latest technologies that stimulate cognitive activity and neuroplasticity are proving to be effective in improving the quality of education. The implementation of neuropedagogical methods faces certain challenges. One of the main aspects is the need for additional resources and teacher training. Without sufficient teacher training and resources to implement the latest approaches, their implementation may be limited or ineffective. To further develop neuropedagogy in vocational education, it is important to continue research and develop effective strategies for integrating new methods into the learning process. This will help to achieve maximum results in learning and developing students'

professional skills. Thus, neuropedagogy is a powerful tool for transforming the system of training new generation education managers, but its successful implementation requires a comprehensive approach and continuous improvement of methods and technologies.

■ Conclusions

The results of the study of the importance of neuropedagogy in the educational process confirm the significant role of this interdisciplinary field in improving learning efficiency. One of the key technologies is that multimodal learning, which involves different sensory channels, contributes to better learning. Students who receive information through visual, auditory, and tactile channels demonstrate a deeper understanding and greater engagement in the learning process. This is supported by data showing the need to develop cognitive strategies such as critical thinking, information analysis and self-organisation. Technologies that support active learning through action also have a significant impact on the effectiveness of vocational education. Teachers who use brainstorming sessions and practical exercises help students better adapt theoretical knowledge to real-life professional situations. The use of neuropedagogical techniques during brainstorming sessions helps to develop students' ability to think critically and make quick decisions. An important aspect of this is also the development of emotional intelligence, which contributes not only to better socialisation of students, but also to their ability to work effectively in a team, manage emotions and resolve conflicts.

A significant part of the study was devoted to assessing the impact of reflection and self-regulation technologies on the cognitive activity of future education managers and the formation of their managerial competence. The results showed that students who are aware of their emotions and are able to control them in stressful situations demonstrate a higher level of independence in learning. 55% of the surveyed vocational students showed high results in terms of independent cognitive activity, which indicates the need to introduce additional training programmes aimed at developing these skills. This confirms the importance of neuropedagogy in shaping teaching methods that support the development of critical thinking and self-organisation skills. The latter methodology has shown that most teachers successfully use modern neuropedagogy methods, including multimodal approaches and critical thinking strategies. However, there is room for improvement in terms of individual adaptation of teaching methods, as well as in the wider use of neuropedagogical techniques to support students' emotional and cognitive activity. The majority of teachers actively use modern neuropedagogical approaches, and the need to individualise methods remains an important task. A wider range of neuropedagogical techniques aimed at supporting students' cognitive and emotional

engagement could lead to even greater learning gains, especially in the context of vocational education, where critical thinking and emotional intelligence skills are key to success. Prospects for further research are the development of new curricula that will take into account the cognitive characteristics of vocational education students and contribute to the personalisation of the educational process.

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Вплив нейропедагогічних технік на ефективність процесу навчання майбутніх менеджерів освіти

Віра Лященко

Доктор філософії, доцент

Харківський національний педагогічний університет імені Г.С. Сковороди

61002, вул. Алчевських, 29, м. Харків, Україна

<https://orcid.org/0000-0002-1698-8557>

Ірина Доброскок

Доктор педагогічних наук, професор

Університет Григорія Сковороди в Переяславі

08401, вул. Сухомлинського, 30, м. Переяслав, Україна

<https://orcid.org/0000-0002-3937-8428>

Аліна Зарва

Аспірант

Університет Григорія Сковороди в Переяславі

08401, вул. Сухомлинського, 30, м. Переяслав, Україна

<https://orcid.org/0009-0000-3542-4813>

■ **Анотація.** Метою дослідження було визначення впливу нейропедагогічних технологій на ефективність процесу навчання майбутніх менеджерів освіти. Методологія дослідження включала використання Шкали емоційного інтелекту для оцінки рівня емоційного інтелекту студентів до і після впровадження нейропедагогічних технологій, методики оцінювання когнітивних стратегій навчання та опитувальник оцінки педагогічної ефективності. Було залучено 120 здобувачів вищої освіти – майбутніх менеджерів освіти та викладачів. Вони проходили оцінювання на здатність розуміти та управляти власними емоціями, а також оцінювали вплив нових педагогічних технологій на свій навчальний процес. Дослідження зосереджувалося на вивченні таких методів, як мультимодальне навчання, навчання через дію, розвиток емоційного інтелекту, застосування технології мозкових штурмів із нейропедагогічними техніками, а також технології рефлексії та саморегуляції. Результати дослідження показали, що нейропедагогічні технології впливають на когнітивний розвиток, емоційний інтелект та мотивацію студентів професійних закладів освіти. Виявлено, що після їх впровадження у навчальний процес спостерігалось значне підвищення рівня емоційного інтелекту студентів. Викладачі, які використовували сучасні нейропедагогічні технології, створювали сприятливі умови для навчання, що призводило до підвищення мотивації, кращого засвоєння матеріалу та зростання когнітивної активності студентів. Було відзначено, що методи рефлексії та саморегуляції значно покращили здатність студентів самостійно керувати власним навчанням, зменшували стрес та підвищували їхню зацікавленість у навчанні. Виявлено, що викладачам слід використовувати технології рефлексії, саморегуляції та мультимодальне навчання для кращого засвоєння інформації та управління емоціями студентів. Важливо також враховувати індивідуальні особливості та розвивати соціальні й комунікативні навички через командну роботу. Ці результати підкреслили важливість інтеграції нейропедагогічних методик у систему професійної освіти для підвищення ефективності навчального процесу

■ **Ключові слова:** професійна підготовка; професійна освіта; інноваційні технології; емоційний інтелект; когнітивна активність; навчальні стратегії; освітні практики