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Features of Training Future Teachers of Natural Sciences in Modern Higher Education in the Context of Modern Neurosciences

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Abstract: *In the article, questions about the features of training future teachers of natural sciences in modern higher education in the context of modern neurosciences are highlighted.It was found that highly qualified and competent teachers are the key to successful higher education. The concept of "neuroscience" is investigated. Publications and books of domestic and foreign scientists on the training of future teachers of natural disciplines in the view of neurosciences are highlighted. The application of methodological approaches in teaching future teachers of natural disciplines is noted. The branch of neuro-andragogy, which is important for adult learning is considered. It is noted that university teachers should enrich the educational process with modern strategies in order to meet the needs of future student teachers. It is noted that future teachers are interested in mastering knowledge of neurosciences, because they understand that this will help them in their professional activities. It has been proven that many scientists argue that education cannot exist today without neurosciences. The facts that have a special impact on the work of the child's body and on learning have been clarified: energy supply, nutrition, stress resistance and environmental pollution. A study of approbation of foreign programs "Scheme of education and neuroscience" and "Science of the brain in motion" was carried out. It was found that students are interested in knowledge about the work of their own brain and try to work on themselves to help the body improve its performance.It is noted that scientists argue that for the activity of the brain to be productive, it is necessary for the neurons, synapse and myelin to work in a balanced way.It was proven that COVID - 19 pandemic to negatively impacted education. It was found that physical activity and the activity of cognitive functions are an integral link. Emphasis is placed on the pedagogy of partnership, which will promote close cooperation of teachers, children and parents and help parents to preserve the health of the child.*

Keywords: *Educational process, neuroscience, neuro-andragogy, neuropsychologist, learning strategies, cognitive processes, brain activity.*

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1. Introduction

Guerriero S. (2017) in his textbook "Educational Research and Innovation" examines in detail the role of the teacher, analyzes the activities, notes the successes and problems of the teaching profession. The author emphasizes that highly qualified and competent teachers are the key of successful higher education. Today, in order to help university students to realize their full potential and become valuable professionals, teachers should possess important professional competence - be ready for a continuous process of updating professional knowledge (Demchenko et al., 2021; Prots et al., 2021; Kosholap et al., 2021; Ovcharuk et al., 2021; Komogorova et al., 2021).

Scientist Bruer J. (1997) noted that neurosciencesare a field that studies the problems of children with special needs, suffering from speech disorders, dyslexia, dyscalculia, attention deficit disorder, social and emotional disorders.

It is known that the human brain is one of the main human organs. A neuropsychologist is a physiologist who studies the relationship between the physical brain and behavior, that is, helps a child overcome learning difficulties and rapid mood changes, as well as memory problems.

It is worth noting the textbook written by Churches R. (2017), which presents a serious theoretical and practical base on neuroscientific findings, which is used by teachers in organizing the educational process. The manual "Neurology for Teachers" provides detailed sections about the study of metacognition, memory, motivation, emotions, skills, attention of children.

In his work, Bergen D. (2017) examines the brain function of children of different ages. The author notes that during the period of primary school and adolescence, children may experience cognitive impairments in the work of the brain, emotional disorders. It is known that often elementary school students who successfully studied have difficulties in higher school: it is difficult for them to concentrate, plan actions, control their behavior, etc. In adolescence, children have to solve conflicts, misunderstandings and disputes between peers and adults can arise and sometimes depression occurs. Adults expect more adult behavior from adolescents.

The work of Tkachenko I. et al. (2020) is devoted to the application of methodological approaches to teaching future teachers of natural sciences, this work analyzes in detail the approaches to teaching physics, chemistry, biology in higher school. The activity approach is focused

specifically on practical actions and independent planning of their activities by students. Psychodiagnostic approach is based on subject, methodological, didactic and psychological knowledge. The competence-based approach is focused on the result in educational activities. The integrity of the above approaches makes it possible to form critical thinking in students and ensure a high level of professional training of future teachers.

In his article, Hrytsai N. (2017) argues that during practical classes, future biology teachers learn new methods, interactive technologies and learning strategies that contribute to the development of intellectual and practical skills and aimed at developing critical and creative thinking. During laboratory classes, future biology teachers conduct lessons with students, using modern forms of work, perform laboratory research. In addition, the author recommends to his colleagues to study the experience of methodological training of future biology teachers in foreign countries and implement them in universities.

In the article by Friederichs A. (2018) we learn that the theorist of adult education Knowles M. (1980) popularized the branch of neuro-andragogy, and also set out his theoretical views in the book "Modern practice of adult education". It is known that currently, universities teach studentsusing Knowles' theory (1980), which is based on six principles: 1) adults learn, 2) gain experience, 3) adults are willing to learn related to social roles, 4) adults want the immediate application of knowledge, 5) they are intrinsically motivated, 6) adults need to understand the reason for learning. As defined by Wilson C. (2006), who is the author of the book "Nobody's Old to Learn", neuro-andragogy examines scientific research about the adult brain. Neuro-andragogy is the anatomical and physiological study of the adult brain, as well as the cognitive functions of the brain systems involved in the development of intelligence, memory, thinking and cognition. The author assures that neuro-andragogy is important for anyone who teaches adults in order to influence the brain of adults during training.

2. The essence of teaching future science teachers in modern higher school

In his publication Friederichs A. (2018) notes that the human brain consists of 100 million neurons, or brain cells. Every time a child or adult learns something new, the brain processes the information and adds it to the previous experience. The author advises to enrich and diversify the educational process with more active forms of work in order to encourage students to take action. He also draws attention to constructivism - a theory that is based on the fact that in the learning process, the student gains

experience and reflects on what he saw. During their studies, the teacher invites students to create mind maps or a collage of their own thoughts, review podcasts or find videos, try to record a virtual review of the results obtained using phones or webcams. Thus, neuro-andragogy shows that educators should enrich the educational process with modern teaching strategies to meet the needs of modern students.

It should be noted the work of Owens M. (2017), which invites teachers to select tasks that will arouse students' interest, then learning will be effective. In addition, it is better to associate tasks with real life, to give exercises for the association of the selection of concepts in order to induce active work of brain cells in students. The author conducted research on four different forms of work, which were proposed for the experiment to first-year students, future teachers of biology. The first was the involvement of active making homework. Reading is known to be a passive learning strategy. Therefore, in order for the training to be effective, students should be faced with tasks and problems that need to be solved. The second type is conceptual maps. When students create concept maps, they should clearly link biological concepts and ideas to each other, rather than consider them separately. The experiment has proven that creating concept maps improves understanding of learning material and makes it easier to remember what has been learned. The third type is problem learning, which helps to solve difficult situations in which attention develops and motivation to learn appears. The fourth type is the study of the experience of various scientists. This form can involve students in various studies. In addition, it is worth using the exchange of views in the work, when students ask interesting questions, to provide a basis for reflection and discussion. Questions encourage students to connect the material being studied with previously studied material, to solve real problems, to think, that is, they increase nervous plasticity. Friendly and collaborative work fosters new ideas.

Particularly noteworthy is the article by Zambo D. and Zambo R. (2009), in which the author notes that students of their university, future teachers are motivated to learn more about the brain. They persistently find information about the brain from textbooks, watch videos from websites, because they believe that they can apply new knowledge and modern techniques in their future professional activities. Students believe that thanks to new research, it is possible to improve and stimulate the cognitive processes of children. If future science teachers gain knowledge about neurons, synopsis and the brain, they will be able to apply the gained knowledge and skills in working with children and effectively organize the educational process. It should be remembered that with the rapid scientific

and technological progress, we are able to find the information we need, but at the same time there are many websites with questionable information about the brain. Thus, future educators insist that today's teachers should study the latest research on the brain and find practical teaching strategies for children.

In her article, Upatova (2020) explores the use of interactive methods in teaching future biology teachers, compares modern teaching strategies to identify more effective and meaningful. The author emphasizes that now it is worth paying special attention to the development of critical thinking of teachers, to develop their potential, to intensify attention to reflection and apply contextual learning. In addition, the author emphasizes the organization of individual, pair, group and collective forms of education.

Attention is drawn to the article by Thomas et al. (2018), who notes that education and neuroscience must complement each other in order to study the brain as a biological organ that must work successfully. In addition, the author focuses on the fact that the relevance of neurobiology for education has been recognized throughout the 20th century. Many scientists have published their studies proving the close connection between education and neuroscience. The development of neurosciences contributed to the creation in 2004 of the International Society of Mind, Brain and Education, in 2009 the European Research Association founded the group "Neurology and Education". But, unfortunately, the author emphasizes that at that time there was no cooperation between psychology, education and neurosciences, there was more competition. It is worth remembering that psychology studies human behavior, and neurosciences studies the work of brain mechanisms that regulate human behavior. Therefore, Bruer J. (1997) wrote about the close connection that should exist between neurosciences, psychology and education. Thomas et al. (2018) identifies energy supply, nutrition, stress resistance and environmental pollution as factors that can affect the functioning of the child's body and, at the same time, the learning of students.Therefore, the goal of neurosciences is to improve learning results to help them develop abilities, focus and promote motivation.

An interesting fact is that in 2014 in the United Kingdom, a charitable organization that took care of poor students in England and the Educational Foundations launched the "Education and Neuroscience Scheme" program, which aimed at the implementation of 6 projects, Howard-Jones P. et al. (2016). The first project aimed at examining sleep model in adolescents and assessing its impact on student achievement. The second project investigated the effect of different cardiovascular activities on learning success, using brain imaging to investigate the mechanism of any

observed correlation. The third project is the potential for open-source training in science and mathematics. The fourth - assessed the effectiveness of distance learning. The fifth project was based on neurosciences. Sixth - studied the effectiveness of computer games to improve reading by developing phonemic hearing.For consideration, let's take the first two projects, which are undoubtedly based on partnerships between education and neurosciences. Restricting adolescent sleep time for several nights in a row affects cognitive functions of the brain, and conversely, regularity and intense exercise during the day contribute to better student performance. Meditation reduces stress, regulates emotions, and helps children to be active and attentive.

3. Strategies for working with students in the paradigm of neurosciences

The question of the introduction of neurosciences in the professional development of teachers of natural disciplines was considered by D. Dubinsky (2013). The author emphasizes that every day during the lesson, the teacher helps the child to develop the cognitive functions of the brain: to understand information, learn new things, understand, read texts, perceive material, etc. The article indicates that students of pedagogical universities study the ionic, molecular and biophysical level of generating brain activity. Two-week BrainU hands-on seminars were held for university educators to learn the fundamental principles of neuroscience, including neurological instructional concepts, and to enhance their knowledge of brain anatomy and physiology. Research has shown that educators have enriched their knowledge of neuroscience and changed their teaching strategies in order to conduct more active classes that are more student-centered. Teachers claim that thanks to the knowledge they received, they began to treat students more positively, energetically and more tolerantly, they had a high motivation to teach, they understood the negative impact of stress on students' knowledge. With great enthusiasm, university teachers passed on knowledge about neurosciences to future teachers of natural sciences, since they understand that this is extremely necessary for young teachers. A competent teacher in the field of neurosciences will be able to easily understand the level of a child's development, choose teaching methods and strategies, and help improve the functioning of brain circuits responsible for the formation of various cognitive skills.

Noteworthy is the article by McNabb C. et al. (2017), which states that the Department of Neurosciences at the University of Minnesota and

the Science Museum of Minnesota jointly developed the program "Brain Science in Motion" for testing by science teachers with students in grades 5-8. This course was aimed at raising the level of knowledge of educators in the field of neurosciences, arousing interest among middle school students and attracting them to the study of brain science, which will help to explore their own thinking and learning processes, to foster partnerships between rural and urban schools, scientists, educators and students. After being trained at BrainU, teachers began to apply new teaching strategies, and an interest in professional activities appeared. In addition, Minnesota participants showed high results in the III International Exam in Mathematics and Science. Thus, teachers, together with students, explored modern researches on the human nervous system and the brain. The "Brain science in motion" course was based on 5 components: 1- BrainU - summer training to improve the professional development of teachers of natural sciences, which would help deepen knowledge and skills, get acquainted with resources for use in practice; 2 - viewing a multimedia presentation by students in order to familiarize themselves with the brain and thinking processes; 3 - exhibition stations - conducting interactive activities for students; 4 - classroom activities, 5 – "Brain Chests" - a set of materials and resources for processing. During their studies at BrainU, teachers examined in detail six main topics: 1) macro/microstructure and function of the nervous system, 2) neurotransmission and neuroimaging techniques, 3) learning and memory, 4) the use of model systems, 5) properties and research design, 6) synthesis and development of an individual action plan for integrating neurosciences into the school curriculum. Teachers took part in a variety of neurosciences classes and assessed the assembly and exhibition station programs, developed their own exercises, modeled teaching strategies, and explored neurosciences-related web resources. Participants had the opportunity to communicate with neurologists, visit laboratories working on neuron cells and sensory-motor integration. The assembly introduced students to neurology in an exciting way, demonstrated a multimedia presentation about the brain. With the help of optical and auditory aids, using modern imaging techniques, students were shown the neural plasticity of the brain and a model synapse to help understand the functions of different parts of the brain and their impact on thinking, perception and memory. There were three exhibition stations in the classrooms, where students had the opportunity to discuss with scientists the structure of the human and animal brains, learn how to determine the work of brain waves using a computer, take part in eight activities to test themselves for relative sensitivity, sensory motor coordination, etc. "Brain

stems" contained CDs, videos, books, coloring books, lists of web resources, models of how the brain looks and works, how neurons interact with each other. According to the observations of teachers, students are interested in neurosciences, and in the future they can connect their profession with this knowledge. In the future, teachers of natural sciences plan to deepen their knowledge of pedagogy and neurology, as well as share their experience with colleagues.

In his article, educator Willis J. (2009) share his best practices and recommendations on how to improve brain function in students. The author assures that if the teacher wants to see his pupils successful, smart, then he must teach them to control their own health, improve the cognitive processes of the brain. It is known that many students believe that they have certain intelligence from birth, and therefore they cannot change the brain. But it's not like that. The teacher recommends practicing mindfulness exercisesand using activities that would help children focus and achieve a positive mood.

A valuable supplement for organizing successful learning is the article by Sriram R. (2020). The author notes that performing interesting and difficult tasks in the lesson stimulates the production of myelin, a substance that improves the functioning of brain signals. To make learning for children productive, four strategies have been proposed. The teacher should take care of the application of modern effective methods and techniques for effective teaching, but for this he must first understand what happens to the brain of students when they study simple and complex material. The brain requires three components: neurons, synapsis, and myelin. Sriram R. (2020) recommends using four strategies to improve the educational process: search, alternation, spacing and mindfulness.

Selected aspects of improving educational performance and mental health of children are covered by Tortella G. et al. (2021). The author notes that the COVID-19 pandemic and the strengthening of quarantine restrictions have negatively affected education, because loneliness, anxiety and stress have led to a deterioration in the mental well-being of both teachers and students. Undoubtedly, electronic resources have come to help teachers in distance learning, which, through the use of information and communication technologies helped to conduct classes but they are not able to replace live communication. Therefore, analyzing the advantages and disadvantages of distance learning, it was found that memorization or repetition in the classroom does not contribute to learning, the best success can be achieved through experiments. Neurologists consider physical activity, healthy eating and restful sleep as important aspects - all of which

directly affect a child's success. In addition, to increase mental health resilience, educators should use modern teaching methods and strategies that will encourage students and develop their mental processes. Therefore, the question arises: are teachers really ready to teach in terms of e-learning and children, in turn, emotionally and physically ready to perceive information and keep it for a long time? Because the learning process in education is easy to change, emotions triggered by life events also affect mental health and academic performance. Scientists from different countries have studied the condition of children in distance learning. Students in Argentine schools who were limited in communication had problems with emotional regulation, so this negatively affected their perception. US college students experienced fear, anxiety, depressed thoughts, concerns about the health of their relatives during the COVID-19 pandemic, and therefore had difficulty concentrating and remembering. Thus, social distance generates loneliness, reduces the appearance of positive emotions and the motivation for learning is lost. Therefore, an important task for teachers and parents is to support students by providing tools that will facilitate learning, as well as inhibit negative emotions that hinder cognitive processes.

In his work, Mercanti-Anthony M. (2021) is concerned that in the fall of 2021 educational institutions will have to use various forms of assessment in order to find out the gaps in children's learning that arose during distance learning in the spring of the same year. It is known that cognitive science has made progress in understanding how the child's brain works over the past 20 years, so in this case teachers should choose strategies for questioning, modeling and feedback. At the Bronx Academy of Research, educators use the principles of the famous professor of educational psychology Rosenshine B. (2012), who developed his own theory and thus offered recommendations for the implementation and modeling of skills in children. The main advice of the scientist is to frequently ask questions to students in order to develop thought processes and assess the understanding of what has been learned.

Knowledge of neurosciences helps to learn about how actions in the brain are related to environmental factors, emotional and cognitive processes. An interesting fact is that many years ago, scientists proved that good nutrition is an important factor for the development of cognitive abilities, food affects the plasticity of the central nervous system and has the ability to recover from injuries. A separate issue is teacher burnout, also triggered by e-learning. Teachers had to quickly learn new programs, manage problem behaviors of children in the classroom, overcome emotional exhaustion.

A literature review shows that there are many publications on the relationship between physical activity and the development of cognitive functions. In particular, the article by Tomporowski P. et al. (2008) investigated the effect of exercise on the mind, cognition and learning activity of children. Of course, mobile, physical education in the classroom is extremely necessary for students.

Modern reform in education prompted the emergence of the term "pedagogical partnership", that is, the new Ukrainian school works on the basis of cooperation and interaction of teachers, children and parents. Many articles are devoted specifically to the topic of exercises that neuropsychologists, psychologists, and educators can recommend for use by parents. Myers R. Ph.D. (2021) offers 6 activities to train the brain of children. The author emphasizes that such exercises help childrento develop mental abilities: learn to plan, remember details, manage time, regulate emotions, solve problems, communicate, be organized. Such executive functions contribute to academic and work success.

The article by Pickering S. & Howard-Jones, P. (2007) confirms that the knowledge of neuropsychology and neuropedagogy is necessary for future teachers of natural sciences. The author of the publication proves that the interviewed teachers have a great desire to introduce knowledge of neurosciences into education in order to acquire practical skills and abilities to improve the functioning of brain activity of children.

4. Conclusions

Undoubtedly, the literature review shows that in the scientific literature there are many works of domestic and foreign scientists, covering the issues of training future teachers of natural sciences in modern high school in the context of modern neurosciences.

It was found that the activities of modern higher education depend on highly qualified and competent teachers. One of the modern subjects for adult education is neuro-andragogy, which is currently important as it helps to influence the brain of adults during learning. It is useful for university teachers to enrich the educational process with active forms of work, to select interesting exercises to encourage students to take action and motivate them.

Both adults and children are interested in mastering the theory of neurosciences and consider it necessary to study it. Therefore, educators should systematically help children generate brain activity and thereby develop cognitive functions.

It has been proven that physical activity has a positive effect on the intelligence, knowledge, learning activity of children. In addition, scientists are developing exercises so that parents can train their children's brain.

Therefore, teachers are convinced that in the organization of the modern educational process they need knowledge of neurosciences.

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