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NEUROPSYCHOLOGICAL AND PEDAGOGICAL FOUNDATIONS OF TEACHING PRIMARY SCHOOL CHILDREN

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Abstract. This article goes on to state that by using the advantages of neuropsychological and neuropedagogical approaches to teaching primary school students, a teacher helps students to optimally develop their abilities and potential. Each student has a unique learning style and different learning abilities. However, teachers often do not know that this diversity should be taken into account in the teaching process, or for some reason cannot do this. Too often, teachers prefer the same method, which they repeat over and over again when teaching any subject, and use the same teaching strategy. This approach reduces students' interest in learning. In order for students to learn more effectively, teachers need to identify their learning styles and take them into account when applying methods in the teaching process.

Key words: primary school student, student, thinking strategy, brain, teacher, right hemisphere, left hemisphere.

Introduction. Human learning is a complex process. Research conducted in the socio-cultural, economic and technological fields aims to clarify various aspects of this problem. The growing interest in the application of neuroscience approaches in education is related not only to the "learning" itself, but also, and perhaps more importantly, to the growth of the "interest in learning" of students. Although the interest in the application of individualized approaches in educational strategies implemented in schools is growing, a number of problems related to the learning difficulties of students still remain. If the content is taught in a way that does not correspond to the learning style of the student, then the student first has problems understanding the content and then loses interest in this content.

Main part. The use of neuroscience-based teaching methods is increasingly being used in schools. The goal is not only to transfer knowledge, but also to develop and increase the cognitive skills, attention, memory and self-regulation abilities of the student.

The effect of neuro-didactic training (NeuroGymnastics): A study published in the journal Frontiers in Education in 2025 shows that “neurodidactic” content and neurogymnastics programs significantly reinforced the verbal intelligence, logical thinking and self-regulation skills of young schoolchildren. The number of those who showed high results on the Wechsler test in the experimental group was 55%, and in the control group it was 40%; the corresponding indicators on the Raven test were 52% vs. 38%. (Zhumabayeva, Bazarbekova, Nurzhanova, Stambekova, Kalbergenova, 2025).

The main purpose of using neuroscience-based learning methods is to reveal students' own learning styles, develop their potential, and adapt them to the requirements of the information society and modern industrial dynamics. This will create a basis for maximum development of students' cognitive skills and rapid adaptation to changing environmental conditions.

The content/curriculum must have a flexible structure to match the speed of updating information. In the conditions of global competition, there is a serious need for methods and tools that maximally develop cognitive skills of students (Schetter, Romascano, Gaujard, Rummel, Denervaud, 2023).

Studies published in the journal Frontiers show that the use of neurogymnastics programs in the classroom significantly increases verbal and logical abilities (Gumbatova, 2018).

The use of teaching methods based on neuroscience in education brings diversity to pedagogical practice, focusing teachers' attention not on pedagogical rules, but on what and how students learn (Franceschini, Bertoni, Puccio, Gori, Termine, Facoetti, 2022). This also increases the teacher's sensitivity to the students' learning processes. It is very important to consider this factor when preparing future teachers to manage research and project activities of schoolchildren in the educational process.

By applying neurobiological methods, teachers can get acquainted with a wide range of teaching methods, which can improve the quality of assimilation of the material in the educational process and get the opportunity to approach traditional methods more critically (Parviainen, Helenius, Salmelin, 2010).

It is also necessary to consider that motivation is important for the development of the creative potential of students. "Motivation is a psychological manifestation of activity. In the psychological-pedagogical process, not only the student himself is important, but also his attitude to the work being performed" (Gumbatova, 2018: 98). The teacher must create motivation, using in the educational process tasks of different development orientations in accordance with the individual characteristics, interests and needs of his students.

As a result of research conducted in the field of neuroscience, methods were formed that stimulate the activity of brain cells of students in the educational process. Plasticity of the brain, extremely important for the processes of training and teaching, is studied with the help of neurobiological studies. It reflects the ability of the brain to grow/develop in the short-term and long-term perspective. This is related to how the brain reacts to the received experience and how its structure changes in response to changes in the environment (Eğitimsel Nörobilim, 2022).

Recent studies of children exposed to neglect in early childhood have sparked interest and emphasized the importance of this topic. The results of these studies show that the long-term absence of environmental stimulation can have irreversible negative consequences for the child's brain. Thus, even after several years of intervention programs in children who were deprived in early childhood, a weak progress in brain functioning is observed (Pınar, Öztürk, 2022). One of the reasons for this is the weak development of synaptic connections. The formation of these connections occurs in response to experience gained in childhood and adulthood (Cüceloğlu, 2018). This also affects the child's education in early childhood and school years.

One of the studies carried out in this area belongs to B. To Dragansky and his colleagues. In this study, adult volunteers learned juggling skills as part of a three-month regular training program. Brain MRI results were studied before and after training to determine structural changes associated with training. The analysis showed a statistically significant difference in the gray matter in the middle temporal region and the left posterior intraparietal sulcus between the participants who trained in juggling and those who did not. In another study of brain structural changes caused by training, E. Magwai and his colleagues (Karpicke, 2012) studied brain morphometry and found both structural and functional changes.

In these studies, it was studied how new skills acquired in adulthood can change the anatomical structure of the brain, especially its structural features, and results were presented on how learning increases neuroplasticity (Tamami, Makoto, Yusuke, Seishi, Shigeru, 2015). Comparing fMRI brain results of participants who can read and write and those who cannot, Dikhin and his colleagues (Duman, 2015) found that even learning to read affects the structure of the cerebral cortex at a later age and increases neuroplasticity. The brain consists of billions of neurons that form complex networks responsible for various functions and thought processes. Learning skills imply changes in these neural networks and the formation of new connections between neurons.

It is important to note that neuroscience-based methods are not only focused on language and logic, but also on aspects such as self-regulation, persistence of activity, and control of behavior in the classroom (Lee, Youn, Jang, Kim, Lee, Lee, Jung, Lee, 2023).

At the same time, it is important to note that neuroscientific studies have also identified structural and functional asymmetries in brain development. For example, MRI studies conducted in preschool and school-age children show that moderate lateralization in frontal-limbic regions (areas related to emotional and social functions) is already formed between the ages of 1 and 5. Asymmetries in the volume of the thalamus and the volume of cortical areas have been recorded in the brain. PubMed.

Neuroscientific studies have also recorded lateralization in the use of oral speech. fMRI studies have shown that in children aged 7 to 9 years, regions in the left hemisphere show strong activation in the perception of oral speech (e.g., the middle and superior temporal gyrus), which is similar to the speech lateralization in adults. JAMA Network+1 (Lyn, Balsamo, Benjamin, Cecile, 2002).

A study published in the journal Frontiers in Psychology in 2024 showed that game-based neuropedagogical and neuropsychological approaches applied in the learning process increased learning motivation and memory in students by 25-30% (Howard-Jones, 2023).

On the other hand, the results of the study published on the ScienceDirect (2023) platform confirmed that interactive digital learning environments play an important role in the development of attention and long-term memory in young schoolchildren (Bowers, 2024).

A report published by the OECD in 2023 notes that the proper use of the results of neuroscience in education also creates the basis for the formation of new methodological approaches in teacher training (Neuroscience and the Future of Education, 2023).

One of the most important areas where the results of neuroscience research in education should be applied is the field of teaching. Although it is not yet possible to talk about a pedagogical approach based on neuroscience, the connection of neuroscience with teacher training is important in many aspects. In the information age, it is essential for teachers to have knowledge about how learning and thinking processes occur in the brain and how this information can be used to improve educational processes.

Research on teacher training and pedagogical practices has shown that differences in cortical thickness asymmetry have been observed in the perception-related structures of the brain (temporal lobe area) of students between different pedagogical systems (e.g. Montessori and traditional methods). This indicates that educational methods have a long-term effect on brain structure (Schetter, Romascano, Gaujard, Rummel, Denervaud, 2023). This factor should also be taken into account when organizing teaching strategies.

For example, the neural network hypothesis proposed by D.O. Hebb provides a theoretical framework for how information is learned and remembered. In this context, knowledge of the mechanisms that directly affect learning processes, such as the strengthening and weakening of connections between nerve cells, neuroplasticity, and transmitters; expands teachers' understanding of how, for example, a student can go through affective and cognitive processes when he first encounters a topic.

The development of neuroscience has also contributed to the development of neuropsychology and neuropedagogy. For example, one of the well-known articles of neurobiology, neuropsychology and neuropedagogy is that the thinking process occurs on the basis of the activation of neuronal groups (Duman, 2015). The teacher must understand how the student can learn best, how he can use his thinking potential, keep this in mind and take it into account in the teaching process.

Neuropedagogy helps the teacher to understand the organization of the student's brain, how the brain is organized at the functional level and adapt teaching methods. The point is that although children are different, we apply the same learning method to them. Each student has his own “thinking nature” (Eğitimsel Nörobilim, 2022). Therefore, at the initial stage, students' learning abilities are different.

It should be noted that in some cases there are people who, referring to the results of neuroscience, put forward extreme ideas and approaches. For example, in some cases they mythologize ideas

about the asymmetric development of the brain. In recent years, researchers have emphasized that ideas such as “left-hemisphere vs. right-hemisphere learning style” are often included in the myths of popular psychology. However, this approach is not sufficiently supported scientifically. In this regard, teachers should be careful not to try to build a teaching strategy based on the student's hemispheric dominance with this approach. This is a controversial issue from a scientific point of view. IBE – Science of learning portal+1, (Lee, Youn, Jang, Kim, Lee, Lee, Jung, Lee, 2024).

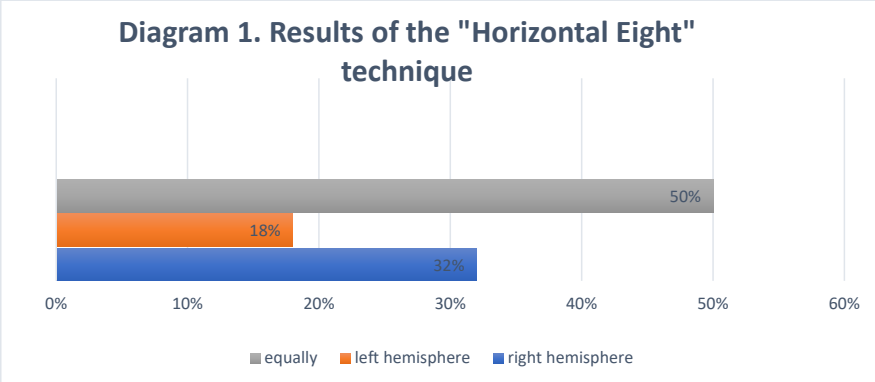
In order to teach effectively, one should be guided by the needs and abilities of the child and for this, it is necessary to carefully examine the student's thinking strategy. The point is that the essence of the methodological “contradictions” between teachers' teaching methods and students' learning styles is that for younger schoolchildren, the “left-hemisphere” teaching strategy and the “right-hemisphere” thinking strategy are preferred. To prevent this bias, it is necessary to know the characteristics of the child's mental activity and build a teaching technology based on it. For this, it is necessary to determine the dominant and non-dominant types of thinking activity among students in the classroom, and to compile a psychological and neurophysiological portrait of the class.

Methodology used. Neuroscience-based teaching methods focus on the individual learning abilities of students and are designed to increase their memory, attention, and cognitive strategies. For example, training programs such as "neurogymnastics" create significant development in language, logic, and visual intelligence.

During the study conducted for this purpose, the "Horizontal Eight" method was used to diagnose the symbolic expression of the integrity and harmony of the brain. In this method, the figure eight is drawn horizontally, and then the size of its two circles is considered. If the right side of the figure eight is larger, the left hemisphere is dominant; if the left side of the figure eight is larger, the right hemisphere is dominant. You can also draw perpendiculars to this figure eight and, by measuring the segments, determine the leading type of perception (visual, kinetic, and auditory).

Analysis of the research results.

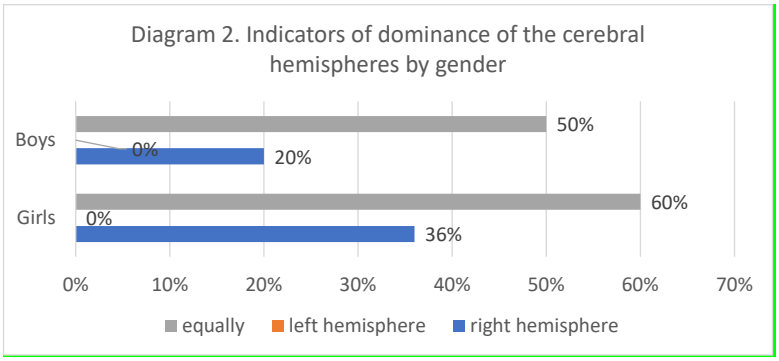
The research results showed that 55% of the students were ipsilateral (n=21), 29% were right-hemisphere (n=11), and 16% were left-hemisphere (n=6). As a result of processing the results obtained, it was possible to determine the following (Diagram 1).



Then, the results were statistically analyzed by gender. It turned out that the right hemisphere: 59% – girls (n= 11), 52% – boys (n= 10); right hemisphere: 35% – girls (n= 6), 24% – boys (n= 4); left hemisphere 6% – girls (n= 1), 24% – boys (n= 5). The results of the study are presented in diagram 2.

As can be seen, it turned out that the majority of students have equal hemispheres. This allows us to assume that the functions of the left and right hemispheres are coordinated and that difficulties in learning activities are not problems at the neurophysiological level. It is noteworthy that there are

quite a few right-hemisphere students among both girls and boys. The main issue here is related to the educational problems of these students at school. Since school education is more focused on the left hemisphere, it can be assumed that students with the right hemisphere have difficulty learning new material, memorizing and perceiving information.



On the other hand, as can be seen from the diagram, the differences in the proportion of left-hemisphere children seem significant. In neurophysiology, the only significant difference in the neurophysiological organization of the brain in men and women is observed in the size of the corpus callosum connecting the left and right hemispheres. This can be explained by the lack of commissural connections – communication cells. In general, the coordination of left and right-hemisphere thinking is the basis of the child's intellectual development.

The child's brain is developed during the learning process. Any disruption in normal development can lead to functional deformation of the brain, even in a normal healthy child. Therefore, the teacher must know the student and "his brain" well. Special attention should be paid to the development of the child's forebrain, which is represented by two cerebral hemispheres that are "closely adjacent to each other like twin brothers." The presence of functional asymmetry of the cerebral hemispheres determines the variability or difference of thinking.

Depending on the specific activity of the child's cerebral hemispheres, the following types of development can be distinguished:

– the predominant manifestation of right-hemisphere development is the dominant left eye and ear with the left hand; this also applies to left-handed people and ambidexters (both ambidextrous hands);

– the predominant manifestation of left-hemisphere development is the dominant right eye and ear with the right hand;

– the mixed type is the right hand with the incompatible dominant eye and ear (Lee, Youn, Jang, Kim, Lee, Lee, Jung, Lee, 2024).

– When children start reading books, visual attention shifts to the left side, and this is associated with the development of attention and text-oriented habits (Franceschini, Bertoni, Puccio, Gori, Termine, Facoetti, 2022).

– If a school system (pedagogical method) encourages children to engage in more creative, game-oriented, or sensory-oriented activities, students' brain functions in other areas (visual, spatial, emotional) besides language lateralization and development of related structures may be more balanced (Howard-Jones, 2023).

In addition to the specific methods of processing the presented information, it is important to know that the left and right hemispheres are connected by the "corpus callosum". It allows both hemispheres to be integrated, recoded and included in the process. However, this "neural connection" is formed for a long time and slowly, especially in boys (Gumbatova, 2018). Thus, currently there are many schools in the world that offer to teach children to distinguish between the "right hemisphere type" as opposed to the "left hemisphere" method. The most optimal and productive from the point

of view of neuropedagogy is synthesis learning. This technology means an appropriate combination of teaching methods and techniques, taking into account the neuropedagogical characteristics of students in a particular class. Based on the general diagnostic picture, it is proposed to synthesize correct methods that allow "entering the child's brain" by activating both hemispheres of the brain in different ways at different stages of the lesson. If the content is always easy, the brain stops working. It can be developed by gradually overcoming intellectual barriers.. Everyone should have the opportunity to test themselves in a difficult but feasible experience.

Conclusions.

– The synthesis of various teaching strategies in the learning process gives more effective results – the combined use of both traditional methods and neuroscience-oriented methods – is more profitable for teachers.

– The hemispheric dominance approach during training should not be completely rejected, but applying only a "left-hemisphere-oriented" or "right-hemisphere-oriented" teaching strategy to children based on it may not be justified, that is, it is a rather risky path.

– The most modern studies show that although asymmetries are formed in brain structures in the early period (1-5 years), the left hemisphere's advantage in specific skills such as functional lateralization and language becomes even stronger later, in the learning process at school.

– Teachers are advised to give more space to neuro-pedagogical exercises, neurogymnastics, active learning methods, the creation of an emotionally rich environment and components such as students' self-regulation skills in the learning process.

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