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The Relationship between Neuropedagogic Approaches and the Formation of Skills of Primary School Students

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Abstract: The article analyzes the relationship between neuropedagogic approaches and the formation of skills of primary school students. Educational technology design potentially introduces another area of expertise and a new set of issues that require the integration of neuroscience, education, and technology concepts and insights. The educational process involves the implementation of a conceptual education system that begins with the child entering the first grade and ends with obtaining a qualification for a person. Therefore, studying involves an educational process, as a result of which certain competencies will be acquired. Thus, education will be effective for a person only when the degree of acquired competencies of the child at school, their value orientations and readiness for education are taken into account. So, in order to introduce effective education, we chose the direction of research on the study, analysis, justification of measures to increase the level of motivation of children to the educational process based on the conclusions of neuropedagogy. For the purpose of the study, the integration method of synthesis of the figurative structure was applied, for analysis on the theory and learning technology. Methods of synthesis in the pedagogical activity of the study can be traced on a number of educational technologies. The results of the study show that in general, neuropedagogic teaching technologies contribute to increasing motivation to learn among primary school children.

Keywords: *Neurobiological research; game technologies; interactive technologies; problem technology; training technologies; neural processes; value orientations; educational competencies.*

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Introduction

Education in Ukraine has been reformed in accordance with new legislation and the corresponding educational strategy. Thus, the main innovation in the educational process is the focus on the competence of the child, and not the acquisition of actual knowledge. The child is the main reference point of the educational program, which after receiving secondary education should be competent and value-based. Therefore, teachers have the main problem – to help children acquire social competencies and, accordingly, form skills and abilities.

In order to study thoroughly the importance of neuropedagogy on the formation of an effective educational process in primary schools we studied the latest conclusions of scientists on this issue (Demchenko, 2021; Prots, 2021; Kosholap, 2021). The development of learning technologies was studied by Howard-Jones et al. (2009, 2009a, 2011, 2014), and they also studied the integration of neuroscience into educational thinking and practice. Neurobiologists, such as Della Sala and Anderson are discovering the relevance of their work for real-world learning. Some researchers, such as Antoshchuk (2007), Blake (2004), Kocherha (2011), Mambetalina (2019), Moskvin (1997), Sirotyuk (2003) emphasize that it is not enough for pedagogy to use knowledge only in psychology. Therefore, we studied the issue in detail and drew our conclusions based on theoretical and methodological analysis and research.

The purpose of the article is to investigate effective technologies for the formation of skills and abilities of primary school children based on neuropedagogy.

Theoretical and methodological approach to substantiating the topic

Modern society needs people who are able to use the achievements of science for new inventions. An important step towards the development of an innovative society is education, that forms a value-oriented competent person who is able to realize himself and use their individual traits for personal success. Therefore, the modern world needs to use the achievements of psychological and pedagogical science in the educational process, which will contribute to the formation of a competent personality motivated to acquire new knowledge and skills. A person begins the process of socialization and acquisition of competence from early childhood, which causes the foundations of a competence-based approach to obtaining knowledge by primary school children.

Researchers of the pedagogical field identify various factors that contribute to the effective process of acquiring new knowledge and skills by students. Based on the psychological perception of new things by children, the following pedagogical technologies have been developed: interactive, person-oriented, project-based, as well as training technology, which contributes not only to a better perception of new knowledge and skills by students, but also is the basis for psychocorrection for various problematic aspects of world perception. Scientists identify the influence of physiological factors on the motivation of children to learn. The development technologies for learning is one field of innovation (P. Howard-Jones, 2014) where the new dialogue between neuroscience and education is considered closest to having a positive impact (Butterworth et al., 2011). However, it has been argued that successful integration of neuroscience into educational thinking and practice requires a so-called "neurobiological" approach (Howard-Jones, 2010), in which transdisciplinary collaboration between those working in education and neuroscience provides optimal results in terms of scientific validity and educational relevance.

Thus, neuropedagogy is a science that combines the biological reaction of a person to achievements, psychological and pedagogical influence on them in the process of educational activity (Sokolianskyi, 1926). A person gets pleasure from achieving success in a certain business. This phenomenon has a physiological explanation, because a person releases a substance – dopamine. Magnetic resonance imaging, computer tomography, positron emission tomography, and electroencephalography are methods for detecting neurobiological manifestations of the brain that researchers rely on when developing pedagogical technologies. Neuropedagogics "aims to introduce the results of scientific research on neural mechanisms of learning into educational practice, which will help increase the child's motivation to learn".

Indicators of neurobiology, which are the main factors for the formation of neuropedagogic technologies, are key for determining the motivation of a child to receive education, taking into account brain activity. Many researchers see the interdependence of the direct approach "from brain scan to the lesson plan" when trying to transfer knowledge from neuroscience to students (Tsvetkov, 2000; 2017). Similarly, in the effective design and implementation of learning technology, a reasonable relationship of knowledge associated with various theoretical perspectives (for example, neuroscience, pedagogical and classroom practice) may be necessary.

One way to achieve this goal may be a design-based research approach to developing learning technologies focused on neuroscience

(Howard-Jones et. al, 2009; Howard-Jones et al. 2009a). The last decade has seen something of a step-change in efforts to bring cognitive neuroscience and education together in dialogue. This may be due to anxieties over the "parallel world" of pseudo-neuroscience (Dekker, 2012), but it may also be because of new insights arising from neuroscience with genuine value for education. Indeed, neuroscientists appear increasingly willing to speculate on the possible relevance of their work to 'real world' learning, albeit from a vantage point on its peripheries (e.g. Della Sala & Anderson, 2012). Such speculation often comes under the heading of 'educational neuroscience', a term that broadly encompasses any cognitive neuroscience with potential application in education. Accordingly, its research basis may be characterised by the epistemology, methodology and aims of cognitive neuroscience.

However, moving from speculation to application is not straightforward, since the educational value of insights from neuroscience rest on their integration with knowledge from more established educational perspectives. Seeking meaningful relationships between neural processes and the types of complex everyday learning behaviours we can observe in classrooms presents a challenge. One thing appears clear from the outset: a simple transmission model in which neuroscientists advise educators on their practice, or developers on their products, is unlikely to be effective. Neuroscientists are rarely experienced in considering classroom practice, and neuroscience cannot provide instant solutions for teachers. Instead, research is needed to bridge the gap between laboratory and classroom (Chojak, 2018). For both scientists and educators, co-construction of concepts requires broadening personal epistemological perspectives, understanding different meanings for terms used in their everyday language (for example: learning, meaning, attention, reward) and appreciating each other's sets of values (Howard-Jones, 2012).

In contrast to such authentic interdisciplinary work, brief intellectual liaisons between education and neuroscience are never likely to bear healthy fruit. A typical example of such myth-making is when synaptic connections in the brain are used to explain how we form connections between ideas. This often involves a conflation of brain and mind that allows some educational practices to gain an apparently neuroscientific flavour (research shows that explanations involving neuroscience provide greater satisfaction, even when the neuroscience is irrelevant (Weisberg et al. 2008). In reality, however, psychological theories about the mind are key to understanding the significance of brain data for behaviours such as learning; and association between ideas is a well-studied psychological concept that is currently impossible to study at the level of the synapse.

Nevertheless, having this important conversation about how different perspectives inform learning is a first step towards a theoretical framework for research at the interface of neuroscience and education. This can help us combine findings more judiciously across perspectives to develop a better understanding of learning. However, such an aspiration also has implications for methodology. If there is a genuine commitment to interrelate findings from component perspectives, the methods associated with these perspectives should be adapted to better support such interrelation (Bogacz, 2007). For example, qualitative interpretation of classroom discourse can draw usefully on neurocognitive concepts in the interpretive analysis of its meaning.

Some brain imaging studies can contribute more meaningfully to the construction of neuroeducational concepts if they include semi-structured interviews of participants, to derive experiential insights about their constructs, strategies and attitudes. In some bridging studies, judicious compromise and innovative approaches may help improve the ecological validity of experimental tasks while still attempting to control extraneous variables. Perhaps most unusually, researchers in the same team may find themselves sequencing radically different methods to collect biological, experiential and social evidence as they attempt to construct answers that, collectively, help span the social– natural science divide.

We believe that using such answers in the design of educational technology requires a similar process of integration (Bourgonjon, 2013). There is no guarantee that a useful learning principle derived in the laboratory and demonstrated in the classroom will be enhanced, or even survive, its implementation in a piece of software. To ensure the best outcome, this implementation must occur through a design process that includes potential end-users (i.e. teachers and learners) and those who possess current understanding of the principle's scientific basis and the current limits of that basis.

Neuroeducational research and educational technologies

Our research involves the study and detailed analysis of neuropedagogy as the main aspect of the formation of technologies for learning children in primary schools. To illustrate the benefits of this approach, we explore developed neuropedagogic-based technologies that allow teachers to teach entire classes using a playful approach. Neuropedagogy technologies were developed iteratively with teachers in five cycles of design, intervention, analysis, and reflection. The design process involved a multidisciplinary team and drew on neuroeducational theory,

teachers' insights grounded in practical classroom experiences, and well-established design expertise (Tsymbalaru, 2013). We described the process as a study based on the introduction of neuropedagogic technologies, in which users are equal partners of the design and development team.

In this way, teachers had a critical role in shaping the design with their insights, alongside those with neuroscientific and design expertise. Accordingly, here we report on some previous research on neuropedagogy, which allows teachers to teach entire classes using a game-based approach that is built on concepts from neuroscience. Instead of simply exploring what works in the technology environment, low-precision prototyping and participant design helped us explore aspects of design technology practice and capabilities that depended on each other. Five cycles of design, intervention, analysis and reflection revealed some potential benefits of a neuroeducational approach to learning technology design, including the development of related pedagogy, identification of immediate and future neuroeducational research questions and the development of language and terms suitable for communicating across interdisciplinary boundaries.

Neurobiology is a science that studies the motivation of a child as a physiological process, because the human body is set up to receive a reward for appropriate work, or rather a reward for success in a certain activity. Motivation for the student is the key to success. But a child in primary school does not understand why he/she needs to study, participate in various educational activities, extracurricular activities, because he/she does not realize the need for this. The only factor that contributes to the development of a child at present is the encouraging of parents. However, the external factors that affect the child's activity are too weak. Therefore, teachers need to attract an arsenal of approaches that will contribute to the internal motivation of the child. Teachers are aware of the importance of neurobiology in shaping the initiative to get achievements in education among primary school children. It is dopamine, a neurotransmitter that is produced in the hypothalamus, that contributes to the motivation of children to study.

Teachers have realized the importance of such conclusions in neurobiology, so they use pedagogical technologies developed precisely on the basis of "physiological reward for success in business" (B. Butterworth et al., 2011). Appropriate methods and technologies of the educational process form the content of neuropedagogy as a branch of science (Cobb, 2003). Science provides for application of the basics of the psychological perception of the analysis of tasks facing students in the context of biological natural processes of the brain, which are the basis for internal

motivation for children to acquire new knowledge (Brown, 1992). Neuropedagogy creates objective conditions for individual psychological perception of new knowledge that the student must learn. The basics of neuropedagogy are effective basic concepts for creating an educational environment for a child that would form a value-oriented personality that can develop its individual traits in the process of self-development, which is inherent in natural human existence.

Natural human development is provided by a unique physiological resource for everyone – the brain. To ensure an effective educational process in primary schools, it is necessary to study the procedure for teaching a child in the context of a holistic perception of a person as a result of socialization, psychological and pedagogical formation of consciousness and natural constructive development (Connolly, 2012). These key structural elements are constants for personality formation in the context of neuropedagogy.

Learning technology is the focus of pedagogical research on obtaining effectiveness in receiving skills, knowledge and abilities among students, by improving the teaching system, using methods, forms, and tools that are most effective for education. A child in primary school is physiologically attuned to the active perception of new knowledge, learns the world much more effectively than in the period of growing up. This physiological feature is an opportunity for teachers to choose individual, personality-oriented learning technologies for the intensive development of the child. Children in primary schools have a unique opportunity for active brain activity. This feature determines peculiar approaches to teaching and upbringing, which are mainly based on the physiological characteristics of a person.

Neuroscience studies the physiology of the body, which actually explains the processes that a person needs for self-realization, but such approaches will interfere with the harmonious development of the individual, because without pedagogical and psychological support, a person will not be complete (S. Della Sala, 2012). Therefore, for a constructive approach to personality formation, scientists rely on the achievements of neuropedagogy as a separate scientific discipline on personality development. Technologies of learning and upbringing created on the basis of neuropedagogy provide for the peculiarities of the human brain. It is the brain that is responsible for the emotional and psychological state of a person, for thinking, imagination, for acquiring socio-cultural values and competencies. Therefore, the teacher should take into account such capabilities of the brain in their activities and, accordingly, organize the

educational process in such a way that the child can progress. Neuropedagogy combines the physiological need of a person to learn, because the need of the human brain to learn is the same as the need for a person to breathe and the psychological and pedagogical motives of a person to socialization. The teacher uses the basics of neuropedagogy as a tool for teaching and upbringing.

One of the most difficult stages of organizing pedagogical work is studying in primary schools. Young children need special approaches to motivate learning activities, they are not aware of their role in society, they do not understand that they need to be educated. Therefore, teachers use a natural phenomenon for novice students, that is curiosity. This feature is one of the key aspects of organizing educational activities in primary schools. The physiological need of the brain for new knowledge forms the appropriate organization of educational activities, using methods and technologies based on neuropedagogy.

Primary school teachers have a task to use the natural curiosity of younger children in learning. To achieve this goal, first of all, it is necessary to create a problem situation for the child that he would like to solve. This situation can be created using problem-based learning technology or using project-based technology. These technologies can be used when studying various subjects. So, the main condition for the corresponding technologies is an initiative to find a solution to the problem. It is necessary to create a situation that will arouse the child's intellectual interest and a certain emotion of surprise or delight. Then the child will begin to solve such a problem and, accordingly, he will have formed a certain arsenal of skills and knowledge. This type of activity is quite energy-consuming, which will lead to brain exhaustion, so the teacher needs to provide the necessary amount of energy resources for the child, and therefore the appropriate number of calories.

An important condition for completing problematic tasks for a student is their emotional state. The teacher should make sure that the child has emotions of surprise, delight, and curiosity that constantly accompany intellectual activity. After all, emotions and the desire for knowledge accompany the life process of each person. The teacher should provide children's curiosity with an emotional coloring that occurs in the process of solving a problem or some paradoxical situation. It will also be effective to learn new things with an increased emotional state. Emotional perception is also enhanced by personal communication, so interactive technologies will be effective for learning activities in primary schools. The morning circle in the concept of "NUS" (New Ukrainian School) is one of the examples of the

formation of communication skills and abilities, which is enhanced by the emotional perception of each other.

The human brain works intensively in the conditions of problem solving, namely, the brain analyzes, synthesizes, and operationally thinks both individual parts of a particular task and as a whole. Education requires a holistic brain function, the ability to interact, analyze, using the method of deduction, induction, synthesis, analysis, and construction. It is this brain option that needs to use the LEGO technologies in the primary school. This approach effectively uses the potential of brain activity.

Neuropedagogy has become the main platform for determining the most effective levers to motivate students to study in primary school. It is due to the basic principles of brain activity that we can explore the most effective learning technologies for primary school children. A special feature of the brain is the freedom of creativity. Thus, in conditions of compulsion, brain activity significantly worsens and the child cannot achieve success, but is only a representative of the "gray mass", and when there is freedom for thinking, a person can reach heights. To ensure the freedom of brain activity, the most effective technology is training technology for learning. Thus, the training exercises "situation modeling", "brainstorming", "waiting", etc. form freedom of choice and creativity for the child, which helps to increase the brain's ability to achieve successful ideas and achievements in learning activities.

In the context of our research, we conducted an online survey of students and teachers to determine the level of academic performance of primary school children, as well as to determine motivation. The survey was conducted in May-September 2021, and the research participants were gathered by means of social media posts. The process of conducting online research using the in-depth interview method involved creating a website with a password that can ensure the confidentiality of information. Respondents were selected by the "snowball method". Firstly, the teacher was offered an interview, and then he invited his colleagues, parents and students. But the number of people was limited to 100 people. The study participants have filled out a Google form that contained information consent, a questionnaire, and actually the selected questionnaires that allowed to achieve the goal – to study primary school learning technologies based on neuropedagogy. The method of in–depth interview as the method of high-quality sociological and marketing research was chosen.

The purpose of the interview is to study the level of academic performance and motivation to learn among primary school students, to assess the role of neuropedagogy in the effectiveness of children's learning.

Each respondent is provided with an individual questionnaire text and an answer form. The response form is a numbering of statements corresponding to the text of the questionnaire.

For teachers there were formed the questions that showed the level of academic performance of primary school children. The questions outlined the impact of various technologies on the indicators of the formation of skills and abilities of children. There were 30 teachers among the respondents. It was determined that technologies that are created on the basis of neuropedagogy indicators significantly better affect children's academic performance (fig. 1).

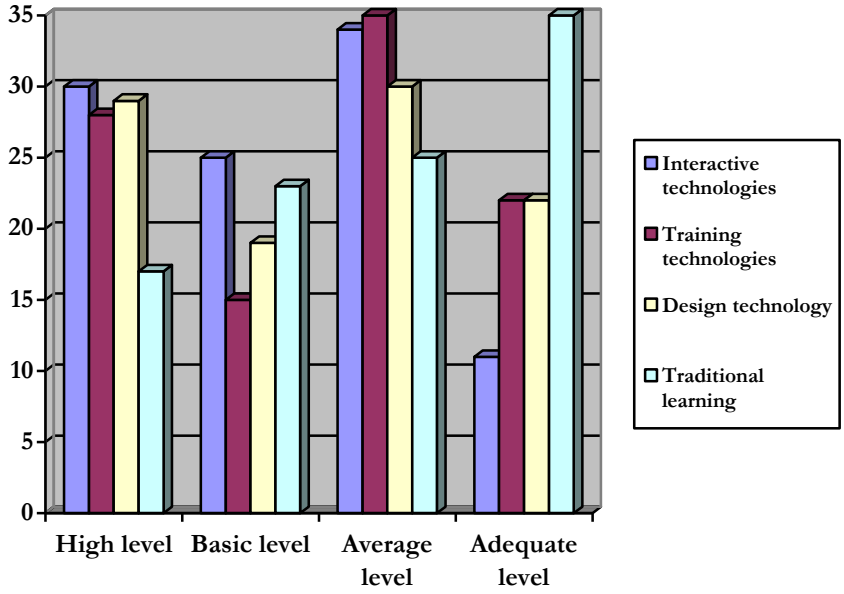

Fig.1. Indicators of the teachers' survey on the level of academic performance

The results of the survey showed that technologies developed on the basis of neuropedagogy give significantly higher success rates than traditional learning technologies.

Parents of children answered questions about motivation for the educational process. They made observations about their favorite subjects, the academic performance in the respective subjects, and the mood with which their children attend the respective academic achievements (fig. 2).

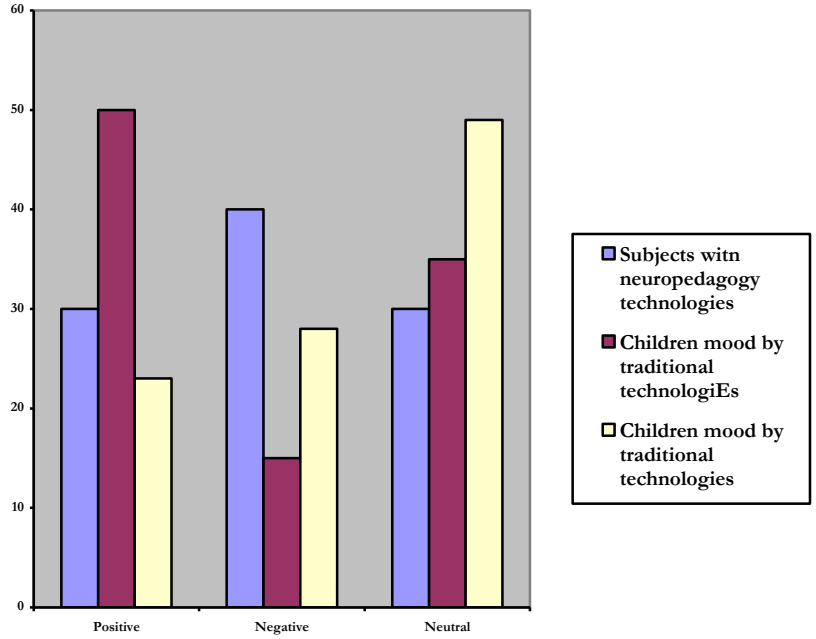

Fig.2. Indicators of a survey of parents on the impact of neuropedagogic learning technologies on their children's motivation

Thus, the study confirms the hypothesis that neuropedagogy and corresponding educational technologies shape the educational activity of primary school teachers in accordance with internal motivation needs, and not external manifestations.

Conclusions

Neuropedagogic technologies are an important principle of successful organization of the educational environment. These technologies are most effective for developing skills and abilities of primary school children. We analyzed factors that effectively contribute to and improve the educational performance of primary school children. For the first time, we determined that the combination of a child's physiological needs and their ability to acquire knowledge and skills are interdependent constants.

We conducted a theoretical and methodological analysis of the conclusions of scientists who studied the physiological properties of human brain activity and its influence on personality development. In the course of

the research, it was determined that the child gets pleasure when performing tasks in the form of dopamine. This conclusion becomes the basis for the introduction of neuropedagogy into the educational process. Learning technologies based on the principles of neuropedagogy are effective for developing competencies of primary school children. Such conclusions of the research were confirmed by the results of an online survey among teachers, parents and children who consider the use of neuropedagogic technologies to be favorable for successful motivated learning in primary school.

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