Neuroeducation as One of the Elements of the Formation of the Digital Economy*

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Abstract. At the turn of the XX - XXI century, along with total informatization and digitalization, the emergence of a new field of knowledge in the field of education takes place. The purpose of this publication is the study and analysis of technologies already being introduced in Russia, and forecasting their further development. The article contains a brief analysis of the prospects and directions for the development of interdisciplinary connections in the field of neurocognitive sciences, contributing to the development of the digital economy. The task, based on the analysis done, is to assess the dynamics and quality of the integration processes. Besides, to assess the degree of their influence on the development of the digital economy in Russia. Today, this is the targeted and most active interpenetration of various sciences to study in greater depth the cognitive abilities of a person. On their basis, new interdisciplinary communication. Now in the field of pedagogy and neurophysiology, a whole cluster is being formed, aimed at the development of neuroscience, studying the mechanisms of constructing knowledge in the human head and the effectiveness of perception of educational information, which directly relates to research in the field of cognitive development. On this basis, the basic principles of neuro formation are built. In support of this progressive movement, there is a process of technological development of neural interfaces and technologies of virtual and augmented reality in training. Moreover, this is the development of educational programs and devices for neuroethologies and not only. Already there are technical capabilities that allow the process of education using a neural helmet, virtual, and augmented reality. There are an active introduction and use of neurocomputer interfaces in education, as well as elements of hybrid intelligence in research and training. The system of training, including the formation of educational content, is becoming more autonomous, eliminating the influence of the human factor on assessment and decision-making. Is it good?! Here is a question that requires serious study...

Keywords: neuroscience, neural helmet, learning quality, neuropedagogics, neurocognitive technologies, Eye-tracking.

1 Introduction

The intensive development of neuroscience at the beginning of the twentieth century gave rise to many disciplines (neurosociology, neuropolitology, neuroeconomics, etc.), which is usually evaluated as a scientific revolution. Now the contours of neuroscience appear ("educational neuroscience", "neuro-formation"), which dispels some established myths in education, allows for a deeper understanding of the features of the educational process, and at the same time substantiates pedagogical methods and techniques at a neurophysiological level. The article analyzes some aspects in the field of neuro-education from modern neuroscience and offers specific recommendations for use in the educational process [1].

Research in the field of neuro-formation is based on paradigms and concepts that were developed in cognitive, developmental, and educational psychology, on the one hand, and on the results of diverse brain research in the framework of neuroscience, which integrates scientific disciplines such as neurophysiology, neuroanatomy, neuropsychology, and computer simulation, on the other hand. In addition, one of the promising scientific directions in the study of the human brain is currently cognitive neuroscience. Many scientists consider the relationship between neuroscience and education as a "two-way street scenario", in which, on the one hand, their combination is assumed in scientific research, on the other hand, each of the sciences convincingly represents its research. Some researchers agree that close collaboration between neuroscience and education may lead to improved teaching technologies in the future. The undoubted advantage is also the possibility, within the educational context, of studying the characteristics of brain activation in natural conditions. Today, the question of how educators imagine the possibility of using neuroscience data in their professional activities remains little studied. Obviously, within the framework of neuroscience research itself, it is impossible to develop innovative teaching programs and create an innovative developmental learning environment. Neuroscience plays an important role only as part of an interdisciplinary paradigm. Neuro-formation has several methodological difficulties and pitfalls. The most obvious of these are unrealistic expectations of the immediate implementation of the results of neuroscience in educational practice, as well as the lack of interdisciplinary vocational training, which leads to a lack of understanding between teachers and neuropsychologists and neurophysiologists. Its potential in education is to create a deeper understanding of the basic cognitive mechanisms and stalemate of the mechanisms of the learning process and educational programs. Educational scientists tend to study the effects of various cognitive tasks on behavioral variables and use this data to test models of the functioning of various cognitive functions. However, the behavioral data obtained using blank methods are scientifically insufficient to study the cognitive processes and characteristics of the assimilation and application of knowledge. The resulting gaps are successfully compensated for using neuroimaging methods. The most significant progress in understanding the relationship between the brain and the process of cognition and reflection of reality was achieved precisely from the standpoint of functional visualization of the brain. Over the past decades, progress in the application of neuroimaging methods has allowed us to obtain new knowledge

about the functional and structural changes in the brain in the learning process. However, when moving from a behavioral approach to the use of neuroimaging techniques, researchers often encounter methodological and ethical problems that interfere with the organization and conduct of an experiment, especially when working with children. Various methods of visualization of processes occurring in the human brain can provide various measurements of the neural correlates of cognitive processes on which school skills are based, such as reading and arithmetic, and allows you to study how neural connections change under the influence of learning and development. The ability to visualize various areas of the brain can help scientists understand typical and atypical development trajectories to better characterize the plasticity limits of various brain regions responsible for cognitive functions, formed under the influence of learning, at a deeper level than based on behavioral research methods only.

2 What is neuropathy

All human abilities, including training, are the result of our brain activity. Therefore, a better understanding of how our brain works can lead to a better understanding of learning. As we continue to unravel the problems and limitations of traditional education, many solutions imply a better scientific basis for how we teach today. The goal of neuro-education (also known as educational neurology) is to strengthen the scientific background in teaching and learning. In this area, the latest data on neurobiology, psychology, and cognitive science are used to form new learning strategies.

The main point of this work is to make the latest scientific results accessible and applicable in practice for teachers and politicians who often do not have the back of the scientific past. This includes addressing any popularized “neuromyths” (such as the widespread idea that we use only ten percent of our brain) and other misunderstandings about how our brain works.

3 Promising methods for monitoring activity and neuroimaging in neuro-formation

Modern neuroimaging techniques that study neural activity include magnetic and encephalography, functional magnetic resonance (MR) and positron emission (PE) tomography, as well as relatively new functional optical tomography (fNIRS) in neuroscience. Although several foreign scientists in the field of cognitive research, the effectiveness and feasibility of such research for direct pedagogy itself is extremely low. They argue that most research in cognitive neuroscience at best suggests looking at the nervous companions of thinking, as if visualizing them, but this does not give any privileged access to the hidden inner world, since the inner world is already manifested in the external behavior of the subject. In their opinion, none of the parties discussing the effectiveness of the use of medical methods for studying brain activity in the process of perceiving information, developed by Purdy and Morrison, does give a good reason to deny or argue that the discoveries in neuroscience can have a significant impact on

improving the field of education [1].

4 Neuroscience, as one of the elements of the digital economy

Now, in the age of information technology, globalization, and total digitalization, one of the priorities facing the dynamically developing countries, and Russia is no exception, is the total digitization of economies. The implementation of these processes is inextricably linked with the formation of new high-quality labor resources and elites. In addition, this, in turn, requires new, more effective approaches to the reform of educational systems. Requires search and implementation of new approaches and technologies in education [2].

However, it is impossible to build an educational system without taking into account the mistakes of the Soviet period, the 90s, and the pre-crisis stagnation of the 2000s. The task of the modern direction in education - neuro-formation is to ensure that the system has gained a flexible and transparent structure due to the availability of information flows, which allow for the most rapid update, adapt to the characteristics of perception, and find the best possible and most effective methods of perception. This will allow the economy to proceed as gently as possible to the next technological order and expand the potential for further growth.

Already, in support and to accelerate all socio-economic processes, the economies of most dynamically developing countries are being transferred to “digital rails” and Russia is no exception. It should be noted that the government of the Russian Federation is working hard in this direction. At the government level, several documents have been adopted, one of which is the program “Digital Economy of the Russian Federation” [2]. “The implementation of the Program is carried out by the goals, objectives, directions, volumes, and deadlines indicated in the list of basic measures of the state policy of the Russian Federation to create the necessary conditions for the development of the digital economy in the Russian Federation.

The range of areas covering all areas of the social, economic, political, cultural, and social life of the country is quite wide. In addition, the program provides for the change and expansion of the list of areas as they appear and develop. Here is a brief list of these areas:

1. Big data;
2. Virtual and additional reality technologies;
3. Neurotechnology and artificial intelligence;
4. Wireless technology;
5. Quantum technologies;
6. Industrial Internet;
7. Components of robotics and sensorics;

8. New production technologies;

9. Distributed registry systems;

10. Cognitive science and neuro formation [3].

Besides, each of the areas of development of the digital environment and key institutions takes into account the development of existing conditions for the emergence of breakthrough and promising end-to-end digital platforms and technologies and the creation of conditions for the emergence of new platforms and technologies.

The dynamics of technology development in all socio-economic spheres dictates and sets the pace of development in education. It is education, which is the intellectual basis for the formation of a strategy for the future rates of technological development and economic growth of the country. Now, the main economic potential of modernity is high-quality human capital and labor resources, the level of quality of training, which, in turn, directly depends on the quality of the educational environment and the availability of relevant and high-quality education.

5 Cross-cutting digital economy technology

Brain science is neuroscience. Neuroscience is the creation within the framework of the neuroscience of artificial intelligence systems, an increase in the volume and speed of information transfer, the mastering of knowledge; the introduction of devices for enhancing memory and analyzing the use of brain resources, the development of forms of learning through a neural network, the massive use of neuro-helmets for using virtual reality in education.

As part of the development of the digital economy, the development of neural interfaces and technologies of virtual and augmented reality in education is underway, educational programs and devices are being developed, devices for enhancing memory and analyzing the use of brain resources are being developed. In the future, the modern education system will be based on the neurocognitive mechanisms for acquiring new knowledge, as well as on data on individual human predispositions and the use of neurocomputer interfaces, elements of virtual and augmented reality, and hybrid intelligence.

At present, the products and services of the Neuroeducation market are developing in such segments as distance learning, lifelong learning, mass open online courses, blended learning, as well as innovative models of additional education. The priorities are the creation of training and laboratory places for pupils and students based on neurotechnologies of expanded perception, optimized memorization and strengthening of cognitive functions, and by 2035 - full use of integrated systems of natural and artificial intelligence [4].

6 Opinions on the theory and practice of neuro production

It should be noted that there are at least two opposing points of view on the problem of

implementation and, above all, the effectiveness of neuro-formation, as an independent direction in pedagogy, and one conciliatory - skeptical. Supporters of the conservative approach include several Russian and foreign authors, such as Arpentieva M. R. According to Arpenteva, taking into account the “types of information metabolism” of each person is a good idea, however, it has long existed and was implemented in classical, traditional pedagogy and traditional education [5]. Of course, each idea can be brought to the “maximum meaningful” and ignore other “maximum meaningful” ideas. Indeed, “identical”, “related”, “activating”, “mirror” and “business” ratios of “types of metabolism” are an interesting topic for reflection, however, as Bern wrote, an expert on fictions and manipulations not only in everyday life, but also in scientific communication: “You may find it interesting and even, perhaps, reassuring if you are told that you are a timemic extraverted piknofil endomorph with an inferiority complex and disharmonious vagotonic borborigms, but there is no healing power” (Bern, 2017, p. 233). Behind the names that are alien to and unrelated to the essence of education are the failures of attempts, committed by comprador corporations and “pseudo-elites” of Russia and the world of specialists, to hide the true goal of these projects, called “foresight” - the destruction of education countries and republics of the former "socialist camp". The colonialist West is actively seeking to turn Russia and a number of other countries into a “raw material base”, primarily turning its population into a “raw material”. Moreover, it actively means quickly: in education, the seemingly indisputable model “a fast world requires fast learning” is being introduced.

According to other neuro-education researchers, misconceptions about the brain and the possibilities of enhancing its cognitive potential for more successful mastering of knowledge and skills have been steadily circulating among the pedagogical community for a long time. Thus, almost half of British teachers and kindergarten teachers are confident that:

1. The potential of the brain by an ordinary person (student, pupil) is used at best by only 10–15%;
2. The child acquires most of the information from the outside world to about three years [6].

The perpetuation of neuromyths leads to the use of scientifically unfounded educational technologies. So, a decade ago, the Brain Gym program was distributed in UK public schools, which rested on the wrong belief that a series of simple physical movements promote the integration of all areas of the brain and effective communication of nerve cells. That is why, according to V.A. Bazhanova, Yu.S. Shkurko, overcoming neuromyths, building the learning process about advances in brain research is one of the central tasks of modern pedagogy [2]. The authors argue that this process should go in two directions, and we should both build links between representatives of education and the scientific community, and inform students about the discoveries of neuroscience.

7 Conclusion

Most of the scientists involved in this issue conclude that neurology, despite all its breakthroughs, is still in its infancy. No matter how exciting and useful these findings may be, one can only guess how far scientific thought can go [6].

In the longer term, it may be possible to use individual data on the structure of the brain and its activity to understand the unique strengths and weaknesses of each student. Besides, we could use this information to obtain personalized learning styles. Some experts are hoping for a complete mapping of human synapses to find out how training is going on, and thus develop new biological strategies for improving learning.

Because of understanding these mechanisms, we also open the way for a wave of drugs that improve human cognitive abilities, genetically enhanced intelligence, and integration with AI devices through brain-computer interfaces [8].

The combination of approaches will allow the maximum use of the intellectual potential of the country for solving problems of any complexity and orientation. In general, this direction of development in education requires a material basis and a scientific approach, but these investments in human capital will pay off. They will entail the development of infrastructure projects, the stimulation of scientific activity, the construction of enterprises specializing in the production of domestic components for electronics, software products, auxiliary instrument-making industries of high accuracy, and much more.

In conclusion, I would like to note that this is a living, dynamically developing direction in the field of neurocognitive sciences, and the limits of its scope have yet to be determined.

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