AMERICAN JOURNALS
Open Access, Peer Reviewed Journals

American Journal of Research in Humanities and Social Sciences
ISSN (E): 2832-8019 Volume 12, | May, 2023

NEUROPEDAGOGY – PEDAGOGICAL SCIENCE BASED ON NEUROTECHNOLOGY METHODS

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ABSTRACT

The article provides an analysis of the history of neurology, its main stages and achievements aimed at the development of neuropedagogy as one of the modern interdisciplinary directions of pedagogical education development. Based on the mutual communication of pedagogy, psychology and neuroscience, the study of pedagogical processes from the point of view of the brain's response lies. The main methods of neuroscience (EEG, MRI, MEG, TD, etc.) are considered in the directions that are actively developing all over the world.

KEYWORDS

pedagogy, education, neurotechnology,neuropedagogy, neuroscience, interdisciplinary research, education development, brain activity.

INTRODUCTION

New economic management teacher education cannot work according to the old model and with the same efficiency without traditional processes, methods, technologies and management tools[1]. One of the promising directions of educational development is the assessment of educational and educational materials at the level of human biological signals (brain activity), which allows observing the direct reaction of the body to various educational conditions. Like a cardiogram, we can command brain activity by recording electrical potential oscillations on the surface of the head (electroencephalogram).

Interest in the scientific direction in question appeared at the end of the 20th century. Methods of determining brain activity have been widely developed in fields such as neurobiology, neurophysiology, neuropsychology, and others, and a lot of experience has been accumulated in its study. It was during this period that a new stage in the development of neurology took place both abroad and in Russia (V. A. Moskvitina, N. A. Moskvitina, T. P. Khrizman, etc.) [2].

Local scientists contributed to the development of the foundations of electroencephalography (EEG) as one of the methods of studying neuroscience: V. Ya. Diagilevsky, N. E. Vvedensky, V. V. Pravdich-Neminsky, and others.

All these serve to develop a new direction of local pedagogy.

Historical development of neuroscience

To reveal the pedagogical possibilities of neurotechnologies, let's look at the origin of this direction and its connection with educational activities. If we consider neurology as a separate field as "the scientific field that studies the chemical, biological, and anatomical properties that affect the

functioning of the brain and nervous system",[3] neurology often has a scientific basis for studying the brain. (knowledge, research, methods) is considered as a direction capable of integration into various fields of science and is called the "umbrella concept".

Neuroscience and neurobiology are often considered as two synonymous concepts, but this is not entirely true. The main focus of neurobiology is the study of the functions of the nervous system, including mediating behavior, while neuroscience studies the structure and function of the brain and nervous system [4]. Neuroscience is a scientific field that studies the chemical, biological, and anatomical properties that affect the functioning of the brain and nervous system.

Richard Cato is one of the founders of the study of electrical signals of brain activity. It was he who in 1875 discovered the presence of electrical impulses on the surface of the brain in animals. Research in this direction developed in 1924. Hans Berger recorded one of the first electroencephalograms (fixation was carried out using a galvanometer with needle electrodes on the scalp). He is considered one of the founders of EEG and the discoverer of alpha rhythms [5]. Berger's work further developed in medicine. Work with data on the electrical activity of the brain continued (N. E. Vvedensky, V. Ya. Dyagilevsky, V. V. Pravdich-Neminsky), new rhythms (delta, gamma, theta, delta) were discovered, EEG is used in the diagnosis of brain diseases in medicine began to be actively used. In addition to the discovery of new rhythms, the possibility of forced strengthening of brain centers and the possibility of conscious regulation of brain rhythms, work on active rhythms of the sensorimotor cortex, as well as many other studies were eventually carried out.. The emergence of the term "brain-computer interface" (brain-computer interface), which allows controlling devices with the help of brain activity.

Neurological methods used in neuropedagogy

In the arsenal of neuroscience, there are many methods that are typical and used mainly in medicine, neuroscience, but they are now used in other fields, including neuropedagogical research:

- Magnetoencephalography (MEG). It records not the electrical pulses, but the magnetic field they create. To do this, you don't need to tie anything to your head - all the necessary sensors are inside the "helmet" placed on the subject's head. The method is correct, but very expensive - in rare cases a research center can afford the equipment for this. In addition, MEG systems are not portable and cannot be used for research purposes, such as in school classrooms.
- Magnetic resonance imaging (MRI). Allows you to take images of internal organs using the phenomenon of nuclear magnetic resonance. For this, the nuclei of hydrogen atoms (many of them are in the human body - in water and not only) are excited by electromagnetic waves of a frequency that is safe for the body, and then the energy nuclei released by the atom are recorded.
- Transcranial dopplerography. Ultrasound examination of cerebral vessels. The brain is almost completely covered by dense and thick bones of the skull, there are only a few "windows of transparency", for example, in the temples. Ultrasound probes are sent to them.

Like MRI, transcranial Doppler also has a functional version. With its help, you can find out how the blood flow in the brain changes during various activities. Ultrasound equipment is not as bulky as MRI scanners or MEG systems, but is used only in laboratory settings [6].

- Eye tracking or oculography. A technology that tracks the movements of the eyes and allows the observer's eyes to fixate on different parts of the object in question. This direction is actively used in marketing, in the study of purchasing power, in the design of various electronic resources (websites, games, applications, etc.), as well as recently in educational activities [7].

- Electroencephalography (EEG). This involves recording the electrical activity of the brain using electrodes attached to the scalp. In recent years, portable EEGs have advanced greatly—they allow subjects to move and behave more naturally.

The method allows you to record changes in the brain almost in real time, but has a low spatial resolution, that is, according to the EEG data, you can tell exactly when the brain activity has changed, but at what point it happened you can only approximate. According to the amplitude and speed of the oscillations, several main types of brain activity are distinguished - alpha, beta, gamma, theta and delta waves. They can be recorded using EEG, recoded in an open form, such as indicators such as attention, mood, concentration, enthusiasm, cognitive and emotional load, etc. This is one of the most convenient methods actively used in neuropedagogy.

Development of neuropedagogy as a branch of neuroscience

In the field of pedagogy, neurotechnologies have been used relatively recently. It all started in 1988, when Gerhard Price defined a new term - "neurodiactics", "aimed at defining an interdisciplinary field that exists at the intersection of neurobiology, pedagogy and psychology, within which the issues of creating conditions for effective learning there is. Research results on the activity of brain and nervous system structures are being developed. [8].

From the point of view of the interaction of the sciences, educational neuroscience or neuropedagogy, this field is the study of the relationship between the physiological processes of the brain and learning, cognitive science, neuroscience, educational psychology, methodology, didactics and other related disciplines. is considered as a scientific direction that combines [9].

If we consider this term based on the functional component, then "neuropedagogy is the practical application of cognitive neuroscience, differential psychophysiology, neuropsychological knowledge, information on the brain organization of the processes of mastering various educational materials is neurology.

The emergence of neuropedagogy as a separate field in Russia occurs in the early 2000s (1997–2000) and is associated with the works of V. A. Moskvin, N. V. Moskvina, N. V. Eremeyeva, T. P. Khrizman and others. Development in other countries began around the same time: "At the same time, this field of pedagogy developed in the United States, which led to the establishment of the largest international project "Brain and Learning" (Brain and Learning).

This project unites scientists from thirty countries of the world, and its main goal is to popularize knowledge about the work of brain structures among educators. Within the framework of educational neuroscience, the International Mind, Brain and Education Society (International MBES) was established, which has been publishing a journal of the same name since 2016 [11]. it allows to think critically about the form in which it is presented to determine which research results are ready for implementation, to be correctly interpreted in practice [12]. Scientific centers, laboratories, and educational institutions are being created all over the world to conduct neuropedagogical research and introduce it into the educational process:

– Center for Educational Neuroscience in London;
– Institute of Cognitive Neuroscience, Academy of Modern Humanities;
– Higher School of Economics Institute of Cognitive Sciences and others.

Various experiments are being conducted in face-to-face education, such as Groupa-Ware, which monitors the learning process and the state of the learner, analyzes emotions and cognitive processes,

and provides feedback. is a system. In Group-a-Ware, the flow of data is recorded using a neuro-headset and biometric wristbands, and from them are calculated indices corresponding to various aspects and characteristics of cognitive load, various psychophysiological indicators that show how the learning process is going. This data is processed in real-time and presented to the teacher along with recommendations so that he or she can adjust the curriculum on the go. In the same way, each listener receives personal feedback to control himself. This occurs in the form of reporting both during the process and after the fact [13]. The novelty of the ongoing research is a unique comprehensive evaluation of the effectiveness of video lectures and educational materials in the framework of e-learning using neurotechnologies: neural interfaces (observation and interpretation of brain activity, EEG) and oculography (observation of eye movements and concentration).

Neiry (a resident of the Skolkovo Foundation), a Russian startup that creates neuro-interfaces and neural data processing algorithms, develops neurotechnologies and creates products based on brain-computer interfaces for education, entertainment, industry, medicine and personal use is engaged in similar studies.

The company is testing a VR helmet with a neural interface installed in Russian schools. In 2021, it launched three pilot projects in Moscow, Kazan and the Leningrad region - schoolchildren tested VR helmets with built-in neural interfaces and were tested on the basis of materials from the school curriculum. The use of VR in conjunction with neural interfaces “allows teachers to gain additional information about student engagement with educational content. So this is a very promising idea: you can create ideal learning scenarios” [14].

Conclusion

Thus, educational neuroscience or neuropedagogy is a promising direction of educational development today, which is proven by the analysis of the literature and the ongoing processes. In educational activities, neurotechnologies allow to look at the educational process from the point of view of the trainee's brain (processes that occur during learning), while actually not interfering with the educational process and not affecting the student. more objective. On this basis, it is possible to build an individual educational tractor and try to personalize the educational process.

Prospective areas of development of neuropedagogy are: assessment of the student's current state (physiological, emotional) based on information about brain rhythms; implementation of the principle of biofeedback (visualization of one's own brain rhythms, training and management of one's cognitive state); effects on areas of the brain important for learning, including emotional states (neuroplasticity). The implementation and study of this direction is an attempt to increase the effectiveness of education and expected learning outcomes.

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