Modern research on the primary school children brain functioning in the learning process

Tatyana V. Bukina
Department of Information Systems and Educational Technologies
Saratov State University
Saratov, Russia
bukinatatyanav@gmail.com

Marina V. Khramova
Department of Information Systems and Educational Technologies
Saratov State University
Saratov, Russia
mhramova@gmail.com

Semen Kurkin
Center for Technologies in Robotics and Mechatronics Components
Innopolis University
Innopolis, Russia
kurkinsa@gmail.com

***Abstract*—The article deals with research related to the study of the primary school children's brain activity in the educational process: the prevalence of such research, the definition of the scientists' activities main directions on the topic and their chosen approaches to research. Conclusions about the need for further study of this issue are presented.**

Keywords—primary school students, education, EEG, fMRI, brain research, BCI

I. Introduction

Neuroscience has been studying the brain for a long time, and over the centuries, various methods have been invented to understand it.

The child's brain is even more interesting, since it is an unstable and forming system, on the correct functioning of which depends the development of the entire body. In the process of this development, it becomes necessary to timely monitor any changes, evaluate the effectiveness of learning and adjust the educational strategy. To achieve these goals, we need informative and convenient tools that will fit into the learning process and will not inconvenience the subjects.

It is relevant to consider recent scientific developments related to the study of the child's brain and technologies that allow continuously reading the received cognitive and personal characteristics of the person in the different activities including educational ones [1-4]. The brain-computer interface (BCI) is an example. The correct application of such technologies can make it possible to personalize learning by creating an objective assessment system of children's psychophysiological state in the learning process, and timely response to these changes.

To achieve this goal, it is important to understand how widespread and effective such developments are. First of all, the main interest was the work aimed at studying the brain using electroencephalography and other monitoring methods in children in the learning process.

II. Review Of Research Papers

The following scientific journals were selected as sources*: Cognitive Development, Brain and Cognition, Computers & Education, Computers in Human Behavior, Developmental Cognitive Neuroscience, International Journal of Psychophysiology, Journal of Sport and Health Science, Trends in Neuroscience and Education*. In these journals over the last 5-6 years, there have been found a significant number of studies on the use of different methods for registering the child's brain activity.

According to observations, the main efforts of scientists are focused on the study of brain responses under the influence of various external and internal factors, as well as the study of age-related differences in the development for cognitive functions. Although the question of applying the obtained knowledge in pedagogical practice is often not raised by the authors.

Most authors used technologies for recording brain activity during short-term testing (one or more tests) of subjects to track certain patterns. Memory and attention tests were carried out in the studies of A. Diaz, F. Simard, Y. Cycowicz, V. Vogan, D. Pindus, et al. [5-9], and writing and mathematics abilities — in the works of A. Dębska, A. Mogadam, A. Matejko, A. González-Garrido, F. Nemmi, et al. [10-14].

As it was explained earlier, at the moment we are more interested in research directly on children in the learning process.

The article by J. Xu and B. Zhong [15] analyzes studies that used PEEG technologies (portable EEG) in educational research. According to the results of the review, it was concluded that this technology was mainly used for reading data about the phases of the subjects' increased attention and relaxation. And the validity of the results obtained for almost half of the selected papers was based on previous research, and the sample was small.

Also, most of the research was conducted in the framework of individual tests. And research of various subject areas, in addition to reading and counting skills, was conducted much less frequently [15], although the specifics of teaching various sciences must be taken into account when analyzing neurophysiological signals.

Thus, it turned out that over the past 5 years, research that fully corresponds to our interests has not been conducted (according to a selection of more than 30 articles covering the issues of brain activity research using various recording technologies).

In the process of developing personalized learning technology, it is necessary to remember that the level of development and psychophysiological state of children will differ. And there is a possibility that there may be several "special" children in the same group where such technologies are supposed to be used, and the approach to working with them will differ. This work requires additional preparation.

For this purpose, E. Pua et al. [16] developed a set of measures that allow children with autism spectrum disorders to get acquainted in detail with the upcoming procedure in advance, so that the stress level during it was minimal. This package includes: an application that allows you to learn how the study is conducted in the format of a game; an illustrated story; recording the noise produced by the device during operation; a study trip to the venue; training on the layout of the EEG device. These steps are selected individually,

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depending on the child's health and readiness for the next stage. According to the results of the study, such preparatory work significantly improved the quality of the obtained indicators by reducing artifacts from head movement.

CONCLUSION

Brain research is an extremely difficult and important area of science. And even taking into account the acquired knowledge and high technology development, there are still a huge number of "dark spots" and questions. The child's brain is an even more complex matter, because due to rapid age changes and strong differences at various stages of development, timely recording of these transformations can be an impossible task.

The use of methods for recording brain activity in the learning process is still an insufficiently developed topic, due to the complexity of technical implementation and correct evaluation of the results obtained. At the moment, the main focus is subjects' one-time testing in the process of studying various of their brain structures and its activities. Studies of the various sciences teaching specifics, continuous training and other were not conducted so actively.

However, the presence of a large number of such studies can be a good basis for further work and upgrowth of studying brain responses during educational activities, as well as for evaluating the individual learning paths effectiveness.

ACKNOWLEDGMENT

The work has been supported by Russian Foundation for Basic Research (Grant 19-29-14101) and President's Program (Grants NSh-2594.2020.2).

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