

Measuring of Cognitive Processes Indicators When Reading Educational Materials Using Brain–Computer Interface

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Effectiveness of educational process is greatly determined by indicators of students' cognitive processes when their learning activities. Using the analysis of electroencephalogram, it is possible to monitor the indicators of such processes and, as a consequence, to predict the success of educational process as a whole.

For such an analysis, alpha and beta rhythms are traditionally used. For example, using alpha-rhythm, one can track the increase of attention (especially visual one), or mental activity. Using beta-rhythms, it is possible to track the presentation of a new unexpected stimulus, mental tension, emotional arousal. However, the use of these rhythms will not always allow monitoring the effectiveness of students' educational process. In this connection, it may be of interest to use both complex indicators, characterizing several rhythms, and alternative types of rhythm, for example, theta rhythm.

To make it possible to use theta rhythm and to assess the level of understanding and interest of the text viewed, the following preliminary experiment was carried out. 10 students of technical specialties were presented (for reading) 3 texts of different subjects: physical, technical, and survey-technical ones.

When viewing each test, every subject was taken an EEG using Neuron-Spectrum apparatus, and the dominant frequency of theta rhythm in the lead FP1-FP2 (frontal region) was determined by coherent analysis of brain activity. At the end of reading, each student evaluated interestingness of the texts viewed, including commenting on the reason for such interest as well as connection of texts with research area and disciplines of studies.

The result of the experiment showed that the maximum value of the dominant frequency of theta-rhythm was observed in case of reading uninteresting texts, or texts in unfamiliar areas. Interesting, or familiar texts led to a minimum value of the dominant frequency of theta rhythm.

However, in general, the use of Neuron-Spectrum apparatus in such a situation is difficult, since it does not allow obtaining integral indicators of cognitive processes. This problem can be solved by using Emotiv Insight Brain–Computer Interface (BCI).

The work objective is to research integral indicators of cognitive processes when reading educational materials of different levels of difficulty and in different areas to evaluate teaching efficiency.

To achieve the objective, an experimental study should be conducted.

Method of conducting

- a. Participants. The participants of experiment were 30 fourth-year students of NRU HSE.
- b. Materials. For EEG analysis, Emotiv Insight was used. This neural interface allows assessing the following characteristics: interest, engagement, relaxation, stress, excitement, focus. Six texts in different areas were used (2 texts in humanitarian area, 2 texts in technical area, and 2 texts in mathematical area); texts in the same area were of different difficulty level. To assess comprehension of each text, some tests were developed; also, a questionnaire was developed to assess participants' preferences and interests in certain areas and disciplines.
- c. Study Procedure. Experiments are conducted in the first half of the day individually for each subject in a computer class. The external conditions for all participants are the same. After conducting the briefing and explaining the meaning of experiment, the subjects filled the preference questionnaires and put on Emotiv Insight BCI. Then every subject was presented with the first text, and comprehension test (after reading) was given. Then the actions of the subject were repeated in relation to texts 2–6.

The results

For every subject, based on the results of the experiment, preferences in the scientific and technical areas, indicators of cognitive processes when reading each text, and the results of measuring reading comprehension were obtained.

Processing of the results of the experiment suggests regression, dispersion, and cluster analysis for constructing models of influence of the type of text and its difficulty on indicators of cognitive processes that make it possible to evaluate effectiveness of education.