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Tomasz PRAUZNER
https://orcid.org/0000-0002-8792-7794
Department of Pedagogy, Jan Dlugosz University in Czestochowa
e-mail: t.prauzner@ujd.edu.pl

Kacper PRAUZNER
https://orcid.org/0000-0002-6032-8433
Medical University of Warsaw
e-mail: kacper.prauzner@onet.pl

Didactic dimension of electroencephalographic research in terms of educational transactional analysis

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Abstract

The paper presents selected results of the author's research conducted at the Laboratory of Experimental Research Biofeedback of Jan Dlugosz University in Częstochowa on the didactic activity of students in technical education. The presented research results are a partial answer to the questions posed in the theory of information technology education. The implementation of online education at the time of the COVID-19 pandemic with the use of deterministic computer simulations is a proposal to start a discussion on the importance of modern information transfer techniques as a key element of student-teacher communication.

Keywords: educational theory, didactics, constructivism, electroencephalographic research, ETA.

Discussions pertaining to the effectiveness of online education in the current pandemic situation limiting direct student-teacher interaction should focus on the importance of information technology in interpersonal communication. Information transfer with the help of available information technology constitutes

the main source of communication and school functioning (Łęski, 2017). In the light of formal limitations in teaching practice, the educational dimension of information technology in shaping human attitudes takes on a special meaning as far as personal and intellectual development of young people is concerned (Pankowska, 2012). The teacher as the Adult, presenting a fully-developed image, equipped with knowledge and experience, was given a slightly different role in the educational process. Their responsibility is not limited to emphasizing their superior role, i.e. the authority of a professional, being a paragon of wisdom and professional experience. Their current fundamental role is their organizational skills and the ability of selecting pragmatic syndication online. This issue is particularly noticeable in creative polytechnic teaching. It should be reminded that a cognitive process in technical education is based on conveying knowledge and skills in developing technical imagination. We are dealing here not only with popularization of theory from a given field of knowledge, but primarily with constructing new, creative images resulting from bonding elementary terms together. Thus, what we face here are elements of the constructivism and collectivism theories, shaping the perception and attitudes of a young person. The psychological concept of interpersonal relations created by Eric Berne is based on the idea of distinguishing three coexisting interpersonal relations taking the shape of the Adult, the Child and the Parent ego states. Each ego state creates a different, uniform and sometimes opposite attitude. As far as education is concerned, a human being is not its only significant element, but it is information technology taking over significant responsibility in the educational process. It is a non-personal element of the educational system, artificial yet playing an increasingly significant role in the effectiveness of teaching and educating. Although information technology tools are the effect of human labour, more and more frequently they become a sophisticated, often learned programme, practically displaying the features of "intelligent personality." Of course, regardless of its perfection, information technology will always be a secondary element working on the basis of some algorithm, yet, as a teaching element, it is perceived as innovative and in the field of didactics more and more importance is attributed to it. It is suggested that it is new media that should cause the biggest revolution, also in the area of teaching methods. On the basis of this technology's development, often exceeding our imagination, neurodidactics is mentioned more and more often. There is no scientific foundation currently to call this area of interest at least a scientific sub-discipline, yet experience of neuroscience is frequently used in pedagogy. This term is exceptionally complex and can constitute an area of analysis for people who are more competent to interpret it. A derivative term used in professional literature is educational neuroscience (Bowers, 2016). It assumes that neuroscience can significantly contribute to the understanding of complex cognitive processes, based

on other branches of science. It should be emphasized that neurodidactics is not able to provide teachers with ready methodological solutions right now. However, professional literature contains information on current research concerning human memory and cognitive processes (Addis, Barense, Duarte, 2015). On the other hand, educationalists are mainly interested in information pertaining to reliable assessment of didactic practice and instructions for didactic work in the light of neuroscience (Chojak, 2019).

The teacher as a coordinator of the process is more and more often attributed a secondary role. Interaction at the student-school level shall be based on an intermediary element, i.e. digitally conveyed content. Currently, the media shape a young person's attitude not only at the level of education but also their personality development, giving it direction and instilling new values in their world. It seems that the development of neurodidactics based on comprehending an individual will soon have a far bigger influence than a schematic approach in education even though it assumes this individual's interpersonal skills. That is why, worldwide media, and as far as polytechnic education is concerned, the emergence of didactic programmes not limiting a young person's ingenuity and supporting their creativity, are the motivation to follow one's dreams and excel at anything one wants. Civilisation development is based on an innovative approach in problem solving, hence it results in lack of barriers that have been considered impossible to overcome so far. Is the Adult ego state approach the only indicator of truth and the only, unquestionable way of development? Let us try to equip a young person with various work tools offering them a possibility of self-development and developing different attitudes, often contrary to well-established scientific principles. Such an approach might highlight new values not known so far, but often perceived as reprehensible and contrary to adopted standards. The human brain is still a body organ known a little. Although contemporary medicine and psychology are learning more and more about it, it still amazes and surprises us.

This generally described area of our concern is the ground of research pertaining to human cognitive processes resulting from artificially created workplace. Although the analysed issues are limited to the content of didactic classes, they are tackled with the help of offered deterministic simulation programmes and equipment that observes human behaviour. Available technology lets us use electroencephalographic tests in the research. Electroencephalographic tests (EEG) are becoming more and more popular in science, not only in medicine and medical therapy. One technique within this method is QEEG technique, i.e. quantitative analysis of data based on the so-called mapping of particular brain activity areas. Apart from the fact that QEEG tests are nothing new, modern technology and potential of computer equipment make it possible to analyse how the human brain works more and more thoroughly. Certainly this method is not the best one among those currently used, yet it has one main advantage, it is non-invasive. Its non-invasive-

ness means that one can read the brain's activity, of course with a certain measurement error, in different situations of human activity without affecting a given organ. Thus, the brain's activity can be watched during one's work on a computer. We can observe both moments of excitement, mental activity and all the symptoms and states detrimental to mental creativity.

As it has been already mentioned in numerous publications, the current method lets us follow and record particular brain waves with the measuring apparatus. This research makes use of Mitsar 202 apparatus, which constitutes an element of equipment in the aforementioned laboratory (Prauzner et al., 2013–20) (Fig. 1).

Fig. 1
Sample photograph taken during a QEEG test
Own sources.

To simplify, the test consists in reading signals coming from the external surface of head skin. To do that, researchers use the so-called specialist caps with installed sensors that read brain waves generated in the skull area. These are very small electric impulses resulting from brain work in its different layers (i.e. brain lobes). They are generated as a result of neuron activity in the brain, and this activity stems from stimulation of the brain's elements whose function is responsible for various activity. Thanks to the very sensitive measuring apparatus, they are strengthened to such an extent that they can be recorded in the course of time. The analysis of professional literature and knowledge gathered so far makes it possible to determine with high probability the brain's activity, and more precisely its selected areas. Registered signals are analysed by specialist software and turned into an image, which is the so-called map of brain activity. Figures 2, 3 and 4 demonstrate examples of wave reading and their occurrence.

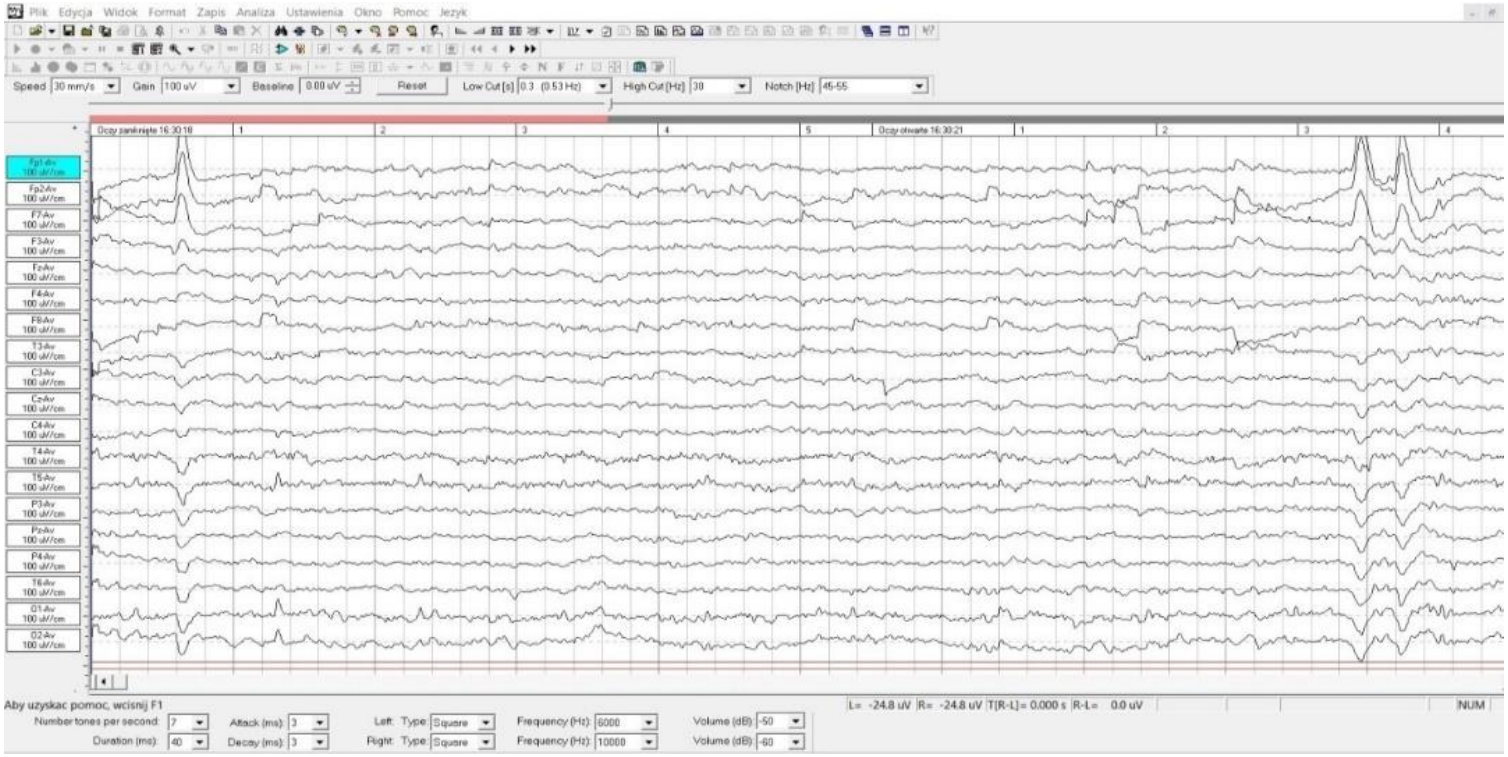

Fig. 2
An example of observed brain activity waves. Particular graphs refer to different wave frequency and the so-called artefacts (interference)
Own sources.

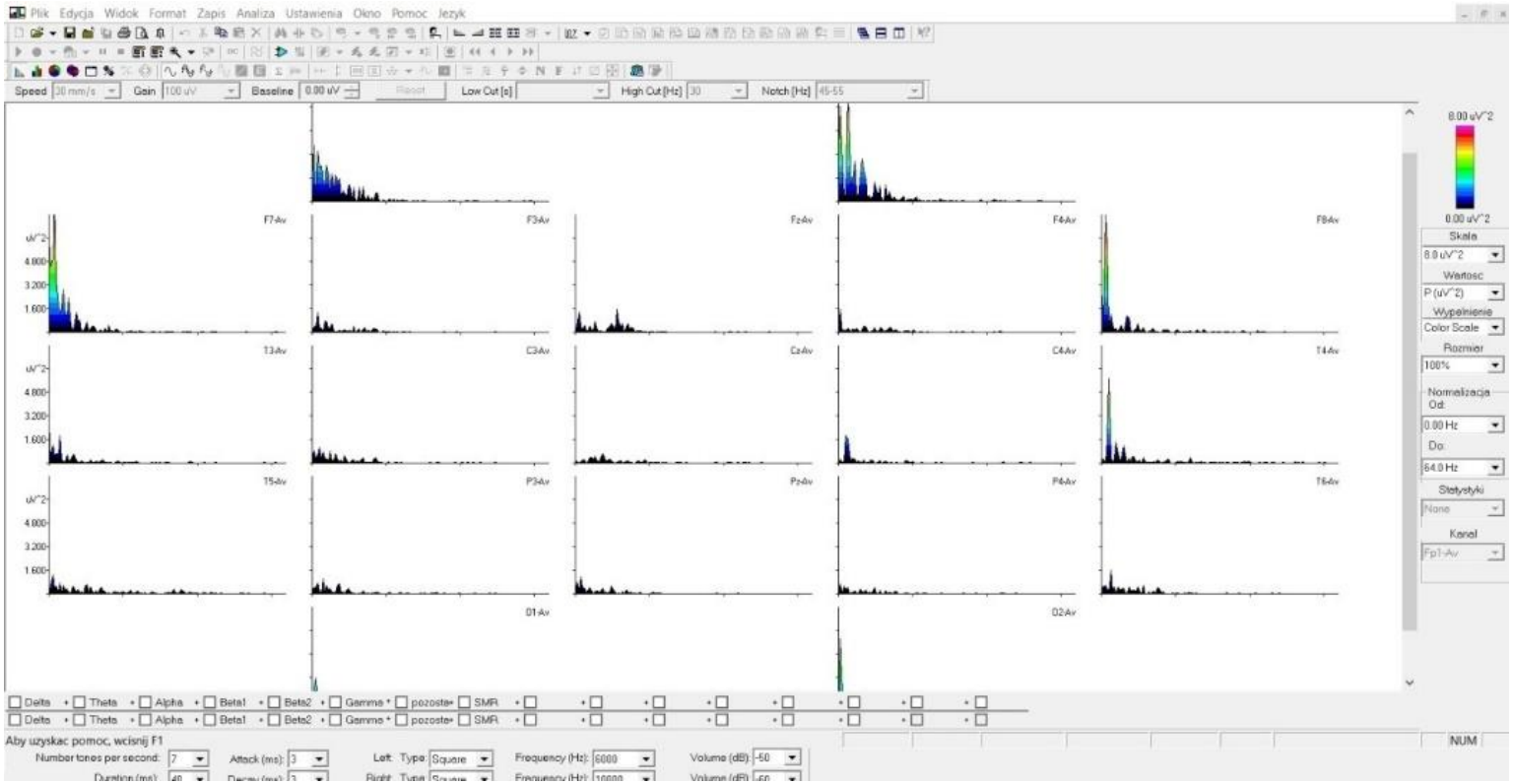

Fig. 3
Wave amplitude
Own sources.

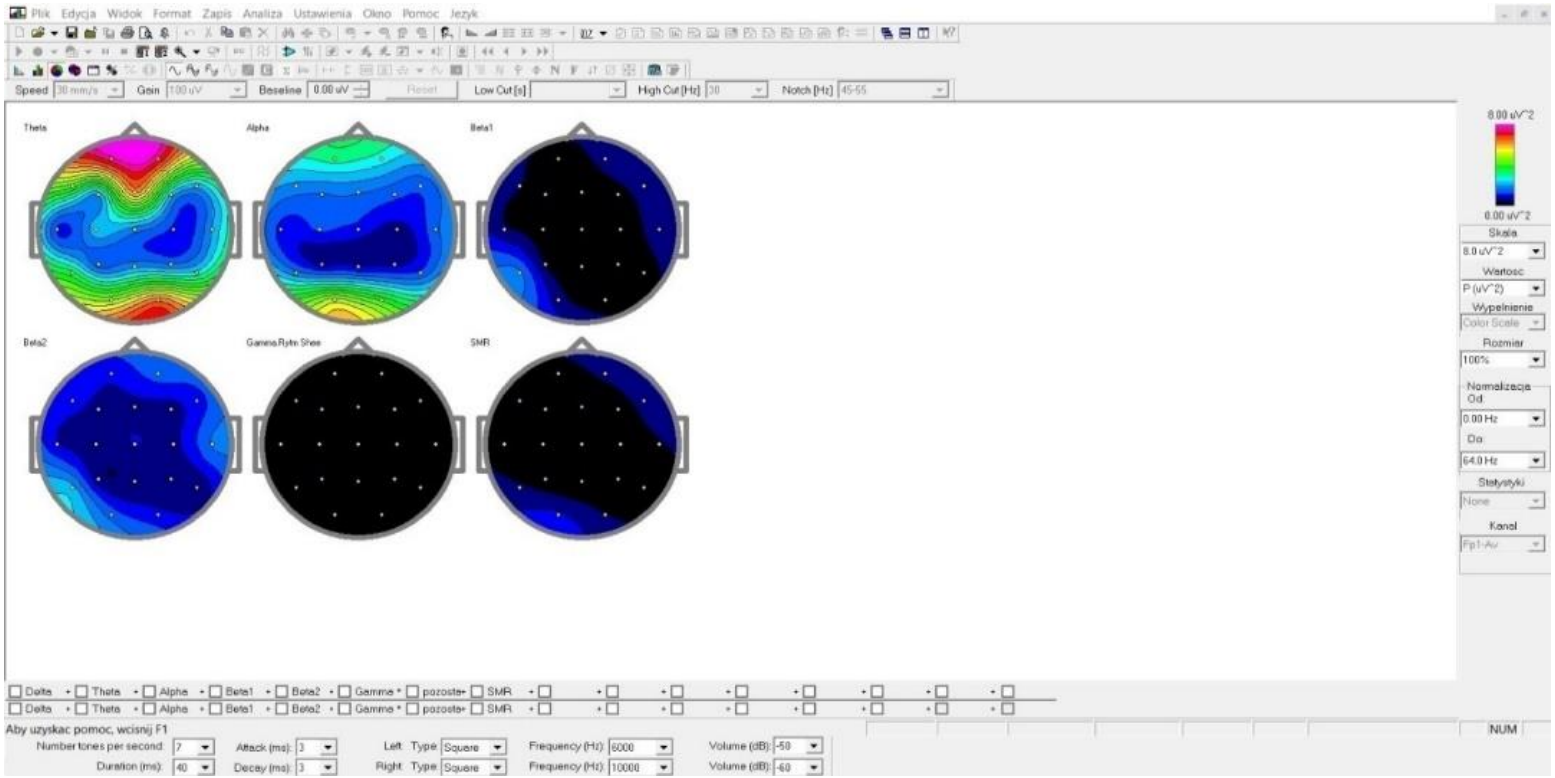

Fig. 4
Mapping of brain activity
Own sources.

It is important to remember which frequencies are observed and most relevant from the point of view of brain activity (Thompson, 2012). As for didactic activity, we are interested in brain activity that shows its significant engagement in intellectual activity. Thus, we shall focus on the so-called Beta waves with a frequency range from 12 to 36 Hz. Initial research during a student's work with simulation software from the area of widely-understood technology showed that a significant increase in the amplitude of these wave frequencies within the range from 16 to 20 Hz could be noticed. These are the waves that accompany people in moments of big concentration and focus, i.e. mental effort. Solving technical problems with the help of simulation software is not easy as we deal here with certain stages of work. The first stage is getting familiar with the software and its options. It is undeniably difficult, especially for students who have not had much contact with or working practice in this environment so far. In this case, such elements of the algorithm itself and software structure were examined as iconography used in the programme, interpretation of technical vocabulary in a foreign language, etc. There are many such elements and each of them can be an example how such programmes should be designed and which elements should be avoided. It is about communicativeness in transferring information between two parties, a student and a computer. The aforesaid waves are accompanied with waves of a frequency within the range from 18 to 36 Hz, the so-called Beta2 waves. Unfortunately, these waves occur during anxiety, heightened emotional states which result from adrenalin occurrence. Of course, we also notice other frequencies of various intensity, which is natural as they are often a result of other body organs' work. Comparing two working stages of people at work, during increased mental effort and during a state of inactivity, e.g. in the stand-by mode, we can notice that the characteristic of our brain's work changes. An identical state, though not researched yet, occurs in the area of contact between two persons. Here we also deal with different emotional states accompanying interpersonal, verbal, gesture communication, etc. According to ETA, emotional states of the Adult, Parent ego states are characteristic and proportional to the dynamism of expressed feelings. The educational process is not only a passive transfer of ideas, but, above all, their reception is conditioned by the form in which they are communicated. Sounds and images can be perceived positively by a given student, but sometimes they can be seen as an element disturbing their cognitive process. The intensity of their occurrence should not be random, as following constructivism and connectivism, concepts should complement each other and not occur randomly. Our brains seeks connections between concepts, which might come from both acquired knowledge and experienced knowledge (long-term memory), yet they should be recalled at a specified moment and presented with great sensitivity. The brain itself memorises only a few percent of signals that reach it, those that seem ir-

relevant, or seem to have no significance at a given moment are immediately deleted. The occurrence of particular concepts should not be incidental, and that is the direction of the latest research in neurodidactics. EEG tests can be a good example of such research. The development of neurodidactics, which is currently perceived as an area not thoroughly examined yet and is not defined by researchers even as a sub-branch of science, seems to be of a paramount importance and potential. Once we get to know our brain well, when we learn about our expectations and about our brain's potential, we shall not only improve but personalize teaching methodology. We shall implement a real process of an individual approach to a given student, taking into account many factors pertaining to their intellectual potential. Thus, it can be generally stated that the complexity of communication in interpersonal relations and in a relation with a digital machine is of a similar nature. Nowadays, in the area of didactics, pedagogy focuses mainly on behavioural studies, but it is more and more willing to make use of the achievements of biology and psychology. The presented research and observations are only a suggestion for further research in this area, we should look for answers where there are reasons for scientific reasoning. EEG tests are a good example. Although imperfect, the testing apparatus used there provides us with observations that cannot be ignored from a scientific point of view.

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Dydaktyczny wymiar badań elektroencefalograficznych w ujęciu edukacyjnej analizy transakcyjnej

Streszczenie

W artykule przedstawiono wybrane wyniki badań autorskich, jakie prowadzone są w Laboratorium Badań Eksperymentalnych Biofeedback Uniwersytetu Humanistyczno-Przyrodniczego im. Jana Długosza w Częstochowie, dotyczących aktywności dydaktycznej studentów w kształceniu technicznym. Przedstawione wyniki badań są częściową odpowiedzią na pytania stawiane w teorii edukacji technologii informacyjnej. Realizacja kształcenia online, w dobie pandemii COVID-19, z wykorzystaniem deterministycznych symulacji komputerowych jest propozycją rozpoczęcia dyskusji dotyczącej znaczenia nowoczesnych technik przekazu informacji jako kluczowego elementu komunikacji na drodze uczeń–nauczyciel.

Słowa kluczowe: edukacja, dydaktyka, konstruktywizm, badania elektroencefalograficzne, EAT.