Advances in Social Science, Education and Humanities Research, Volume 489
Proceedings of the International Conference Digital Age: Traditions, Modernity and Innovations (ICDATMI 2020)

Research on the Functional Status of Teachers and Students Through Educational Dialogue

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***Abstract*—The article deals with the evaluation of the functional status of teachers and students through an educational dialogue, using e-learning and distance learning technologies. A comprehensive methodology for assessing the neuro-emotional state of teachers and students was developed, that was based on computer electroencephalography and polygraphy. On the basis of the developed comprehensive methodology, the studies on the assessment of the neuro-emotional state of teachers and students under conditions of real educational dialogue in the system «teacher - computer - student» have been carried out. It has been found that both teachers and students experience significant neuro-emotional overload in the context of educational dialogue; statistically significant differences in the individual characteristics of the examined persons have been identified. It has been established that providing the teacher with information on the neuro-emotional state of the student (introduction of feedback) in the course of educational dialogue results in a statistically significant decrease of the stress level (more than twice). The need to develop peer review methods for teachers and to establish on them a library of reference elements of an educational dialogue to provide future teachers with skills in educational dialogue conducting, based on the knowledge of methods and on the results of the neuro-emotional assessment of the students.**

Keywords—educational dialogue, neuro-emotional state, e learning, computer polygraph

I. INTRODUCTION

In addition to traditional forms, the training of a future teacher for an educational dialogue should include the preparation for it by means of information technology, based on the learning objectives, strategies and elements of the educational dialogue. This is particularly relevant at present when the educational process is being organized with the use of e-learning and distance-learning technologies in increasingly sanitary and epidemiological measures.

A special role in such interaction is played by the neuro-emotional state of the teacher and student during the educational dialogue. Kutepova L. et al. showed that underestimation of this factor can have a very negative impact [1].

However, today the problem of assessment of the functional (neuro-emotional) state of a teacher and a student in the mode of educational dialogue, in both traditional and information technologies of teaching is not thoroughly researched in scientific-theoretical or methodical aspects. Therefore, it is not possible to develop scientifically traditional (pedagogical) approaches to the training of future teachers in educational dialogue as well as and to create information technology of teaching, that are able to avoid neuro-emotional

overload of learners and take into account their individual cognitive characteristics. This makes it possible to identify the problem and it makes research relevant in this direction.

In pedagogy and psychology, a number of common methods are used to evaluate the results of the didactic process, based on the use of different types of tests [2-6]. These methods do not consider continuous monitoring of the neuro-emotional state of the teacher or the student in the didactic process, and therefore they cannot be used for objective functional diagnostics of participants in the educational dialogue.

One of the first attempts to objectively assess the functional state of students in solving mathematical problems was made by Lebedev A. [7], who tried to find the signs of intellectual development using electroencephalography methods. However, the functional diagnostics of teachers and students on the problems of educational dialogue in both traditional and information teaching technologies was not conducted because of the lack of learning objectives and research methods.

Menyaylenko A. et al. [8, 9] assessed the functional condition of students by computer electroencephalography method and by computer polygraph examination (breathing changes, galvanic skin reactions, changes in blood pressure). However, these methods require special laboratory conditions and equipment, which makes it impossible to use them directly in the didactic process.

Menyaylenko A. et al. [10], Kutepova L. et al. [11, 12] for the first time conducted studies to assess the neuro-emotional state of students in a real didactic process by means of multi-level voice computer polygraph examination. However, this work did not address the assessment of the neuro-emotional state of the teacher and students in the course of educational dialogue. This does not allow for the direct use of these research methods to the organization of educational dialogue.

The present study aims to develop methods and study the functional (neuro-emotional) state of teachers and students in the process of educational dialogue using e-learning and distance learning technologies, that is, in the system «teacher - computer - student».

II. MATERIALS AND METHODS

The human body is characterized by a large number of conditional and unconditional responses, so that the reaction of the organism being trained at different stages of the didactic process is complex and connected with emotions that have been formed during the long-term evolutionary development. This can be mathematically written as [13, 14]:

$$MS=LM+FSLB, \quad (1)$$

where MS is mental stress, LM is level of motivation and FSLB is functional state of the learner's body.

Formula (1) is consistent with all existing theories of human physiological responses [14].

A number of physiological indicators vary according to the value of the mental stress of the examined student: electrical activity of the areas of the cerebral cortex, heart rate, blood pressure, skin resistance, the nature of breathing movements, voice pulsation, changes in the basic tone of the voice, vibration of the micromuscles of the vocal apparatus, etc. The monitoring of these physiological features is the basis for the assessment of a person's mental state by computer electroencephalography, computer polygraph examination, voice polygraph examination [13, 15-18].

In accordance with the stated aim of the study, the methods specified (computer electroencephalography and computer polygraphic examination) were further developed for assessing the neuro-emotional state of the teacher and student during the educational dialogue in the system «teacher - computer - student».

The method of studying of the neuro-emotional state of teachers and students in the process of educational dialogue in the system «teacher - computer - student» includes the following steps:

1) removal (if possible) of outside noise and setting of silence in the classroom;

2) creation and maintenance of permanent pedagogical conditions in the process of study;

3) recording of electroencephalography (EEG) of the teacher and student before the dialogue (mode 1), during the dialogue and after completion (mode 2);

4) identification and removal of EEG artifacts and diagrams;

5) selection of the areas on EEG corresponding to the different stages of educational dialogue;

6) identification and isolation of spikes on EEG during the educational dialogue;

7) brain electrical activity mapping of the teacher and student;

8) isolation of dominant rhythms and mapping of transitions during the dialogue;

9) recording of parameters characterizing the functional status of the teacher and students (chest and diaphragmatic breathing, tremor (movement), galvanic skin reactions and blood pressure (volumetric blood flow));

10) selection of the areas on the diagrams of the registered parameters corresponding to the elements of the educational dialogue;

11) calibrating of the voice polygraph to the teacher's and student's voice for 10-30 seconds before the start of the educational dialogue mode (mode 3);

12) recording of voice polygraph parameters characterizing the neuro-emotional state of the teacher and student (Str (Stress), SNS (Subject Non Sure) and Exc (Excitement)), as well as their threshold values of PStr, PSNS and PExc, respectively;

13) statistical processing and making plots of the recorded parameters;

14) identification of information signs on the diagrams of the registered parameters, their processing;

15) assessment of statistical significance of the outcomes.

Computer EEG DX-400 Practic was used for the EEG, and for polygraph - computer polygraph Delta and the multi-level voice polygraph eX-Sense-Pro-R were used. Menyaylenko A. et al. [8-10], Kutepova L. et al. [11, 12] gave the pilot schemes in their works. These devices process information on the basis of international standards.

To assess the statistical significance of the outcomes of the parameters: upper and diaphragmatic breathing, tremor, galvanic skin reactions, blood pressure, stress level, degree of uncertainty and excitement, it is appropriate to use the Kolmogorov-Smirnov non-parametric two-sample criterion, which checks the differences between the two samples and is also sensitive to the difference in the common forms of distribution of these samples (scattering, asymmetry, etc.) [19, 20]. In addition, in order to assess the significance of the information parameters, for carrying out the polygraph examination we also use the methodological guidelines by Zubrilova I. [13] used in forensic science. According to these recommendations, response to exposure is considered credible if the information parameters differ by more than 60%.

The study was carried out with the teachers and students of the Kazan branch of Volga State University of Water Transport and Kazan Cooperative Institute.

The research using the developed methodology, was carried out according to two fundamentally different experimental patterns of the educational dialogue: the traditional pattern of dialogue - without providing the teacher with information about the neuro-emotional state of the student (Fig. 1) and with feedback - providing the teacher with information on the neuro-emotional state of the student (Fig. 2) during the dialogue process.

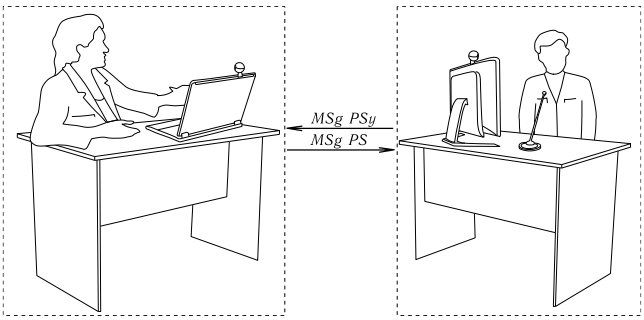

Fig. 1. Pilot scheme for educational dialogue studying in the system «teacher - computer - student» based on the traditional approach where MSgPSy - student's messages; MSgPS - teacher's messages

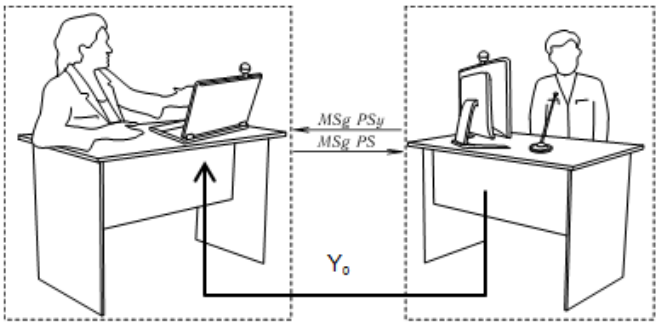

Fig. 2. Pilot scheme for educational dialogue studying in the system «teacher - computer - student» on the basis of feedback about the neuro-emotional state of the student, where MSgPSy - messages of the student; MSgPS - messages of the teacher; Y_0 - information to the teacher on the student's condition (feedback)

III. Results and Discussion

Figures 3 and 4 illustrate the example of mapped changes in the brain activity of the teacher and student for the dominant rhythms in the course of educational dialogue (see Fig. 1), which indicate significant changes in the brain activity for both the teacher and student.

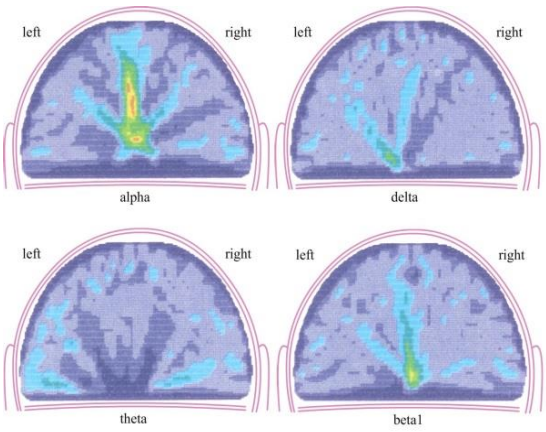

Fig. 3. Mapping changes in brain activity for the dominant rhythms during the teacher's educational dialogue ($\alpha \rightarrow \delta \rightarrow \theta \rightarrow \beta$).

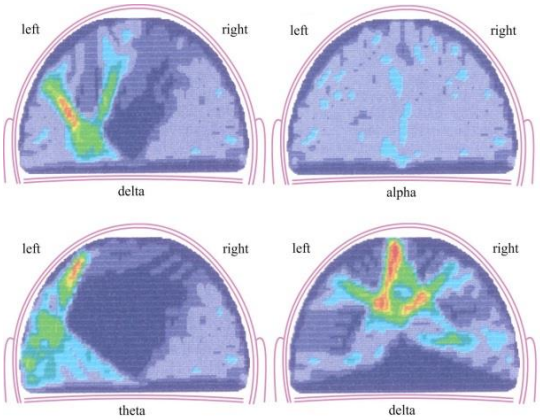

Fig. 4. Mapping changes in brain activity for the dominant rhythms during the student's educational dialogue ($\delta \rightarrow \alpha \rightarrow \theta \rightarrow \delta$).

In the course of the study, some students and teachers experienced monophase and polyphase spikes during the educational dialogue (Fig. 5). A number of students have also been identified with significant EEG features and with a large number of polyphase spikes and significant changes in the amplitude of all EEG sensors, which points to a lot of neuro-emotional overload of the students. Figure 6 shows EEG of these students in an educational dialogue mode.

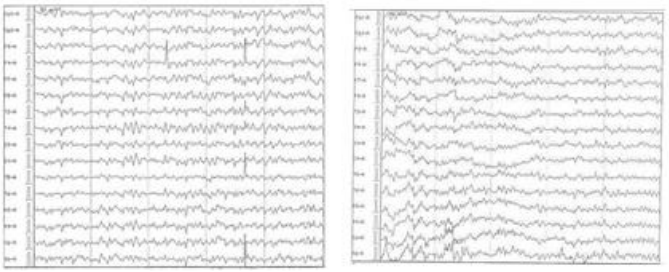

Fig. 5. Examples of monophase and polyphase EEG spikes during the educational dialogue, where the teacher is on the left and the student is on the right

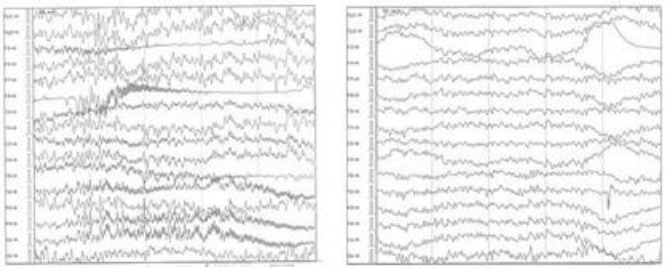

Fig. 6. Example of EEG of the students with neuro-emotional overload in an educational dialogue mode (see pilot scheme in Fig. 1)

As informative features characterizing the polygraph curves, the assessments of the average value of the amplitude in the mode 1 and 2, and the deviation of the amplitude of signals from the average values in the educational dialogue mode were used, as well as qualitative indicators - the appearance of polyphase or monophase spikes, breath holding.

Figure 7 shows an example of the neuro-emotional overload of the student with computer polygraph in the dialogue mode (see Pilot scheme in Fig. 1). The teacher is also affected.

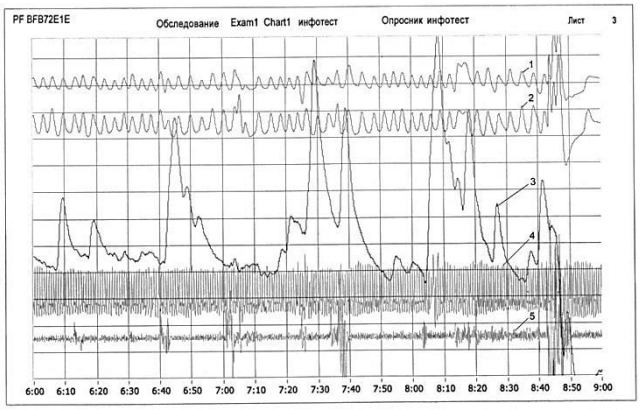

Fig. 7. Example of the assessment of the neuro-emotional state of the student by polygraph in the educational dialogue mode (see Pilot Scheme in Fig. 1), where 1, 2 - sensor signals of upper (chest) and diaphragmatic breathing, respectively; 3 – galvanic skin reaction sensor signal; 4 - signal of arterial pressure sensor (volumetric blood circulation) 5 - tremor sensor signal (movement)

According to the study conducted, the student's reaction to the dialogue mode will be most active in the signals of the sensor of galvanic skin reactions.

Furthermore, the amplitude of a signal against the amplitude in the mode 1and 2 is increased by more than 100%, indicating a significant change in the parameter. Also in the dialogue mode, breath holding occurs both in the student and the teacher and polyphase spikes in the tremor sensor signals.

Figures 8 and 9 show typical examples of changes in the mental state of the student and the teacher during the educational dialogue, where the following legends have been adopted: a) changes in the amplitude of a sound signal; b) stress level Str; c) subject non sure SNS; d) degree of excitement Exc; min is the time in minutes.

Figure10 shows stress (Str) threshold values (PStr) for a student, where: 0 is a small value of stress; 1- Stress, 2 - High Stress, 3 - Extreme Stress.

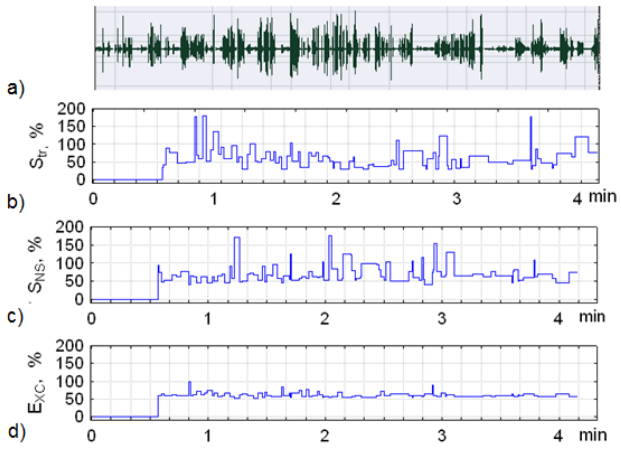

Fig. 8. Example of the assessment of the student's neuro-emotional state by means of multi-level voice polygraph examination in an educational dialogue mode (see Pilot Scheme in Fig. 1)

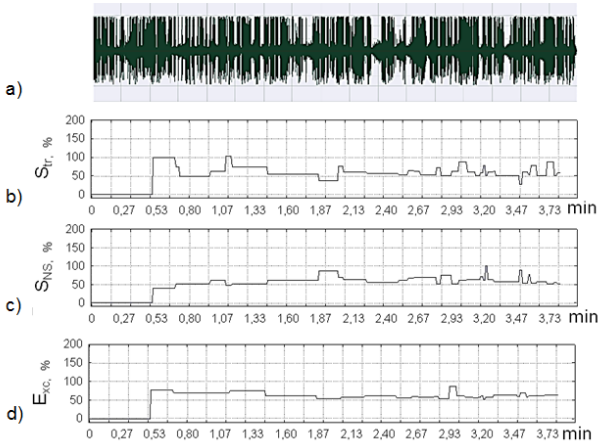

Fig. 9. Example of the assessment of the teacher's neuro-emotional state by multi-level voice polygraph examination in an educational dialogue mode (see Pilot Scheme in Fig. 1)

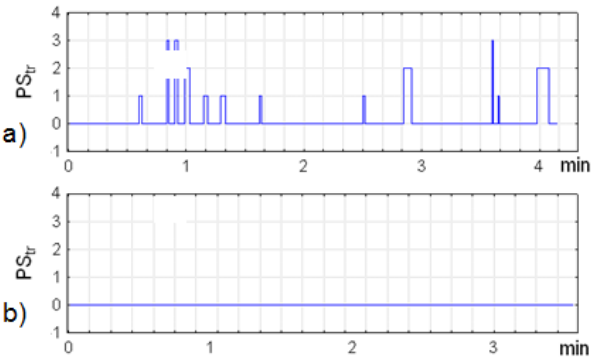

Fig. 10. Threshold values PStr of stress level Str (see Pilot Scheme in Fig. 1), where a) student S3; b) student S7

According to experimental data received, there are significant individual differences in the neuro- emotional state of students in the dialogue mode. For example, the student S3 experiences high and extreme levels of stress (Fig. 10a) and the student S7 experiences little or no stress during the dialogue process (Fig. 10b).

In order to effectively conduct the educational dialogue and manage the didactic process, the teacher must take into account the individual characteristics of the students in order to avoid significant neuro-emotional overload on the learners, which requires that the teacher be provided with objective information on the neuro-emotional state of the students in the course of educational dialogue.

The study has shown that providing the teacher with information (introduction of feedback, see Pilot Scheme in Fig. 2) on the neuro-emotional state of a student and taking it into account in the course of educational dialogue results in a significant reduction of the neuro-emotional overload in the student.

Table I illustrates the outcomes of experimental studies of the student stress value in 5 consecutive series of the educational dialogue with various pilot schemes (see Fig. 1 and 2).

TABLE I. ASSESSMENT OF STUDENT'S STRESS

Educational dialogue number series	Average stress value (Str)	Dispersion of stress value (Str)	Availability of information on the neuro-emotional state of a student to the teacher (Yes/No)
1	62,25	806,25	No
2	61,28	260,15	Yes
3	57,36	311,38	Yes
4	59,81	342,99	Yes
5	55,55	293,40	Yes

On the basis of the Kolmogorov-Smirnov non-parametric two-sample criterion ($p<0,05$), statistically significant changes in the test parameters of Str., SNS and Exc. have been identified for two schemes of the educational dialogue (see Fig. 1, 2, 9-11).

According to data received (see Table I) the educational dialogue in the system «teacher - computer - student» is a heteroscedastic object in which the introduction of feedback (providing the teacher with information on the neuro-emotional state of students) results in a statistically significant decrease in neuro-emotional stress level of learners, the stress dispersion drops down to less than a half (see Table I).

Therefore, the training of a future teacher for educational dialogue should be based on the best pedagogical practices and the reference elements of the dialogue developed on their basis, which is particularly important in the context of training information technologies (automatic learning systems, distance learning systems, etc.).

The outcomes also coincide with the outcomes of the assessment of the neuro-emotional state of students by means of computer electroencephalography and computer polygraph examination [8-12] in the context of information technology education.

In addition, the study also shows the need to develop methods of peer review of teachers and to establish on them a library of reference elements of the educational dialogue, formation with its help of techniques and skills of an educational dialogue in the system «teacher - computer - student», based on the knowledge of the techniques and the outcomes of the assessment of the neuro-emotional state of the learners.

IV. CONCLUSIONS

A comprehensive methodology has been developed for assessing the neuro-emotional state of teachers and students in the context of educational dialogue, which is based on further refined methods of computer electroencephalography, computer polygraph and multi-level voice polygraph and includes a number of physiological indicators of the examined persons: electrical activity in areas of the cerebral cortex; blood pressure, skin resistance; the nature of breathing movements; pulsation of the voice associated with blood flow;

changes in the main tone of the voice; vibration of the micromuscles of the vocal apparatus as well as their threshold values; statistical processing and making plots of registered parameters.

On the basis of the developed comprehensive methodology, the studies on the assessment of the neuro-emotional state of teachers and students under conditions of real educational dialogue in the system «teacher - computer - student» have been carried out. It has been found that both teachers and students experience significant neuro-emotional overload in the context of educational dialogue; statistically significant differences in the individual characteristics of the examined persons have been identified (from the absence of significant stress to its extreme values).

It has been established that providing the teacher with information on the neuro-emotional state of the student (introduction of feedback) in the course of educational dialogue results in a statistically significant decrease of the stress level (more than twice).

The need to develop peer review methods for teachers and to establish on them a library of reference elements of an educational dialogue to provide future teachers with skills in educational dialogue conducting in the system «teacher - computer - student», based on the knowledge of methods and on the results of the neuro-emotional assessment of the students.

Acknowledgment

The authors express his gratitude to anonymous reviewers for useful suggestions and recommendations, which allowed the authors to strengthen scientific reasoning, to extend bibliographic analysis and, in general, to improve the quality of the text.

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