

STATEMENT

Regarding the dissertation thesis for the acquisition of the educational and scientific degree
Doctor

Title of the dissertation thesis:

“A Neurocognitive Approach Based on a Brain–Computer Interface for Identifying Emotional and Mental States”

Professional field:

5.2. Electrical Engineering, Electronics and Automation

Scientific specialty:

Application of the Principles and Methods of Cybernetics in Various Fields of Science

Author of the dissertation thesis: Master Engineer *Gagandeep Kaur*

Member of the scientific jury: Assoc. Prof. Dr. Eng. *Mila Ilieva-Obretenova*

The submitted dissertation thesis consists of 123 pages. The content is structured into four chapters, a Conclusion, Directions for Future Work, Contributions, References, and Appendices. The information is illustrated with 32 figures and 18 tables.

1. Relevance of the Problem Addressed in the Dissertation in Scientific and Applied-Scientific Terms

Fatigue is described in the literature in various ways. Generally, it is a function of behavioural and cognitive engagement that occurs during wakefulness. Wakefulness can be viewed as a spectrum rather than a single moment. At one end lies alertness, and at the other—falling asleep. As natural processes unfold along this spectrum, alertness gradually decreases and fatigue emerges. The unresolved problems in this field include:

- Most EEG-based fatigue studies are conducted in controlled laboratory environments using scripted cognitive tasks designed to induce fatigue. There is limited research on fatigue during real professional activities.
- EEG-based studies of teacher fatigue during actual pedagogical work are scarce.
- The primary activity recorded during simulated tasks is well documented in the literature. Few studies investigate fatigue using resting-state EEG measurements taken before and after full workload exposure.
- Neurological EEG research in education initially focuses on students; neurophysiological studies of teachers' cognitive states are limited.
- EEG-based research has not examined fatigue among teachers practicing suggestopedia.

Therefore, challenges arise when applying a brain–computer interface for neurocognitive analysis and assessment of emotional states, with a particular focus on fatigue. The problem is significant due to the unexplored relationships between positive and negative emotions and fatigue.

2. Degree of Familiarity with the State of the Problem and Creative Interpretation of the Literature

The doctoral candidate demonstrates awareness of the current state of the problem. The dissertation uses 116 literary sources, all in English. The sources relevant to the topic are cited correctly. Forty-one sources (35%) are from the last ten years.

3. Consistency of the Selected Research Methodology with the Aim and Tasks of the Dissertation and with the Achieved Contributions

I consider that the methodology chosen by the doctoral candidate:

1. Selection of participants (teachers practicing suggestopedia)
2. Baseline condition – pre-task (resting-state EEG recording)
3. Task (3 hours of teaching using suggestopedia)
4. Post-task (resting-state EEG recording)
5. Evaluation of EEG changes before and after the task
6. Results and interpretations

is consistent with the aim stated in the dissertation:

“To design a new approach for collecting experimental evidence in order to test the hypothesis and the relationship between emotional and cognitive states using an EEG-based brain–computer interface framework and to generate new knowledge.”

The hypothesis is that there is no significant difference in EEG activity before and after the task, i.e., the task does not induce fatigue. To achieve the stated aim, the doctoral candidate formulated four main tasks, all of which are fulfilled in the dissertation.

4. Evaluation of the Author’s Abstract and the Publications Related to the Dissertation

The author’s abstract complies with the requirements of the Act for the Development of the Academic Staff in the Republic of Bulgaria (ZRASRB) and its Regulations. Its structure and content correspond to those presented in the dissertation. The main results of the dissertation have been published in three articles issued between 2019 and 2024. Two of the publications are co-authored, and one is a single-author article. Two articles are published in scientific journals and one in a conference proceeding. Two citations in scientific journals are indicated. The publication activity is reflected in the dissertation. The data from the submitted materials on the scientific and publication activity of M.Eng. Gagandeep Kaur show that the doctoral candidate meets the minimum national scientometric indicators required for obtaining the educational and scientific degree *Doctor*.

5. Evaluation of the Scientific Results and Contributions, and the Degree of the Doctoral Candidate's Personal Participation in the Developed Topic

The contributions in the dissertation can be divided into two groups—scientific-applied and applied. The doctoral candidate formulates three scientific-applied contributions and one applied contribution. All contributions are adequately substantiated.

The new model and methodology for neurocognitive analysis and assessment of various emotional and cognitive states in working adults, based on an EEG brain–computer interface, enable the definition of the main functional requirements for recording, preprocessing, feature extraction, and analysis using the interrelationships between EEG frequency bands across different EEG electrodes.

The new methodology for the experimental procedure makes it possible to conduct research in a real working environment with teachers who teach using the Suggestopedia method.

The original neurophysiological model, identified after statistical analysis, allows fatigue to be characterized as a state of prolonged cognitive engagement and compensatory brain activity rather than mental exhaustion.

The methods integrate a new toolkit for processing and interpreting neurophysiological states, which accounts for the individual responses of the participants.

6. Opinions, Critical Remarks, and Recommendations

No editorial errors were found in the dissertation. It is evident that the author has applied knowledge and skills in conducting the research, processing the results, and synthesizing the contributions in the dissertation. This is an excellent attestation for the doctoral candidate and their scientific supervisor and serves as grounds for a positive evaluation of the overall presentation of the dissertation.

7. Conclusion

The dissertation reflects in detail the doctoral candidate's research, which has an indisputable scientific-applied and applied character. The submitted dissertation, the author's publications, and the correctly formulated contributions possess all the necessary merits, and I consider that they fully comply with the requirements of the *Act for the Development of the Academic Staff in the Republic of Bulgaria (ZRASRB)* and its Regulations.

I give a positive evaluation of the dissertation and propose to the esteemed scientific jury to award M.Eng. Gagandeep Kaur the educational and scientific degree **Doctor** in professional field **5.2. Electrical Engineering, Electronics and Automation**, scientific specialty **Application of the Principles and Methods of Cybernetics in Various Fields of Science**.

18 April 2026

Member of the Scientific Jury:

(Assoc. Prof. Dr. Eng. Mila Ilieva-Obretenova)