REFEREE STATEMENT

on the procedure for obtaining the educational and scientific degree "Doctor"

by

candidate: **Fabien Theofanis Kunis**
topic of the dissertation: **Creating and using information systems for team problem solving in physics education**
in the professional field**: 1.3 Teaching methodology of ...**
doctoral program**: Teaching methodology of physics**

This statement was prepared by **Assoc. Prof. Dr. Venelin Kozhuharov**, Faculty of Physics, Sofia University "St. Kl. Ohridski", as a member of the scientific jury in the professional field: **1.3 Pedagogy of training in …** doctoral program **Teaching methodology in physics** according to Order **No. RD 38-311 / 03.07.2023** of the Rector of Sofia University «St. Cl. Ohridski».

1. **General characteristics of the dissertation and the presented materials**

Fabien Kunis has submitted a dissertation and an extended abstract, as well as the mandatory tables for compliance with *The regulations on the terms and conditions for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski"*. Other documents supporting the applicant's achievements are also presented.

The dissertation presented by the candidate has a total volume of 192 pages, of which 19 pages are appendices. It is worth noting that in the spirit of open science, the data obtained by the PhD candidate are presented in full and is part of the appendices. This allows independent analysis and interpretation of the results. The presented PhD thesis includes an introduction, three chapters and a summary, where the research outcomes, the conclusion and the personal contributions to the scientific field defined by the doctoral student find their place. The introduction briefly presents the purpose of the study, arguing its necessity and relevance. The author defines the goal as "to develop a concept, tools and models for the formation of students' teamwork skills in the teaching of physics and astronomy at the junior high and high school levels and for the formation of the key competence of collaborative problem solving in a learning environment." In addition to "for formation", I would add "and for evaluation" of students' teamwork skills in the presented goal. The first chapter is dedicated to clarifying the competence "Team Problem Solving". Teamwork and problem solving skills are reviewed, presenting the different frameworks for defining the Team Problem Solving competence. For the subsequent purposes of the dissertation, the definition according to PISA (collaborative problem solving) was adopted, namely as a matrix representing a direct product of the vectors of the (sub)processes and the components of the competences "problem solving" and "teamwork". The results obtained from the PISA 2012 and 2015 studies are also summarized in the first chapter, devoting special attention to the performance of the Bulgarian students.

The second chapter is devoted to the role of information and communication technologies in education and to the creation of an information system to develop and study the competence "team problem solving". The benefit of using interactive simulations of physical processes in learning the learning material in school education is argued. The software products developed by the candidate are presented. They are divided into two parts - simulations of natural phenomena with different methods (simplified mathematical models or cellular automata) and development of an information system for team problem solving.

The third chapter is devoted to the use of the developed information system for conducting a didactic experiment. The research questions are clearly selected and the methodology is tailored to them. This "experimental" chapter describes in detail the selection of the target group and its division into experimental and control groups, the investigated components of team problem solving in physics, the chosen statistical methodology. The results of the conducted experiment are presented, which are further systematized in "Conclusions".

A conclusion, a summary of scientific contributions and the candidate's bibliographic reference, including publications and reports on the topic of the dissertation follow in the text of the PhD thesis. The achievements of the dissertation are supported by 45 figures and 10 tables. 195 bibliographic sources related to the subject are also cited.

2. Data and personal impressions about the candidate

Fabien Kunis graduated with a master's degree in engineering physics with a specialization in "Microelectronics and Information Technologies" in 2014. From February 2020 to 2023, he was a doctoral student in the professional field 1.3 Pedagogy of teaching in... (Methodology of teaching in physics). In June 2023 he successfully presented a dissertation on "**Creating and using information systems for team problem solving in physics education"** at the Methodics of Physics Education department, as a result of which a procedure for the defense of the dissertation was initiated. Fabien Kunis worked actively in the field of Teaching Methods in Physics and is a co-author of 7 scientific publications and 18 presentations at international scientific conferences. During his doctoral studies, he was actively working with high school students from 125. SU Boyan Penev and participated in the Open Days at Faculty of Physics, SU "St., Kl. Ohridski". Fabien Kunis is an active teacher of physics and astronomy, informatics and information technologies at 125. SU Boyan Penev.

3. Content analysis of the scientific and scientific-applied achievements of the candidate, contained in the presented thesis and the publications to it, included in the procedure

The scientific topic of the dissertation, namely team problem solving, is extremely relevant in view of the increasing importance of the competence approach in the education of high school students. Developing a methodology to train and improve a given competency is not an easy task. And even more difficult is to develop a methodology to assess how well a target group, in this case secondary school students, have improved their competence.

The PhD thesis of Fabien Kunis is focused exactly in these two directions - improvement and evaluation of the "team problem solving" competence, considering the particular case of physics problems. In general, I summarize the candidate's contributions as:

- systematic analysis of the nature of the competence "team problem solving" and selection of a specific framework for its study

- development of an original information system implementing a methodology for researching the components of the selected framework of skills included in the competence "team problem solving"

- application of the information system in real environment of secondary school students, which leads to the testing of both the information system and the methodology as a whole.

In this sense, the candidate's contributions is related to both theory and applied pedagogical sciences. This reflects the highly positive impression of the presented work. The candidate has also presented ideas for future development, which shows a broader view of the scientific subject.

The topic of the PhD thesis is innovative for Bulgaria, and in this sense the presented scientific studies do not raise any doubts about reuse of former results. The methodology developed by the candidate is original, validated in real environment and the conclusions obtained are reliable and verifiable. No suspicion of any plagiarism by the candidate is available.

4. Approbation of the results

The assessment of the quality of the obtained results is based on the candidate's scientific production, published in refereed scientific journals, namely the publications. The candidate has claimed 7 publications on the topic of the dissertation. It should be noted that the candidate did not indicate the Faculty of Physics, SU "St. Kl. Ohridksi" as his affiliation in two of his articles, which were published during the doctoral studies and presented as publications in connection with the dissertation. On the other hand, the results of these two publications, "Creating a Physical Wallet for Cryptocurrencies" and "Manipulating Pixels, Graphic Images and Video Using Javascript", are in fact not included in the dissertation. For this reason, I consider that the dissertation work is based on 5 scientific publications and the inclusion of the aforementioned two publications in the claimed list is completely unnecessary.

All five publications related to the PhD research are published in refereed journals, three of which are indexed in SCOPUS and have an impact factor or impact rank (SJR). Fabien Kunis is the leading author in 4 out of the 5 publications, which indisputably proves the candidate's contribution and his role in the conducted research. I strongly support and welcome the applicant's desire to publish in open access journals, although this is not always possible. The results have also been presented at 18 conferences, which confirms the wide interest in the described research.

I consider that the material presented in addition to the dissertation work fully supports the results in the dissertation. It is fully compliant and significantly exceeds the required 30 points for the award of a Educational and scientific degree “Doctor” according to the existing Bulgarian regulations and is also compliant with the regulations on the terms and conditions for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski" (PURPNSZADSU).

The candidate has not submitted a list of the citations to the publications.

5. Qualities of the extended abstract

The extended abstract is presented on 43 pages and represents a consistent and complete summary of the candidate's scientific achievements, discussed in more detail in the dissertation work. The extended abstract is presented both in Bulgarian and in English, with the English version being a direct translation of the Bulgarian and in this sense it also correctly reflects the dissertation work.

6. Critical remarks and recommendations

The materials presented by the candidate for the acquisition of the ONS "Doctor" in professional direction 1.3 Pedagogy of training in ... (Physics training methodology) are at an extremely high level. The candidate demonstrates high language culture, the few errors being mainly punctuational. The inaccuracies in the text are purely technical (eg PISA 2018 and PISA 2015 on page 65, etc.) and do not affect the conclusions of the dissertation. Additional remarks on the layout of the dissertation are related to the fact that some of the figures are of poor quality (eg Fig. 3.6, Fig. 3.8, etc.); part of the tables are presented as figures (fig. 1.8, fig. 3.3 and others in chapter 3); used the word "screenshot" rather than "screenshot";

In view of the main topic, namely team problem solving, I do not think that the purpose of presenting in the dissertation the two methods for simulating the predator-prey system using numerical

methods is sufficiently well justified in the text. Such an argumentation would be the possible joint (team) participation of students in the development of the relevant models. Also, there is no argument in the text why the graphics presented in fig. 2.8 plot starts from step t ~ 440, and not from 0 or any other value. The title of the third chapter, 'research part, data analysis the study and results', is too general.

However, the mentioned remarks do not underestimate the scientific achievements and depth of the candidate's PhD thesis, which are indisputable. They are aimed solely at the presentation of the obtained results in the presented work.

7. **Conclusion**

After reviewing the presented materials and taking into account the specifics of the scientific field and the conducted research, I strongly recommend to the respected jury to award **Fabien Theofanis Kunis** educational and scientific degree "doctor" in a scientific field 1.3 Pedagogy of training in ... (Methodology of training in physics) **of Fabien Theofanis Kunis.**

20.09.2023 Prepared by: .....

(Assoc. Prof. Dr. Venelin Kozhuharov, FzF, SU)