O P I N I O N

by Assoc. Prof. Kamelia Bozhidarova Koleva, PhD
Department "Communication and Information Systems",
Faculty "Logistics and Technologies",
Vasil Levski National Military University

regarding a dissertation for the award of the educational and scientific degree "Doctor" (PhD)

Area of higher education: 1. Pedagogical sciences,

Professional field: 1.3. Pedagogy of teaching in … ,

PhD Programme in Methodology of Teaching Mathematics

Author: **PENKA GEORGIEVA KARADZHOVA**

Title: **SYNERGETIC ASPECTS OF CONTINUITY IN MATHEMATICS EDUCATION IN THE SECONDARY SCHOOL (5TH – 7TH GRADE)**

Scientific supervisor**: Assoc. Prof. Dobrinka Vasileva Milusheva-Boykina, PhD**,
Plovdiv University „Paisii Hilendarski", Faculty of Mathematics and Informatics

1. General overview of the procedure and the PhD candidate

1.1. General description of the submitted materials

By order No. RD-22-395/20.02.2026 of the Rector of the University of Plovdiv "Paisii Hilendarski" (PU) I have been appointed as a member of the scientific jury in the procedure for acquiring the educational and scientific degree "Doctor" in the area of higher education 1. Pedagogical sciences, professional field 1.3. Pedagogy of teaching in … , doctoral program "Methodology of Teaching Mathematics".

The author of the dissertation is Penka Georgieva Karadzhova – a part-time PhD student at the Department of Education in Mathematics, Informatics and Information Technologies at the Faculty of Mathematics and Informatics of the PU with PhD supervisor Assoc. Prof. Dr. Dobrinka Vasileva Milusheva-Boykina from the same university and the same department.

The set of paper materials presented by Penka Georgieva Karadzhova is in accordance with Art. 36 (1) of the Regulations for the Development of the Academic Staff of the PU, includes the following documents:

- application to the Rector for initiation of the PhD dissertation defense procedure;
- curriculum vitae in European format;
- opinion of the PhD supervisor on the dissertation's readiness for preliminary review by the department council;
- protocol of the preliminary discussion in the department;
- report from the Head of the department on the proposed composition of the Scientific Jury and the date of the defense;

– abstract in Bulgarian and English;

– declaration of originality and authenticity of the submitted documents;

– report on compliance with the National Minimum Requirements;

– list of the publications related to the dissertation topic;

– dissertation work;

– declaration of originality of contributions and results;

– copies of publications related to the dissertation topic.

A separate list of noted citations has not been included.

The documents presented by the doctoral student are distinguished by a clear structure and very good layout.

1.2. Brief biographical data for the doctoral student

The doctoral student Penka Karadzhova was born on 06.03.1979. In 2002, she graduated with a Bachelor's degree in "Mathematics" from the Plovdiv University "Paisii Hilendarski", and in 2004 – with a Master's degree in Accounting and Control from the "St. Cyril and St. Methodius" University of Veliko Tarnovo. In 2018, she obtained a qualification as a Mathematics teacher at the Plovdiv University "Paisii Hilendarski". From August 2019 to present, she has been a part-time PhD student in the Department of Education in Mathematics, Informatics and Information Technologies at the Faculty of Mathematics and Informatics of the PU.

During the period 2002 – 2005, Penka Karadzhova worked as an accountant. From 2006 to 2013, she successively held the positions of team leader, manager, supervisor, and accountant in the trade and production sector. From 2013 to 2017, she worked as a consultant on projects and programs. From 2021 to 2023, she was a researcher at the Institute of Robotics, Bulgarian Academy of Sciences. Since 2016, she has worked as a mathematics teacher in Asenovgrad and later in Plovdiv. This experience has enabled her to observe the learning process directly and to carry out the pedagogical experiment related to her dissertation research.

The PhD student demonstrates a clear commitment to professional development, having successfully completed eight courses at Telerik Software Academy and Slot Academy. She possesses an expert level of proficiency in English.

2. Relevance of the research problem

The relevance of the dissertation topic can be considered in both theoretical and practical terms.

The contemporary context of rapidly evolving knowledge and technologies necessitates the search for new and effective methods, tools, and approaches to ensure greater continuity across the different stages of school mathematics education.

The main parameters of the research methodology (object, subject, aims, objectives, hypothesis, and research methods) highlight the significance of both the synergetic approach and

the choice of the lower secondary stage (Grades 5th – 7th) of mathematics education. Self-organization processes and dynamic complex interactions ensure smooth synergistic continuity between intuitive-practical and abstract-theoretical mathematical knowledge in students from grades 5 to 7. The relevance of the topic is also determined by the main goal set in the dissertation: the formation and development of synergetic thinking in students, enabling them to achieve a higher level of understanding, acquisition, and application of mathematical knowledge.

3. Knowledge of the problem

The doctoral student demonstrates a very thorough understanding of the state of the research problem at the theoretical, methodological, and applied levels. To this end, she has reviewed and accurately cited 144 sources, 80 of which are in Cyrillic and 64 in Latin script. The bibliography also includes 10 online sources. The reviewed Bulgarian and international scientific and educational literature has been purposefully and creatively used to construct the theoretical foundation and methodological framework of the study.

4. Research methodology

The research methodology is consistent with the main goal, objectives and hypothesis. The object of the pedagogical experiment comprises students of the lower secondary stage (Grades 5th – 7th) and the subject of the research includes the synergetic aspects of continuity in mathematics education and the methodological approaches for its realization. To conduct the study, various theoretical, empirical and statistical methods were used, including the analysis of pedagogical, psychological, methodological literature and educational documentation, observation of the educational process, comparison, analysis, synthesis, modeling, group discussions, interlocution, testing, pedagogical experiments, etc. Criteria and indicators were developed to conduct the didactic experiment and test the hypothesis. The obtained results have been processed and analyzed using appropriate mathematical and statistical methods, which has enabled the doctoral student to formulate well-founded conclusions and recommendations for teaching practice.

5. Analytical characteristics and evaluation of the research work and contributions

The dissertation consists of an introduction, three chapters, a conclusion, a reference list, and three appendices. The dissertation comprises a total of 256 pages, including 178 pages of main text, 9 pages of references, and 69 pages of appendices.

The **introduction** outlines the concept of the dissertation research, including the relevance and motivation for the choice of topic; the object and subject of the study, as well as the main goal expressed through six tasks, are correctly defined and formulated; the main hypothesis with three working sub-hypotheses is appropriately formulated; and six generalized groups of research methods are employed.

Chapter I presents a systematic theoretical analysis of the key concept of *continuity* in mathematics education within its historical, scientific, methodological, and psychological-pedagogical contexts. Various classifications of the concept, along with principles, assumptions, and approaches to implementing the continuity in education, are examined. The key synergetic principles and concepts are presented, as well as the possibilities for integrating a synergetic approach into mathematics education at the lower secondary level. Based on this, **the synergetic aspects of continuity** in mathematics education are analyzed.

Chapter II presents tthe theoretical and applied frameworks of the technological model for teaching mathematics that meets both curriculum requirements and the principles of self-organization and nonlinear development. The conceptual foundation of the model, its goals and didactic functions, components, and principles of construction and operation are described in detail. The described modular approach in the pedagogical experiment, implemented through six clearly defined modules: language and symbolism; problem-solving strategies; work with errors; digital technologies; interdisciplinary connections; and effectiveness and reflective assessment, leads to the synergetic effects in teaching mathematics.

Chapter III presents the organization and methodology of the pedagogical experiment conducted in an authentic school environment with equivalent control and experimental groups. Criteria and indicators for diagnosing the results of the experiment are developed. Two complementary experimental designs, “control group – experimental group” and “pre-test – post-test”, are applied. A detailed statistical analysis and a comprehensive comparative analysis of the experimental results are presented.

The conclusion summarizes the importance of the developed technological model for achieving the stated goals and objectives, as well as for confirming the formulated hypothesis.

The doctoral candidate has grouped the contributions of the dissertation into two categories – scientific-applied (three in number) and practical-applied (four in number) – which I consider to be correctly formulated and systematically organized.

The Appendices present a wide range of diagnostic tests, their results, and the didactic materials developed for the study.

An analysis of the dissertation’s content reveals the following **positive characteristics**:

(1) A precise and comprehensive definition of the research parameters demonstrates the author’s scientific, methodological, and mathematical competence.

(2) An in-depth review of the scientific and pedagogical literature has been conducted, providing a solid theoretical foundation for the research.

(3) A very strong impression is created by the synergistic links, presented in a table, between the contributions, the research tasks, their place of description in the dissertation, and the publications on the topic.

(4) The conducted pedagogical experiment confirms the doctoral candidate's research assumptions and outlines opportunities for optimizing mathematics education at the lower secondary level.
(5) Concluding each chapter with summarizing findings gives the work structural coherence and helps clearly highlight the main points and results.
(6) A large part of the theoretical ideas are illustrated with tables, graphs, and diagrams, which make the presentation clearer, more precise, and easier to comprehend.
(7) The dissertation is well organized and well formatted, with a clear text that does not contain any significant linguistic, stylistic, or formal inaccuracies.

6. Assessment of the publications and personal contribution of the PhD student

Between 2021 and 2025, the doctoral student published five papers related to the topic of the dissertation: three conference papers, one seminar paper, and one journal article. Three of these publications were single-authored and in Bulgarian, while two were co-authored with the supervisor – one in Bulgarian and one in English. One of the doctoral candidate's single-authored publications is cited in two conference papers. The content of the publications is reflected in the dissertation research and attests to the doctoral candidate's consistent scholarly work. The noted citations confirm the significance of the publications and their contribution to the study.

Critical remarks and recommendations:

(1) I recommend that the doctoral student consider the possibility of finding suitable Bulgarian equivalents on a number of foreign terms used in the dissertation, such as *emergent*, *facilitator*, *transmitter*, *cumulative*, and others, in order to increase the accessibility and readability of the text for the Bulgarian scientific audience.
(2) On page 20 of the dissertation, the use of the expression "deductive order" in connection with the transition from simpler to more complex concepts could be terminologically clarified or omitted.

7. Abstract

The abstract, prepared in both languages, complies with the national requirements as well as with the Regulations for the Development of the Academic Staff of PU. At 32 pages in length, it presents the main points and results of the dissertation in a clear, systematic, and informative manner.

8. Recommendations for future use of PhD thesis contributions and results

The results and contributions of the dissertation have the potential to be applied in the practice of teaching mathematics at the lower secondary level and can be used and further developed in teacher preparation and professional qualification, as well as in other educational stages. It is

advisable that the main results and findings of the study be published in international scientific journals in order to ensure their wider dissemination and greater scholarly impact.

CONCLUSION

The dissertation contains **scientific, scientific-applied and applied results**, which represent an original contribution to science and meet all the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), the Regulations for the Implementation of the LDASRB and the relevant Regulations of PU "Paisii Hilendarski".

The dissertation shows that PhD student Penka Georgieva Karadzhova **possesses** in-depth theoretical knowledge and professional skills in the scientific specialty Methodology of Teaching Mathematics, and demonstrates qualities and abilities for conducting independent scientific research.

Considering all the above-mentioned, I give my **positive assessment** of the conducted research, presented by the above-reviewed dissertation, abstract, achieved results and contributions, and **I propose to the honorable scientific jury to award the educational and scientific degree "doctor"** to Penka Georgieva Karadzhova in the area of higher education: 1. Pedagogical sciences, professional field 1.3. Pedagogy of teaching in ..., doctoral program Methodology of Teaching Mathematics.

23.03. 2026 **Member of the Scientific Jury:** .....

V. Tarnovo Assoc. Prof. Kamelia Koleva, PhD