

REVIEW

by **Prof. Dr. Maria Petkova Hristova**

of a dissertation thesis submitted for awarding the educational and scientific degree "Doctor"
in the field of higher education **4. Natural Sciences, Mathematics and Informatics**,
professional field **4.6. Informatics and Computer Science**,
Doctoral Programme "**Informatics**"

Author: **Maria Metodieva Gorgorova**

Title: **Intelligent Components in E-Learning Environments**

Scientific Supervisors:

Prof. Dr. Stanka Hadzhikoleva, Paisii Hilendarski University of Plovdiv
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1. General Description of the Submitted Materials

By Order No. RD-22-1412 dated 17 July 2026 of the Rector of Paisii Hilendarski University of Plovdiv (PU), I was appointed as a member of the scientific jury to conduct the procedure for the defense of the dissertation thesis entitled "*Intelligent Components in E-Learning Environments*" for the acquisition of the educational and scientific degree "**Doctor**" (**PhD**) in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.6. Informatics and Computer Science, Doctoral Programme "Informatics". The author of the dissertation thesis is Maria Metodieva Gorgorova, a full-time doctoral student at the Department of Computer Informatics, under the supervision of Prof. Dr. Stanka Hadzhikoleva and Assoc. Prof. Dr. Silvia Gaftandzhieva of University of Plovdiv.

The set of materials submitted by Maria Gorgorova complies with Article 36(1) of the Regulations for the Development of the Academic Staff of PU and includes the following documents:

- Application to the Rector for opening a procedure for the defense of the dissertation thesis;
- Curriculum vitae in European format;
- Statement by the supervisors regarding the readiness of the dissertation thesis for preliminary discussion;
- Minutes of the preliminary discussion of the dissertation thesis at the department;
- Dissertation thesis;
- Abstract (in Bulgarian and English);
- Declaration of originality and authenticity of the submitted documents;
- Report on the fulfillment of the minimum national requirements;
- Full list of scientific publications;

- List of publications related to the dissertation topic;
- Copies of the scientific publications.

The doctoral student has submitted **8 publications** related to the topic of the dissertation thesis.

The submitted set of documents has been prepared in accordance with the requirements of the Regulations for the Implementation of the Development of the Academic Staff in the Republic of Bulgaria Act and the Regulations for the Development of the Academic Staff of PU.

2. Brief Biographical Information about the Doctoral Student

Maria Gorgorova graduated in 2022 with a Bachelor's degree in Software Technologies and Design from the Faculty of Mathematics and Informatics at Paisii Hilendarski University of Plovdiv. In 2023, she obtained a Master's degree in Business Informatics with English Language from the same faculty. Since 1 March 2024, she has been a full-time doctoral student in the Doctoral Programme “Informatics” at the Department of Computer Informatics of the Faculty of Mathematics and Informatics. Since 2022, she has been a part-time lecturer at Paisii Hilendarski University of Plovdiv, where she conducts practical classes in disciplines related to databases, software technologies, software project management, and Internet programming. At the same time, she has been a part-time lecturer at the Academy of Music, Dance and Fine Arts “Prof. Asen Diamandiev” – Plovdiv, where she teaches the course “Interactive Design.” From 1 October 2024 to 30 June 2025, she was a researcher at PU and participated in a research project dedicated to intelligent technologies and tools for supporting the learning process. Since 2023, she has served as a coordinator at the Union of Scientists in Bulgaria – Plovdiv.

The doctoral student's research interests focus on the application of artificial intelligence in education, e-learning, educational technologies, gamification, and the development of intelligent tutoring systems. Her CV indicates participation in 7 national and international research projects, a total of 13 scientific publications, 13 presentations at prestigious scientific forums, and awards for presented research studies. She was awarded the Crystal Prize for “Best Scientific Paper” at the Second and Third National Scientific and Practical Conference “Digital Transformation of Education – Problems and Solutions,” Ruse.

3. Relevance of the Topic and Appropriateness of the Objectives and Tasks

The dissertation thesis is devoted to the study of a subject area that is among the most topical directions in the development of modern educational technologies. The intensive adoption of artificial intelligence in various spheres of public life, including higher education, creates a need for the development of new models, methods, and software solutions that support the learning process without replacing the role of the instructor, but rather expanding

their capabilities. The presented dissertation research is positioned precisely within this scientific field. The relevance of the topic is determined both by the rapid development of generative artificial intelligence models and by the need for educational institutions to adapt their e-learning environments to new technological opportunities.

The objective of the dissertation thesis is clearly formulated as follows: „to develop conceptual models and a methodology for the design, development, and implementation of intelligent and gamified educational resources for higher education based on artificial intelligence technologies, tools for integrating the developed resources into e-learning environments, as well as to experimentally evaluate their effectiveness in increasing students' motivation, engagement, and learning outcomes.” Five tasks have been formulated to achieve this objective. They are logically related to the main objective and contribute to its realization.

The research is interdisciplinary in nature, combining knowledge from the fields of informatics, software engineering, artificial intelligence, educational technologies, and pedagogy. The topic of the dissertation is undoubtedly relevant and significant both from a scientific and an applied perspective. It is fully consistent with current trends in the digital transformation of higher education and responds to the growing need for the development of intelligent solutions that enhance the quality, efficiency, and personalization of e-learning.

4. Knowledge of the State of the Problem, Language and Style

The dissertation thesis and its bibliography demonstrate that the doctoral student has thoroughly and carefully studied the state of research in the field under consideration. The bibliography contains 169 literature and Internet sources, of which 165 are in English and 4 are in Cyrillic. The cited sources are correctly reflected in the text in accordance with the citation system used. A significant proportion of the cited studies were published during the period 2023–2025, demonstrating the doctoral student's effort to rely on contemporary scientific research in the field. The doctoral student demonstrates the ability to interpret the scientific literature used in an analytical and creative manner.

The exposition is presented in a clear, analytical, and precise scientific style characteristic of research works.

5. Evaluation of the Research Methodology

To achieve the stated objective and address the research tasks, the doctoral student has applied an appropriate methodology consistent with the specific nature of the research problem. The methods used for data collection, processing, and interpretation are appropriate to the stated objectives and tasks. The research is based on a combination of theoretical, empirical, and applied methods, providing a sound basis for the substantiation and interpretation of the obtained results.

The logical consistency of the research process should also be noted. The study progresses from an analysis of the literature sources to the identification of the research problem, the formulation of requirements for intelligent components, the development of architectural and software solutions, and finally their experimental validation. This sequence ensures internal coherence among the individual stages of the research and creates the prerequisites for the reliability of the conclusions drawn.

6. Characteristics and Evaluation of the Dissertation Thesis

The submitted dissertation thesis comprises 187 pages, of which 158 pages contain the main text. The dissertation includes an introduction, four chapters, a conclusion, a statement of the scientific contributions, a list of publications related to the thesis, a list of identified citations, a declaration of originality, three appendices, and a bibliography. The graphical component of the thesis contains 52 figures and 15 tables.

The introduction substantiates the relevance of the research and formulates the objective and tasks of the dissertation. Chapter One presents an in-depth analysis of the state of the problem and examines current trends in the development of intelligent technologies for e-learning. The literature review provides a comparative analysis of various scientific approaches and solutions, on the basis of which the need for the development of new intelligent components for e-learning environments is substantiated.

The empirical part of the research includes a survey among students at Paisii Hilendarski University of Plovdiv, through which their awareness, practical experience, attitudes, and expectations regarding the use of artificial intelligence technologies in education were analyzed. A structured instrument containing **46 statements**, organized into **5 thematic sections** and assessed using a five-point Likert scale, was developed for data collection. The results obtained were analyzed and used as a basis for formulating the functional requirements for the developed intelligent components.

Chapter Two presents the conceptual foundation of the dissertation research. Its main objective is to propose models and a methodology for the development of intelligent game-based components based on artificial intelligence technologies, as well as approaches for their integration into e-learning environments. Criteria for selecting appropriate intelligent tools are formulated, with emphasis on pedagogical effectiveness, personalization capabilities, adaptability, ease of integration with existing LMS systems, and support for interactive learning.

On this basis, a methodology for creating educational mini-games using generative artificial intelligence has been developed, combining pedagogical, technological, and game-design principles. A significant contribution of the chapter is the development of two conceptual models: +Escape Room – an educational game based on a game scenario

involving the sequential solving of SQL tasks, combining theory, practical exercises, and game mechanics to increase motivation; and **Temple of Data** – a comprehensive gamified learning environment incorporating missions, progression, rewards, feedback, and adaptive mechanisms supporting the acquisition of database knowledge.

A conceptual model for integrating educational games into e-learning systems is also presented. A mathematical model, a database model, a REST API, a lifecycle model for game components, and mechanisms for communication between the games and the Moodle platform have been developed. In this way, a universal architectural framework is created that enables the integration of different types of educational games into e-learning environments.

Chapter Three presents the practical implementation of the developed conceptual models through the creation of intelligent educational games and their integration into the Moodle system. Several types of educational mini-games have been developed for the „Databases” course, including flashcards, quiz games, SQL puzzles, and games for filling in missing elements. The comprehensive SQL Escape Room game has been developed as a sequence of missions in which students solve practical SQL tasks in a game-based environment. In parallel, the gamified learning environment Temple of Data has been implemented as a fully functional web system with its own client-side and server-side architecture, database, game mechanics, rankings, progression system, and user interface. A significant contribution is the development of a specialized Moodle module that enables the integration of external educational games into the e-learning environment. The chapter demonstrates the practical applicability of the proposed conceptual models and shows the possibility of implementing intelligent game-based components in a real university educational environment.

Chapter Four presents the experimental validation of the developed solutions and the evaluation of their effectiveness in a real educational environment. Particular emphasis is placed on the impact of intelligent components on students' motivation, engagement, and satisfaction. An experimental study of the AI plugins in Moodle was conducted to analyze the practical usefulness of artificial intelligence tools in supporting the learning process.

The SQL Escape Room game was evaluated and demonstrated a high level of student satisfaction. The gamified learning environment *Temple of Data* was also evaluated. The results obtained demonstrate that the proposed conceptual models, implemented software solutions, and developed Moodle integration mechanism can be used for implementing intelligent and gamified educational resources in higher education. The practical significance of the thesis is confirmed by the experimental studies conducted with students. Analysis of the results demonstrates increased motivation, higher engagement, and positive perceptions of the

developed intelligent components, supporting the applicability of the proposed solutions in a real educational environment.

The completion of each chapter with a summary of the main conclusions and results is particularly commendable. The conclusion summarizes the main results of the research work. The relationship between the developed conceptual models, implemented software solutions, their integration into an e-learning environment, and the experimental validation conducted is traced.

I share the doctoral student's view regarding the outlined prospects for future development of the research. They logically derive from the results achieved and are consistent with current trends in the development of intelligent educational technologies.

I assess the dissertation thesis as a complete, methodologically well-structured, and scientifically substantiated research study.

7. Contributions and Significance of the Work for Science and Practice

Following an analysis of the dissertation thesis as a whole, I accept the main contributions summarized at the end of the dissertation, which are categorized as scientific, scientific-applied, and applied contributions.

The main *scientific contribution* of the dissertation consists in the development of a conceptual model for the design of intelligent and gamified educational resources, integrating pedagogical approaches, game mechanics, and artificial intelligence technologies into a unified conceptual framework for supporting learning.

I consider the following to be significant *scientific-applied contributions*:

- the proposed methodology for designing and developing intelligent educational resources, combining the principles of gamification, adaptive learning, and generative artificial intelligence in the creation of interactive educational applications;
- the development of a comprehensive set of intelligent and gamified educational resources implementing the proposed conceptual models and intended for teaching the “**Databases**” course;
- the development of conceptual models for the individual game applications;
- the development of an architecture, integration models, and a software module for incorporating educational games into Moodle;
- the development of a methodology for implementing intelligent game-based components in an e-learning environment.

The applied results are convincingly demonstrated through:

- the development of fully functional software products – mini-games, SQL Escape Room, Temple of Data, and the AI Games module for Moodle;

- the experimental implementation and testing of the developed resources in a real educational environment with students.

The results presented make a significant contribution to the development of gamified educational environments and the integration of artificial intelligence technologies into e-learning systems. They can serve as a basis for future research and for implementation in university practice.

At present, the developed resources have been integrated into the educational process at Paisii Hilendarski University of Plovdiv in the teaching of the „Databases“ course. The results achieved in the dissertation correspond to the stated objective and tasks.

8. Evaluation of the Publications Related to the Dissertation

The doctoral student's publication activity includes 8 scientific publications, through which the main results of the dissertation research have been presented and validated. They were published during the period 2024–2025 and are thematically related to the development and application of intelligent components in e-learning environments. Of these publications, 3 are indexed in the international databases Web of Science and/or Scopus, with 2 published in IEEE conference proceedings and one in the internationally refereed scientific journal *Mathematics and Informatics*, indexed in Web of Science with IF = 0.3 (Q4). The remaining 5 publications were presented at international and national scientific forums and published in scientific proceedings. Four publications are in English, ensuring broader international accessibility and visibility of the research results. In 5 of the publications, the doctoral student is the first author, while in the remaining 3 she is the second author, indicating her substantial involvement in the realization and presentation of a major part of the scientific results.

The publications cover the main aspects of the dissertation research and focus on the development and application of intelligent tools for supporting learning, including the use of generative artificial intelligence, the integration of AI functionalities into Moodle, the development of educational games and gamified learning environments for database education, as well as the study of learners' attitudes toward the use of artificial intelligence in higher education. The publications provide scientific validation and public dissemination of the results to the national and international scientific community. The doctoral student's publication activity is sufficient in terms of both quantity and quality for the acquisition of the educational and scientific degree „Doctor“ (PhD).

Nine citations of 4 publications related to the dissertation topic have been identified. Of these, 3 were made in publications indexed in Scopus.

Fulfillment of the Minimum National Requirements

The report submitted by the doctoral student certifies that she meets the minimum national requirements under Article 2b, paragraphs 2 and 3, respectively the requirements

under Article 2b, paragraph 5 of the Development of the Academic Staff in the Republic of Bulgaria Act, as specified in the Regulations for its Implementation, for the acquisition of the educational and scientific degree „Doctor” in professional field 4.6. Informatics and Computer Science. According to the report, under indicator group A, the dissertation thesis carries 50 points, thereby meeting the requirement for this indicator. Under indicator group G, the requirements specify a minimum of 30 points, while the doctoral student has 72 points, obtained from the 8 scientific publications listed above.

A declaration of originality and authenticity of the work and the submitted materials has been provided. There is no evidence of plagiarism established in accordance with the legally prescribed procedure in the submitted dissertation thesis and scientific publications.

9. Personal Contribution of the Doctoral Student

The personal contribution of the doctoral student is clearly evident from the submitted research work, as is her ability to define research tasks, solve problems, and formulate logically substantiated conclusions.

10. Dissertation Abstract

The abstract is available in two versions – in Bulgarian and English – and comprises 32 pages, with 26 literature sources cited therein. It accurately reflects the content of the dissertation thesis, the main aspects of the research, and the results achieved. It is properly structured and complies with the requirements of the Regulations for the Implementation of the Development of the Academic Staff in the Republic of Bulgaria Act.

11. Remarks, Recommendations and Questions

The dissertation thesis is characterized by the relevance of its topic, a strong practical orientation, and a substantial volume of research and scientific-applied activities. Alongside its undisputed merits, the following remarks and recommendations may be made:

- The experimental part of the research could be further enriched and expanded by including a larger number of participants from different higher education institutions and professional fields. This would increase the statistical reliability and generalizability of the results.
- The practical implementation is primarily focused on teaching the „Databases” course at PU. It would be useful to demonstrate the applicability of the developed methodology in other computer science disciplines or beyond them, which would further confirm the universality of the proposed model.
- The experimental evaluation is primarily based on indicators of satisfaction, motivation, and engagement. In future research, it would be useful to include more objective indicators for assessing the impact on the actual acquisition of knowledge and skills.

- The conclusion could be supplemented with a more synthesized assessment of the scientific novelty and originality, as well as of the significance of the results achieved.

In relation to the presented research, I raise the following questions:

- What criteria were used to select generative artificial intelligence as a means for developing educational components, and what are its limitations in creating educational content, including the risks associated with the reliability of generated responses, as well as issues related to academic ethics and personal data protection?

- To what extent is the proposed integration model independent of a specific LMS platform, and what are the possibilities for applying it in environments other than Moodle?

The remarks, recommendations, and questions raised are intended to further develop the research and do not diminish the scientific value of the dissertation thesis. They outline promising directions for future scientific research and practical developments by the doctoral student.

12. Personal Impressions

I do not know the doctoral student personally, but the dissertation thesis and the submitted documents give the impression that Maria Gorgorova is an erudite young scholar who possesses in-depth theoretical knowledge in the field of Informatics, as well as the knowledge and abilities required to conduct independent scientific research.

CONCLUSION

The dissertation thesis addresses a relevant and practically significant research problem, demonstrates a high level of scientific-applied implementation, and has good applicability to higher education. The stated objective and tasks have been successfully achieved. The results obtained meet the requirements of the Development of the Academic Staff in the Republic of Bulgaria Act, the Regulations for its Implementation, and the relevant Regulations of Paisii Hilendarski University of Plovdiv.

In view of the above, I hereby give my **strongly positive evaluation** of the research conducted, the submitted dissertation thesis and abstract, the results achieved, and the scientific contributions, and I propose that the esteemed Scientific Jury award **Maria Metodieva Gorgorova** the educational and scientific degree „**Doctor**” (**PhD**) in the field of higher education: **4. Natural Sciences, Mathematics and Informatics, professional field 4.6. Informatics and Computer Science, Doctoral Programme „Informatics”**.

20 August 2026

Reviewer:

/Prof. Dr. Maria Hristova/