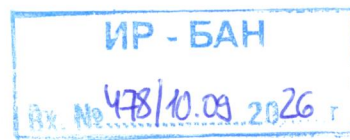


OPINION



on the dissertation for the acquisition of the educational and scientific degree "**Doctor**"

Author of the dissertation: Borislava Lyubomirova Kostova

Topic of the dissertation: Integrating 3D printing robotics and emerging technologies for the purposes of education

Professional field: 5.2 Electrical engineering, electronics and automation

Doctoral program: Application of the principles and methods of cybernetics in various fields of science

Scientific supervisors: Prof. PhD. Ivan Chavdarev and Assoc. Prof. DSc. Galya Georgieva-Tsaneva

Member of the Scientific Jury: Assoc. Prof. DhD. Neda Venelinova Chehlarova, Institute of Robotics – BAS

According to order № 94/29.07.2026 of the Director of the Institute of Robotics - BAS and decision of the Scientific Council of the IR-BAS – Protocol No. 7/28.07.2026, p.1.1. I have been appointed as an internal member of the Scientific Jury, under the procedure for acquisition the educational and scientific degree "doctor", with the topic of the dissertation "Integrating 3D printing, robotics and emerging technologies for the purposes of education", in professional field 5.2 Electrical engineering, Electronics and automation". I have been assigned to prepare opinion according to the minutes of the first meeting. I have received all the necessary documents submitted by the candidate under the procedure.

1. Relevance of the dissertation research

The presented dissertation work, authored by Borislava Lyubomirova Kostova, MSc, is dedicated to a contemporary, complex and topical problem – the integration of innovative technologies in the educational process. The relevance of the work stems from the need to overcome the methodological, cognitive and technological barriers to the mass penetration of STEAM education in Bulgarian schools and assist ve technologies.

The aim of this dissertation is to develop, validate, and evaluate an approach for integrating 3D modelling, 3D printing, robotics, and chat bots with AI to enhance the effectiveness of STEAM educational activities. To achieve the set goal, the following main tasks have been formulated:

1. To develop, validate, and evaluate a protocol for the automated design and implementation of a STEAM educational activity incorporating AI as a teaching support tool, together with the use of 3D-printed educational models and instructional scenarios involving an educational robot.

2. To propose an approach for the automated generation of personalized 3D-printed models and to investigate their application for educational purposes.

3. To develop a software program for automated 3D modelling in the AutoCAD environment, based on the proposed approach and intended for the creation of decorative objects. Using the developed application, to design and evaluate 3D-printed models for teaching applied arts. Furthermore, to investigate the application of the proposed approach, the

developed software program, and the resulting 3D-printed objects within the educational process.

4. To investigate and evaluate the effectiveness of 3D-printed assistive writing devices for students with SEN. To analyse approaches for designing personalized assistive devices, including methods for user adaptation, acquisition of individual anthropometric measurements, and determination of the key geometric parameters required for device customization.

5. To develop a software program for the automated generation of a 3D model of a personalized writing assistive device (WAD) for students with impaired fine motor skills. The application will be developed on the basis of the findings and design principles established in Objective 4.

The doctoral student successfully defined the research gap: the need for protocols and software tools that would allow rapid personalization of learning content and assistive devices without the need for in-depth engineering knowledge on the part of teachers and therapists.

2. Degree of knowledge of the state of the problem and general characteristics of the work

The dissertation is 150 pages long, including an introductory part, 5 chapters, followed by a conclusion, a list of publications on the dissertation, a bibliography of 140 works and appendices. A declaration of originality of the results is presented in a separate file. The dissertation includes 13 tables and 44 figures that illustrate the presented research. The structure of the dissertation is logically sound and consistent:

Chapter 1. provides an analysis of literature examining the application of 3D printing, robotics and AI in education, including for people with SEN.

Chapter 2. proposes a protocol for a STEAM activity using 3D printed educational models, scenarios with NAO robot and the use of AI, as well as results from an experiment conducted in a secondary school.

Chapter 3. proposes an approach for the automated creation of 3D printed devices for educational purposes, which includes 11 steps.

Chapter 4. describes an author's program in AutoCAD (developed with Visual Lisp), which offers automatic ("rings") and step ("steprings") modes for 3D modeling of rings, based on the approach from Chapter 3.

Chapter 5. presents a program for automated 3D modeling "pinky" of writing assistive devices (WAD) for people with SEN. A survey was conducted among 36 specialists in the field and criteria for the effectiveness of the WAD were defined.

I believe that the set goals and tasks have been met, since the dissertation covers a cycle from engineering and technological design to its real testing in educational and therapeutic practice.

3. Contributions of the doctoral student

I accept the formulated contributions, which are of a scientific-applied and applied nature, and I would summarize them in this way: A protocol for a STEAM lesson using robotic systems and 3D printing has been developed and validated in a secondary school. A program with two modules in AutoCAD has been created, allowing the modeling and generation of rings suitable for 3D printing. The properties and qualities of the final printed models have been studied. The program has been tested with students in a real environment. A program has been developed

for creating a WAD to help students with fine motor difficulties. The effectiveness of 3D printed writing aids with students with SEN has been studied.

4. Assessment of publications on the dissertation work

The main results of the dissertation are presented in four publications, three of which are co-authored, and one is independent. The three co-authored works are published in editions indexed simultaneously in Web of Science and Scopus. One of these articles is published in the Q3 quartile with SJR. With the required 30 points, according to the Law on the Development of Academic Staff of Bulgaria, the doctoral student exceeds the minimum national requirements with a total of 51 points - respectively 31 points from the indexed joint works and 20 points from the independent non-indexed publication. 6 citations in international and Bulgarian publications were noted.

5. Abstract and author's reference

The submitted Abstract in Bulgarian is 45 pages long. The Abstract in English is fully consistent with the one in Bulgarian and is 44 pages long. Both Abstracts are prepared in accordance with the academic standards - the key approaches, testing and results of the study are included.

6. Critical notes, recommendations and questions

According to the essence and size of Chapter 3, it is appropriate to move it as the first sub-item in the following Chapter 4.

I recommend that the doctoral student continue the research in the field of 3D printing and assistive technologies with larger representative samples, the results of which should be published in editions with an impact factor.

7. Conclusion

After having familiarized myself with the dissertation work and the accompanying scientific papers presented in the procedure and based on the analysis of their significance and the scientific-applied and applied contributions contained therein, I confirm that the submitted dissertation work and the scientific publications to it, as well as the quality and originality of the results and achievements presented therein, meet the requirements of the Law on the Development of Academic Staff of Bulgaria, the Regulations for its implementation and the relevant Regulations of the IR-BAS. In particular, the candidate meets the minimum national requirements in the professional field and no plagiarism has been established in the scientific papers submitted in the competition. Based on the above, **I recommend to the esteemed Scientific jury to award Borislava Lyubomirova Kostova the educational and scientific degree of "Doctor" in the professional field of mechanical engineering, electronics and automation.**

10.09.2026


/ Assoc. Prof. Neda Chehlarova /