OPINION

by Prof. Desislava Ivanova Paneva-Marinova, PhD
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

on the Dissertation for awarding educational and scientific degree **"doctor"** (PhD),

in the Area of Higher Education 4. Natural Sciences, Mathematics and Informatics,

Professional Field 4.6. Informatics and Computer Sciences

PhD Program „Informatics"

Author: Plamen Dimitrov Petrov

Topic: Models and Methods for the Application of Virtual and Augmented Reality in Education

Scientific supervisor: Assoc. Prof. Tatiana Atanasova, PhD, Institute of Information and Communication Technologies, Bulgarian Academy of Sciences.

1. General presentation of the procedure and the PhD student

In accordance with Order № 304 from 27.10.2022 of the Director of the Institute of Information and Communication Technologies, Bulgarian Academy of Sciences (IICT-BAS) I have been appointed as a member of the Scientific Jury to provide the procedure for the defense of a dissertation titled "Models and Methods for the Application of Virtual and Augmented Reality in Education" of Plamen Dimitrov Petrov for awarding the educational and scientific degree "doctor" in the Area of Higher Education 4. Natural Sciences, Mathematics and Informatics, the Professional Field 4.6. Informatics and Computer Sciences of the PhD Program "Informatics". The author is a PhD student at the Department "Modelling and Optimization" at IICT-BAS, with scientific supervisor Assoc. Prof. Tatiana Atanasova, PhD, IICT-BAS.

The presented Opinion is made in accordance with the Act for the Development of the Academic Staff in the Republic of Bulgaria, the Rules for its implementation and the Rules on the Specific Conditions for Acquiring Science Degrees and Holding Academic Positions in IICT-BAS.

The set of materials by Plamen Dimitrov Petrov is in accordance with Article 6 (1) of the Rules on the Specific Conditions for Acquiring Science Degrees and Holding Academic Positions in IICT-BAS.

Plamen Dimitrov Petrov was born on 12.03.1974. In 1997 he obtained a Master's degree with professional qualification "Teacher of Mathematics and Informatics" at Sofia University. Since 1999 he has been a teacher of Informatics and Information Technology and Head of ICT in 134. Secondary School "Dimcho Debelyanov", Sofia. Since 2005 he is a lecturer at New Bulgarian University. In the

period 2002 - 2007 he was a lecturer in postgraduate courses for teachers at the Faculty of Mathematics and Informatics of Sofia University.

2. Relevance of the topic

The dissertation presents the results of research to create models and methods for using of virtual and augmented reality in education, an extremely recent development of great scientific and practical interest.

3. Knowledge of the problem

The realization of the dissertation goal requires in-depth theoretical knowledge and practical skills. It is evident from the dissertation and the materials presented that the PhD student has a solid theoretical background and extensive insight into modern technologies required to achieve the research objectives. He demonstrates good knowledge of the research object. He formulates clearly and performs the tasks leading to specific results. The research is presented competently and with well-founded analyses and inferences.

4. Characteristics and evaluation of the dissertation and contributions

The dissertation of Plamen Dimitrov Petrov contains 114 pages, presented by a table of contents, a glossary of terms and abbreviations, used in the dissertation, an introduction, a structure of the dissertation, four chapters, a conclusion - summary of the obtained results (including scientific and applied results of the dissertation), guidelines for future research, list of author's publications on the topic of the dissertation, list of citations, declaration of originality, bibliography of 121 literature sources in English and Bulgarian.

The goal and objectives of the dissertation are presented in the Chapter 1 after an analysis of the state-of-the-art of the research area.

Chapter 1 includes an analytical overview of current trends and technologies in e-learning. Goals, opportunities, application areas, models, challenges and risks of using virtual and augmented reality (AR/VR) in education are presented. The need for proposing new models for the application of virtual learning resources to specific target groups is motivated, as well as the need for specific mothodss, tools, scenarios and approaches based on AR/VR to allow their effective application in the learning process.

Chapter 2 presents the developed models for application of augmented and virtual reality in different STEAM disciplines with different educational goals, combining them with project-based approach and specially designed physical environment.

Chapter 3 describes methods for evaluating the effect of applying the developed models.

Chapter 4 provides an overview of software environments for creating and hardware tools for using AR/VR educational materials. Bloom's taxonomy adapted to digital technologies and its im-

plications for the creation of standards-based AR/VR educational resources is discussed. A SWOT analysis of the application of AR/VR technologies in education is made.

In the **Conclusion** relevant summaries are made on the problems raised, the results obtained and directions for future development.

The dissertation is thoroughly developed. The problem area is competently and critically analyzed. The presentation of the developed models for using AR/VR in education is detailed, well-argued and appropriately illustrated.

5. Assessment of publications and personal contribution of the PhD student. Remarks

The author's list of publications on the subject of the dissertation includes 7 titles, 2 of which are currently indexed in Scopus or Web of Science. Three publications are in international refereed scientific journals and 4 publications are in proceedings of international and national conferences. One publication is in a scientific journal with SJR and with open access (Information). All publications are in English. In all publications Plamen Petrov is the first author. All publications are co-authored. 41 citations. The PhD student reports results at 4 international conferences and participates in 3 national scientific programs.

Having read the dissertation and the submitted materials, I believe that the formulated applied results are the personal work of the PhD student. There is no doubt that the PhD student is the real author in his publications as he is first author in all his publications.

I have no critical remarks. There are some incorrectnesses in the indicated indexing of the PhD student's publications in the Reference for fulfillment of the minimum requirements of IICT-BAS (some of the publications have not yet appeared in the mentioned bibliographic database for science), but the required minimum points for the groups of indicators for the educational and scientific degree "PhD" in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.6. Informatics and Computer Science have been achieved and exceeded.

6. Abstract

The abstract is 43 pages long and correctly reflects the structure of the dissertation, the results obtained and the conclusions drawn from the study. The requirements of the Act for the Development of the Academic Staff in the Republic of Bulgaria, the Rules for its implementation and the Rules on the Specific Conditions for Acquiring Science Degrees and Holding Academic Positions in IICT-BAS have been met.

7. Recommendations for future use of the dissertation contributions and results

The topic and results provide certain opportunities for development and new applications. I recommend Plamen Dimitrov Petrov to continue his research and expand their popularization.

CONCLUSIONS

The dissertation *contains scientific and applied results, which represent an original contribution to science* and *meet all the requirements* of the Law for the Development of Academic Staff in the Republic of Bulgaria, the Rules for its Implementation and the Rules on the Specific Conditions for Acquiring Science Degrees and Holding Academic Positions in IICT-BAS.

The dissertation shows that the PhD student Plamen Dimitrov Petrov **possesses** in-depth theoretical knowledge and professional skills in the scientific specialty "Informatics", **demonstrating** qualities and skills for independent scientific research.

Due to the above, I confidently give my *positive evaluation* for the conducted research, presented in the dissertation, abstract, achieved results and contributions, and *I propose the honorable Scientific jury to award educational and scientific degree "doctor"* to Plamen Dimitrov Petrov in the Area of Higher Education 4. Natural Sciences, Mathematics and Informatics, Professional Field 4.6. Informatics and Computer Sciences, PhD Program "Informatics".

22.11.2022   **Scientific jury**

Pı   НА ОСНОВАНИЕ

ЗЗЛД

4