

REVIEW

by **Georgi Petrow Dimitrov, PhD**

professor at the **University of Library Studies and Information Technologies (ULSIT)**

on a PhD thesis for acquisition of educational and scientific degree "Doctor"

in higher education field: **4. Natural Sciences, Mathematics and Informatics**

professional field: **4.6 Informatics and Computer Science**

Doctoral Program "Computer Science"

Author: Plamen Dimitrov Petrov

Title: „MODELS AND METHODS FOR THE APPLICATION OF VIRTUAL AND AUGMENTED REALITY IN EDUCATION“

Scientific supervisor: Assoc. Prof. Tatiana Atanasova, PhD

1. General description

By order of the IIKT Director Prof. MD. G. Angelova 304/27.10.2022 I have been selected as a member of the scientific jury to ensure a procedure for the defense of a dissertation work on the topic "Models and methods for the application of virtual and augmented reality in education" for the acquisition of the educational and scientific degree "doctor" in the field of higher education 4. Natural sciences, mathematics and informatics, professional direction 4.6 Informatics and computer sciences, doctoral program Informatics. The author of the dissertation is Plamen Dimitrov Petrov - a full-time doctoral student with scientific supervisor Assoc. Dr. Tatiana Atanasova.

The set of materials presented by Plamen Dimitrov Petrov is in accordance with the Rules for the specific conditions for acquiring scientific degrees and for holding academic positions at IIKT-BAS.

2. Relevance of the topic and appropriateness of the set goals and tasks

The dissertation is undoubtedly dedicated to a current topic, namely "Models and methods for applying virtual and augmented reality in education".

The main objective of the dissertation is: To propose models and methods for using augmented and virtual reality in education.

To achieve the main goal, the following tasks are set:

1. To develop a model for the use of augmented and virtual reality in STEM education, taking into account the different educational goals and specifics of individual subjects.
2. To propose a model for the combination of augmented and virtual reality with a physical learning environment.
3. To develop a model for combining augmented and virtual reality with project-based learning in a unified teaching scenario.
4. To propose methods for evaluating the effect of combining a learning environment, augmented with augmented reality, implemented to improve the learning process and the understanding of learning material for certain learning goals.

I believe that the goals and tasks defined by the doctoral student, as well as the subsequent development of the dissertation work, are undoubtedly current and with a high level of applicability.

4. Knowing the problem

The dissertation contains 114 pages, 42 figures and 18 tables, as well as a considerable number of cited sources - 126 in total.

The list of author publications on the topic consists of 7 titles.

All this to me is proof of the thorough research done by the PhD student.

5. Research methodology

The results presented in the dissertation testify to the choice of a methodically correct approach to solving the research tasks. In the dissertation, a theoretically researched and practically developed approach to solving the given task was carried out, and the obtained results demonstrate that these methods can be successfully used to obtain new results.

The conclusions of the review and analysis are well systematized, and the purpose and tasks of the dissertation are presented in a justified and motivated manner. It can be concluded that the author has chosen and applied the necessary research methodology according to the set goals and objectives.

6. Characterization and evaluation of the dissertation work

The submitted dissertation consists of an introduction, four chapters and a conclusion, a list of the literature used, a list of the author's publications on the topic, appendices and a declaration of originality.

In Chapter 1. Overview and status of research, the concepts of play, didactic play and serious play are discussed. A study was made of the types of serious games - game-based learning, gamification, etc. The game elements and techniques that are applied in the games, their relation to the types of players and their possible use in the learning process are described. Modern innovative approaches to learning are examined - game-based learning (including e-learning and m-learning), adaptive learning (including systems for adaptive learning and adaptive testing), micro learning, learning through the "inverted classroom", just-in-time teaching, blended learning and ubiquitous learning. An overview of the existing mobile educational games in mathematics for the elementary stage is made. Research has been done in the field of energy efficiency of mobile applications.

In Chapter 2. Mobile Educational Game Model for Primary School Children, a general model of mobile game-based learning suitable for primary school children is created. A classification of game tasks has been made, suitable for mobile implementation and for the relevant age group of learners. A model of the player (obu-chaem) is proposed based on the following approaches: game-based learning, adaptability and micro-learning. Appropriate game elements and techniques are selected to be used in the models. Didactic, behavioral and functional models are proposed, which can be used both to create a stand-alone game application and a mobile game platform. The functional, non-functional and pedagogical requirements that the prototype must meet are indicated.

In Chapter 3. Software implementation of mobile educational games, the development process of the software prototype of the mobile educational math game for elementary school children is presented, according to the model presented in Chapter 2. The general architecture of a mobile game-based system is presented training based on modules: "Game environment", "Synchronization" and "References". Added descriptions of the file structure, classes, and methods used in the module implementation. A mobile game design based on templates is proposed. A number of software tools were used to implement the mobile application. The general schema of the local SQLite database is presented. All game functionality and data synchronization in multiplayer game are described in detail. A web server and a server database are used for data synchronization. A web application has been implemented that enables the teacher to get all the information from the game through various references.

In Chapter 4. Experiment. Testing the mobile educational game "Fun Math" presents an experiment to apply mobile game-based learning to 3rd grade elementary school students in a real

learning environment. All the intended functional characteristics of the developed game have been tested. A survey was also conducted with the students and teachers, participants in the experiment, which investigated the attitude towards using the mobile game-based learning in mathematics in the direction of: practical applicability, motivation, design, accessibility, support and feedback. The experiment is described through setting, methodology and analysis of the results of the experiment and the obtained results of the surveys.

The Conclusion summarizes and systematizes the results obtained for Tasks 1.-4., indicating the main scientific, scientific-applied and applied contributions of the dissertation work. Prospects for future development of the dissertation topic are formulated.

7. Contributions and significance of the development for science and practice

I accept the following scientific and applied contributions formulated in this way:

1. A model has been developed for using augmented reality in STEM education.

The model allows for easy adaptation to the specifics of different STEM disciplines, encouraging creativity and teamwork.

2. A model has been developed for the use of augmented reality in mathematics education. The model allows the use of various augmented reality technologies, making it suitable for application both in the classroom and outside. Enables the use of different educational approaches.

3. A model for using augmented reality in art education is proposed. The model allows the use of both augmented and virtual reality. This makes it flexible and applicable to a very wide range of activities in art education. It enables the use of different educational approaches, encourages creativity, discovery and teamwork.

4. A model for combining project-based learning with augmented and virtual reality was developed. The model is practically oriented and allows the use of a multidisciplinary approach in working with students. Working on a real problem using both types of realities creates a real sense of experience and successfully addresses an important but intractable problem such as student motivation.

5. Methods for evaluating the implementation of technological means for augmented and virtual reality for certain educational purposes are proposed.

8. Assessment of dissertation publications

Results of the dissertation research are presented in 7 (seven) publications. Six of them are indexed in world-renowned databases, one in Q2 and one in Google Scholar.

9. Personal participation of the doctoral student

After getting acquainted with the materials presented by the doctoral student, I am left with the impression that the results presented in the dissertation work are his personal work, of course under the guidance of the scientific supervisors. The achieved scientific-applied and applied results were obtained in fulfillment of the set tasks as a result of the scientific guidance and are the personal work of the doctoral student.

10. Abstract

Abstract contains 43 pages and presents in detail the relevance and motivation for work on the selected topic, as well as the content of the dissertation by chapter.

11. Critical remarks and recommendations

From the presented reference, I am left with an impression of the candidate's scientific interests and pursuits with a variety of topics.

From a technical point of view, the dissertation work is well formed. The research is sufficiently voluminous and covers important aspects of the given issue.

I have no critical remarks.

12. Personal impressions

I do not personally know the doctoral student Plamen Dimitrov Petrov, but from the presented materials I remain convinced that he is an excellently prepared and highly competent specialist, a successful participant in research projects and a professional with experience in the field of Information Technologies.

13. Recommendations for future use of dissertation contributions and results

I have no recommendations.

I hope that the excellent results achieved will be widely used in education.

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 (ZRASRB), the Regulations for the Implementation of the ZRASRB and the relevant Regulations on the specific conditions for acquisition of scientific degrees and for occupying academic positions at IIKT-BAS.

The dissertation work shows that the doctoral student Plamen Dimitrov Petrov has in-depth theoretical knowledge and professional skills in the scientific specialty of Informatics and Computer Science, demonstrating qualities and skills for independent conduct of scientific research.

Due to the above, I confidently give my positive assessment of the conducted research, presented by the above-reviewed dissertation work, abstract, achieved results and contributions, and I propose to the honorable scientific jury to award the educational and scientific degree "doctor" to Plamen Dimitrov Petrov in the field of higher education 4. Natural sciences, mathematics and in-

formatics, professional direction 4.6 Informatics and computer sciences, doctoral program Informatics.

28.11.2022 г.

НА ОСНОВАНИИ

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