**REVIEW**

according to the procedure for the defence of a dissertation
**Methods and Tools for Supporting Inquiry-Based Learning**
for the purpose of acquiring the educational and scientific degree "Doctor"
by **Elitsa Vasileva Peltekova**
Doctoral supervisor**: Prof. Eliza Petrova Stefanova**, PhD
in the area of Higher Education **4. Natural Sciences, Mathematics and Informatics**,
Professional Field **4.6 Informatics and Computer Science**,
(Informatics - Information and Communication Technologies)
Doctoral Program "Information Technologies"
Chair: "Information Technologies", Faculty of Mathematics and Informatics,
Sofia University "St. Kliment Ohridski"
by ***Prof. Dr Sc Eng. Ketty Georgieva Peeva***, FAMI, TU-Sofia
member of the scientific jury according to Order РД № 38–307 / 01.07.2022 г. of the Rector of the SU

## I. General characteristics of the presented materials and the dissertation work

### 1.1.The presented materials contain

Dissertation;
Abstract of the dissertation in Bulgarian and in English;
Folder with personal documents containing:

- CV European sample.
- Copy of diplomas for completed bachelor's and master's degrees.
- Orders for enrollment in full-time doctoral study and its transformation into part-time doctoral study, order for deduction with right of defense, order for preliminary defense.
- Certificate of passed exams according to an individual doctoral plan.
- List of publications on the dissertation work and their copies, as well as the corresponding screens from Web of Science.
- Declarations for ESD "Doctor", for quantitative contributions of the authors in the publications on the dissertation work.
- Reference on the fulfillment of the minimum requirements for ESD "Doctor".
- Reports of the research supervisor to the "Information Technologies" chair in connection with the opening of a procedure for the defense of the dissertation work and protocol of the meeting of the Chair council.
- Internal review of the dissertation by Assoc. Prof. Mariana Ilieva Atanasova, PhD.

### 1.2.Dissertation

The dissertation has a volume of 173 standard typewritten pages, of which 98 are structured in an introduction, five chapters, conclusion, author reference (containing the contributions of the dissertation), declaration of originality of results, used literature, list of author's publications of the thesis, 58 pages are for 9 appendices, and the rest are lists of: 67 figures, 15 tables, abbreviations, and a glossary of terms.

The dissertation is well structured, the presentation is lucid and professionally written.

**Actuality of the problem**

The dissertation is related to the use of new technologies in education in a new field - the development of STEM technologies (from Science-Technology-Engineering-Mathematics, i.e. natural-technical-engineering-mathematical sciences). The dissertation contributes to the development of scientific research in the field by proposing innovative teaching methods in STEM technologies with detailed planning, analysis and evaluation. The topic of the dissertation work is actual, the dissertation work of Elitsa Peltekova corresponds to the professional field 4.6. "Informatics and Computer Sciences" and the results obtained are scientific and scientific-applied contributions.

**Knowledge of achievements in the scientific field**

The dissertation uses 148 references - articles, monographs, dissertations, mainly in English. The materials are in the field of methods and technological means for educational purposes and training - mobile technologies, interactive whiteboards and virtual reality technology. The dissertation's good awareness of the content of the references on the subject is impressive.

**Purpose and tasks of the dissertation work**

**The aim** of the dissertation is **to research and propose methods and means** to support the research approach in the education of natural, technical, engineering and mathematical sciences (STEM), to increase the interest and results of the learners, as well as to **develop a methodology** (system model) for building educational scenarios combining the methods, means and context according to the application.

To achieve this goal, the following **tasks** are set before the doctoral student:

1. To investigate and analyze: a) factors that influence increasing the interest, motivation and results of learners;
   b) methods (e.g. research approach to learning, educational research) applicable in STEM education and provoking students to independence, creativity and decision-making, also wider use of ICT tools.
2. To research and analyze: a) modern technological means applicable in STEM education, identifying their main characteristics, properties, limitations. To define criteria for the selection of technological means according to the context of research training;
   b) the possibilities and attitudes for the application of modern technological means in education.
3. To create a model system for educational scenarios. To create sample models of a platform for creating, finding educational scenarios, according to the methods, means and context of their application.
4. To describe, experiment, and implement sample educational scenarios that combine methods and tools to support an inquiry-based learning approach to meet science learning goals. To analyze and evaluate the extent to which the created sample educational scenarios increase interest and outcomes in science education.

**Contents of the dissertation work**

In the Introduction, the statement of the problem is given, the purpose of the dissertation work and the resulting tasks are formulated. A chapter-by-chapter review has been made, which supports the overall tracking of the results in the dissertation.

**Chapter 1** has an overview-theoretical character. It is dedicated to the methods: research approach in education; scientific research in pedagogy; different forms of research data collection.

In the **Second chapter**, a retrospective is made of the technological means used for educational purposes and training - mobile technologies (smartphone and tablet), interactive whiteboards and virtual reality technology, which are part of the experiments and studies of the dissertation. Historical data on their appearance and examples of their use in training, basic characteristics and properties are given for them. Criteria are defined for the selection of technological means according to the context of research training. The presentation is extremely clear and well illustrated with figures, enriched with comparative characteristics and comparative criteria and classification analysis, bibliographic data. Special attention is paid to virtual reality and its application in education. I consider the main result of the chapter to be the extremely useful and labor-intensive collection of these data, their systematization and visualization in a complete and deeply thought-out scheme.

**Chapter 3** describes the research done through surveys and interviews regarding the willingness of Bulgarian teachers to apply modern technologies in STEM education. Surveys were designed and implemented for the application of interactive whiteboards (Appendix 1) and virtual reality (Appendix 2) in education, and the interview was for the application of virtual reality (Appendix 3). Participants in the study are Bulgarian teachers - teachers and principals in kindergartens and schools, university teachers, teachers in private schools and future teachers, as well as experts in education. The results of the surveys and interviews are summarized and analyzed in detail. Substantial reasons for using or not using an ID are given. The survey and interviews show a belief in the use of VR technologies in STEM education. The results are described and analyzed in detail in Appendices 1, 2, 3.

*The contributions* in the first, second and third chapters are theoretical and have a *scientific character*.

In the **Fourth chapter**, a model for searching, finding, creating educational learning scenarios based on a service-oriented architecture is proposed. The creation of the model is to make it easier for teachers to use more diverse methods and means in teaching in order to increase students' interest in the studied subjects. The software architecture of the model is described and requirements for the platform for creating educational scenarios are formulated. Mockups visualize how the system would look like from the user's side, how to select different criteria - method, tool, subject, class, purpose, and then output an example learning scenario.

The **Fifth chapter** describes developed, tested and applied samples of STEM scenarios with a research approach to learning in the subjects "Man and Nature", "Physics and Astronomy". They were experimented with doctoral students and scientists from SU "St. Kliment Ohridski" within the international project weSPOT and with students, teachers, teacher trainers within the European Night of Scientists in 2018, 2019 and 2020. The scenarios are validated with practicing teachers. The "Lost Energy" scenario, implemented within the international weSPOT project, is presented. The "Dream and Reality " scenario (Appendix 4) is a continuation of the weSPOT project. It is based on an established template and has been translated into several languages in an abbreviated version. It was carried out as part of the international project ELITe. From the "Dream and Reality" scenario came the”Space Safari“ Experiment (Appendixes 5, 6, 7), the “Space Rangers” Demonstration Experiment (Appendix 8) and the “XR Cosmos” Demonstration. The created sample scenarios and feedback maps (Appendices 5, 6, 8, 9) are carefully prepared, analyzed and graphically designed.

*The contributions* in the third, fourth and fifth chapters have a *scientific-applied character*.

Research results in Chapters 2-5 were mostly reported at national and international conferences and published in their proceedings, and one publication with the highest number of citations was published in an international journal.

The **conclusion** contains a brief description of the main results of the dissertation.

The **author reference** correctly classifies the contributions of the dissertation work as scientific and scientific-applied

**Applications.** The designed survey and interview are given as data collection methods for the application of interactive whiteboards (Appendix 1) and virtual reality (Appendix 2) in education, and the interview in Appendix 3 is about the application of virtual reality. Included are reasons for use/non-use of IBD, socio-demographic issues; type of educational institution, professional position, type of settlement, range of disciplines, advantages and disadvantages of virtual reality. The results are analyzed and visualized with bar and pie charts, as well as with textual information. Appendices 5-9 are detailed in the review above.

**Bibliography**. The dissertation used 148 references - reports, articles, monographs, electronic pages, dissertations, of which 137 are in English, 10 are in Bulgarian and 1 is in Russian. About 80% of the references are from the last 7 years, the rest are foundational. Elitsa Peltekova has an excellent knowledge of the literary sources on the subject.

## II. Data and personal impressions about the candidate

### 2.1. Education

**Elitsa Vasileva Peltekova** graduated from higher education ESD bachelor in 2009 at TU-Sofia, Faculty of Applied Mathematics and Informatics with a professional qualification as mathematician and ESD master in 2011 at SU-"St. Kliment Ohridski" - Sofia, Faculty of Mathematics and Informatics with a professional qualification in mathematics and informatics. She shows a marked interest in the problems of e-learning, which is also her chosen master's program with a thesis "Digital Libraries in Education". She has completed two Erasmus mobility in 2008 as a student and Erasmus + in 2016 as a doctoral student.

*Professional Development*. Expert in "Information provision of electronic learning" (in the "Electronic and distance learning" sector); Expert on programs and projects at SU-"St. Kliment Ohridski" - Sofia, FMI, lecturer at RAABE - Bulgaria for training seminars on topics: Working with an interactive board; Work with office products; Cloud technologies in education. Elitsa Vasileva Peltekova was enrolled in a full-time doctoral program in the state field on 01.02.2014, transformed on 01.04.2014 into a part-time program at SU-"St. Kliment Ohridski" - Sofia, FMI and was dismissed from doctoral studies in 2019 with the right to defend. She passed her exams from an individual doctoral student plan with excellant marks.

### 2.2. Personal impressions

I am impressed by the innovative thinking of the PhD student, her creative knowledge in a wide range of information technologies.

The dissertation is well prepared, its layout demonstrates deep knowledge of the material, precision, word processing skills and linguistic literacy.

To this I can add my personal impressions of Elitsa Peltekova. She graduated with high marks from the Bachelor of Science in Applied Mathematics at the FAMI at TU-Sofia in 2009. I taught her two compulsory subjects from the curriculum, in which she performed excellently.

She was my graduate student and her thesis "E-Learning Platform-Application in an Undergraduate Linear-Algebra Course" was graded excellent and shows her scientific interests since she was a student. She is a participant in the international conference "Application of mathematics in technics", annually organized by FPMI, where she has always presented herself eruditely and at a high professional level.

### 2.3. Participation in scientific projects

Elitsa Peltekova has participated in 1 international European project and 6 national projects on the subject of the dissertation work: 1 at the Ministry of Education and Science, 1 at the Erasmus+ program, 2 at the National Fond Research Investigations, 2 at the National Fond Research Investigations of the SU. To this I will add that Elitsa Peltekova has an impressive participation in 35 scientific projects, of which 60% are with institutions in Bulgaria, the rest are with European commissions.

## III. Scientific and scientific-applied contributions

After investigating the dissertation work, I find that the goal and the resulting tasks have been achieved.

The obtained results have scientific and scientific-applied contributions as follows:

***Scientific contributions***

1. A creative overview and analysis of modern technological means and methods applicable in STEM education was made. The emphasis is on mobile technologies, interactive whiteboards and virtual reality technology.
2. Criteria for the selection of technological means according to the context of research training are defined and systematized.
3. The advantages and limitations of the application of technological means in the teaching of natural sciences are developed.
4. Factors influencing the increase in the interest, motivation and results of the learners are given.

***Scientific-applied contributions***

1. A system model for educational scenarios is proposed, which is based on a service-oriented architecture.
2. Models have been created for the application of the system in the detection of scenarios, according to the methods, means and context of their application.
3. Samples of standard educational training scenarios have been developed and tested (within the international research projects weSPOT and ELITe).
4. It has been experimentally established that the created examples of educational scenarios lead to an increase in interest and results in science education.

## IV. Approbation of the results

**4.1. Publications.** In the list of publications on the topic for the dissertation, 5 articles are included, all in English, of which 1 is withouth co-authors, the rest are co-authored. There are 4 articles in Proceedings of international conferences, one is in an international journal. Three of the puplications are with SJR. The publication

> **Peltekova, E.**, Stefanova, E., Nikolova, N. (2019) Space Safari – Challenge for STEM Rangers, Proceedings of ACM CompSysTech'19, 21-22 June 2019, University of Ruse, Bulgaria

has received an award for the best paper of the international conference. For the completeness of the presentation, a list of 30 articles in proceedings of national and international conferences is attached, as well as a list of 43 participations in conferences with a report, as well as organizationally as a member of the organizing committee. Data on 5 articles published in scientific journals are included, of which 3 articles are in book series. I consider this publication and organizational activity impressive.

**4.2. Citations.** These 5 publications have a total of 16 citations, with the article in the international journal *Modern Information Technologies and IT-Education* having 14 citations. This convincingly shows that Elitsa Peltekova should strive to publish results in international scientific journals.

**4.3. Minimal requirements.** Минималните национални изисквания по чл. 2б, ал. 2 и 3 на ЗРАС в РБ за научна област 4.6. Информатика и компютърни науки (Информационни технологии), професионално направление Информатика и компютърни науки, и съответно на допълнителните изисквания на СУ „Св. Климент Охридски" за придобиване на ОНС „доктор" са удовлетворени The minimum national requirements under Art. 2b, para. 2 and 3 of Law for the Development of the Academic Staff in RB for scientific field 4.6. Informatics and computer sciences (Information technologies), professional direction Informatics and computer sciences, and accordingly to the additional requirements of SU "St. Kliment Ohridski" for the acquisition of the Educational and Scientific Degree "doctor" are satisfied and in indicator Г - exceeded by Elitsa Peltekova - with a normative requirement of 30 points, she has 126 points. I will add to this that citations of the scientific publications are not required according to the rules, while Elitsa Peltekova has 16 such.

There is no plagiarism in accordance with the law in the results presented by the candidate in the dissertation work and scientific works.

## V. Abstract of Dissertation

The abstract has been prepared in accordance with the requirements of the Regulations for the terms and conditions for acquiring scientific degrees and for occupying scientific positions of FMI – SU.

The abstract correctly presents the content of the dissertation and gives an idea of the problems under consideration, as well as the contributions of the dissertation work.

## VI. Critical notes and recommendations

As I previously red the dissertation, I made remarks which were fully taken into account. Now I have a recommendation for Elitsa Peltekova to focus on publishing her articles in international journals if she wants to be seen.

When developing the surveys and applications, what international experience was used? To what extent are these new methods used in education in other highly developed countries?

## VII. Conclusion

Having familiarized myself with the dissertation work and the accompanying scientific works presented in the procedure and based on the analysis of their significance and the scientific and scientific-applied contributions contained in them, my assessment of the dissertation work, the abstract, the scientific publications and the contributions of **Elitsa Vasileva Peltekova** is **POSITIVE.** In the reviewed dissertation, results of a scientific and scientific-applied character were obtained. **Elitsa Peltekova** demonstrates in-depth knowledge in the specific scientific field and scientific potential for the realization of original ideas.

Due to all of the above, I consider that the dissertation work of **Elitsa Vasileva Peltekova** meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), the Regulations for the Implementation of LDASRB, the Regulations on the Terms and Procedures for Acquiring Scientific Degrees and for occupying academic positions at SU "St. Kliment Ohridski".

The candidate meets the minimum national requirements in the professional direction and no plagiarism has been found in the academic works presented in the procedure.

The achieved results give me reason to propose to the respected scientific jury to give the scientific and educational degree **"doctor" to Elitsa Vasileva Peltekova** in the field of higher education: **4. Natural sciences, mathematics and informatics**, **professional field 4.6 "Informatics and computer sciences""**.

01.09. 2022

Prepared the review:

(***Prof. Dr Sc Eng. Ketty Peeva***)