

## REVIEW

**under the procedure for acquisition of the educational and scientific degree "Doctor" by the candidate Ralitzia Liubomirova Stamenkova, of the PhD Thesis entitled: "The Role of Applied Problems from the School Mathematics Course for the Learning Purposes",**

In the Scientific field: **1. Pedagogical Sciences**

Professional field: **1.3. Pedagogy of learning in ...**

Doctoral program "Teaching Methodology of Mathematics and Informatics",

Department "Education in Mathematics and Informatics", **Faculty of Mathematics and Informatics (FMI), Sofia University "St. Kliment Ohridski" (SU),**

The review has been prepared by: **Assoc. Prof. Philip Petrov Petrov, PhD**, Sofia University "St. Kliment Ohridski" as a member of the scientific jury for the defense of this PhD thesis according to Order № ПД-38-669 / 20.12.2023 of the Rector of the Sofia University.

### 1. General characteristics of the dissertation thesis and the presented materials

The dissertation is relatively large in volume: 187 pages in A4 format with about 2500 characters per page. The structure of the dissertation consists of an Introduction, seven chapters, a Conclusion and a Bibliography with 148 titles (of which 45 are in Bulgarian language), 6 documents with EU strategies, 6 curricula from Ministry of Education and Science in Bulgaria and 29 Internet sources. The literature review includes sources in three languages – Bulgarian, English and German. The layout is aesthetically pleasing, comfortable and easy to read. The text includes 81 figures and 15 tables, placed in the appropriate places and titled properly, which complement and enrich the text with graphical information. All figures, tables and abbreviations are systematized and described at the beginning of the dissertation.

There are 3 scientific publications which are related to the dissertation. In all of the doctoral student is the first and only author. Two of the publications are in international scientific journals. All publications are presented on scientific conferences.

The doctoral student receives a total of **30 points** on the scale for requirements of group D for the scientific degree doctor, which **covers the minimum required metrics for 1.3. Pedagogy of learning in...**

Related with the dissertation are the following activities:

- participation with a report at the National Seminar on Mathematics Education, 2019 with the following presentation: "Analyzing a process set with a function in Geogebra". The presentation received an award for excellent performance;
- participation with a report on the topic "The mathematical essay as a tool in mathematics education" at the FMI Spring Scientific Session, 2021.

The doctoral student has participated in the following scientific projects:

- Organizational forms for the professional qualification of pedagogical specialists in the teaching of Mathematics, Informatics and Information Technologies, SU - Scientific Research Fund, Contract number: 80-10-61/25.4.2023
- 21st Century Skills: Changing the Approach to Teaching in Higher Education, Contract Number: 2019-1-TR01-KA203-074482 (2021)
- PLYful Environment for Inclusive learning Design in Europe (PLEIADE), EU, Erasmus+, Contract number: 2020-1-IT02-KA201-080089
- Methodological approaches to increase student achievement when applying the competence approach, Contract number: 80-10-151/05.04.2021
- MODERNIZATION in partnership through digitization of the Academic ecosystem, Contract number: BG05M2OP001-2.016
- Targeted use of organizational forms laid down in the new curriculum of the Ministry of Education and Culture in the cultural and educational field of Mathematics, Informatics and Information Technologies, SU - Scientific Research Fund, Contract number: №80-10-199/28.4.2020
- Organizational models for extracurricular activities in the conditions of the new curricula of the Ministry of Education and Culture in the cultural and educational field of Mathematics, Informatics and Information Technologies, Ministry of Education and Culture - Scientific Research Fund, Contract number: 80-10-210/17.04.2019

## **2. Short CV and personal impressions of the candidate**

Ralitsa Stamenkova graduated high school from the 91. German Language High School in Sofia in 1994. After that, she completed a bachelor's degree in Informatics. In 2019 she also completed a Master's degree in the field of teaching methodology in mathematics. In the period from 2004 to 2013 she worked on projects in the ICT sector. In 2013 she started working at the Millennium Learning Center, where she deals prepared students in Mathematics for tests in 7<sup>th</sup> and 12<sup>th</sup> grade. I guess this is what sparked her research interest in the scientific field of methodology of learning.

My personal impressions of Ralitsa Stamenkova are excellent. She attended almost on all the departmental meetings, even though she was not required to do so. She was active in all the seminars of our department. I noticed that she went to consultations with her supervisor very often, and from this I concluded that she was an active doctoral student who worked actively and conscientiously during the entire period of her study.

## **3. Content analysis of the scientific and applied achievements of the candidate, contained in the presented PhD thesis and the publications to it, included in the procedure**

The topic of the dissertation has methodological significance, practical value and due to the dynamics in the educational environment is subject to permanent updating and further development. At the same time, it is complex, multi-directional, multi-layered, but with one unifying factor – the mental and intellectual development of students. The development of such a research topic requires not only good theoretical training, analytical and synthetic abilities, but also positivism, faith and hope in the potential of the young generation. Each element of the content structure - introduction, seven chapters and conclusion - corresponds to the different emphases of the study, and in its entirety represent a completed study.

The **Introduction** begins with discussion of the relevance of the scientific problem. Some quotes from famous scientists are presented. The text focuses on strategies of the European

Union for the so-called *key competences*. There are citations from various historical sources. The conclusion is that the school Mathematics course plays a key role in the development of the listed competencies.

After that, the topic of the dissertation is defined, supplemented with brief explanations. The object of the study is defined as *the use and application of knowledge of functions in solving practical problems in secondary school mathematics education*. I think it is defined correctly. The subject of the study is *the importance of applied tasks for the development of cognitive and metacognitive skills and competences of students in the first and second years of secondary school*. Rather, I expected it to reveal the practical applicability of the object in the schools where the particular pedagogical experiments were conducted.

The aim of the thesis is defined as the achievement of a research section of the applied tasks in view of their role in the development of students' mathematical thinking, skills and competences. Then, 7 research tasks are defined to achieve this goal. I think they are described correctly.

Six research hypotheses were defined. This volume is quite large for a PhD thesis. Later in the chapters these hypotheses are discussed and tested, which is commendable and shows that they were not simply thrown up to add prominence to the introduction, but were actively worked on.

The research methods are described correctly. The introduction ends with a brief description of the chapters of the dissertation.

**Chapter One** begins with an exploration of the concept of *problem* and in particular *text problem* and *applied problem*. The literature review is good and the examples are illustrative. Some problem-solving methods are presented. Numerous foreign-language authors are cited, starting with the works of Poya. The review is reaching relatively new articles on the topic. Some methods for creation or selection of didactic systems of applied mathematical problems are described. Some of the problem-solving strategies are discussed in more details. The thesis discusses some questions from the psychology field – the development of cognitive and metacognitive skills. The chapter concludes with an overview of the European frameworks for the so called *21<sup>st</sup> century skills*, as well as the concept of *functional literacy*. I generally agree with the summary, although it could have been more detailed and better argued.

**Chapter Two** is relatively short and is devoted to some fundamental philosophical questions surrounding the main learning paradigms. A brief literature review was made, but with a fairly wide range. It begins with one of the main questions of the methodology: why it is necessary to study mathematics at school. There are some screenshots with answers from automatic content generation systems based on large language patterns (ChatGPT). I think it will be better to replace them with a personal literature review. Many different points of view are touched upon from a psychological point of view – both in the fields of behaviorism and constructivism. The modern interpretation of the lifelong learning paradigm is also discussed. Some sources are cited, the conclusions from which support some of the hypotheses in the dissertation.

**Chapter Three** begins with the author's view of the current state of mathematics education in schools. I generally accept the conclusions. The importance of text and applied problem assignments is outlined and the alarming trends of their gradual decline and removal from textbooks in higher classes. The author pays attention to the problem with the fixation in grades after 4th and 7th grade (the reasons are the exams for high schools). Some examples of specific problems from different levels of education are given, such as the cognitive transformation of mathematics from *important* to *difficult* when moving from junior to high school. The increasing role of the extracurricular activities in schools and private mathematics lessons is indicated. A specific example of the decreasing interest in competitions in each subsequent class is given by data from the European Kangaroo competition. It shows that the difference in the number of participants between the 1<sup>st</sup> and 10<sup>th</sup> class decreased 30 times in

Bulgaria, while in Germany the interest for the same drops only 8 times. The drop in the success rate from the graduation exams in 4th and 10th grade was also examined, but here the comparison is harder to conclude because the tests are not comparable. The chapter ends with a description of some imperfections of the curricula in the different educational stages, which are supported by examples. A brief overview of similar problems from other countries is also made.

**Chapter Four** begins with an example of word problems from the junior high school stage. Approaches to solving such tasks in educational systems from different countries are shown. The literature review was used to confirm one of the author's hypotheses that the main problem facing text problems is the difficulty of starting with their solution attempts. It is shown how the Bulgarian education system in the initial stage is ahead of the others, but then loses its strength. The doctoral student assesses that the reforms of recent years are rather negative and the "lightening" of educational content leads Bulgaria to lag behind other countries, i.e. a good start is followed by a serious decline. Questions from the field of IT use in mathematics education are also discussed. For example, an interesting example of solving a text task using ChatGPT is shown. Questions about the potential of project-based learning and the development of "mathematical essays" are discussed. The latter is described in detail as an important tool which is poorly represented in the Bulgarian education system when is actively used in other countries at the same time. The chapter ends by presenting a classification of applied tasks according to the Bloom's taxonomy.

**Chapter Five** presents a pedagogical experiment. Specific tasks were selected, after which the main difficulties for the students were analyzed through a survey. The experimental groups are described. A significant distinguishing feature of the conducted experiment is that the focus is not on the results (final grades), but on the approach to solving the tasks. The scale of the experiment is good – in its first phase it was conducted with 138 students, and in the second 54. Given that it was also conducted in an extremely difficult epidemic situation, this should be applauded.

**Chapter Six** is devoted to a quantitative and qualitative analysis of the results of the experiments from Chapter Five. The doctoral student is sufficiently self-critical and checks the hypotheses correctly. I believe that sufficient knowledge, skills and attitude have been demonstrated in conducting a pedagogical experiment, which indicates good competence.

**Chapter Seven** is entitled "Look Back" and is a very useful summary of the experience gained from the experiment, together with the author's ideas for a possible follow-up product development. A didactical system of problems is presented, through which the author's vision for upgrading knowledge and stimulating students' creativity is presented. This is very positive, because such summary works usually appear as a consequence of doctoral dissertations, and less often are part of them.

The **Conclusion** logically summarizes the entire work. Special attention is paid to confirming or rejecting the thesis hypotheses. Although not everything is conclusively proven, within the volume of dissertations, it is enough within the scope of the thesis.

Following is the **Contributions** list. The list is divided into scientific, scientific-applied and applied. A large number of contributions are listed. I have remarks on some of them, which will be presented below.

The **Bibliographic reference** gives me a reason to consider that the doctoral student is well acquainted with the state of the scientific problem. The sources used are scientific, educational, teaching-aid literature, normative documents at the national and European level and others. Their diversity and relevance are a serious request for in-depth research. Not only it demonstrates good awareness, but there is also serious critical analysis in the selection and citation. The sources are used correctly with a clear distinction between the original text and the quotations. This impression is also confirmed by the quantitative results of the plagiarism

prevention system, which gives a citation rate of 9.87% when the acceptable is everything below 20%.

#### 4. Approbation of the results

**The publications** which are related to the dissertation work have no impact factor and are not indexed in Scopus or Web of Science; however, they **fully meet the minimum national requirements and the additional requirements of SU** for the acquisition of an educational and scientific degree "doctor" in direction 1.3.

The results presented by the candidate in the dissertation work and related scientific works **do not repeat those from previous procedures for acquiring a scientific title or academic position** as the candidate did not have any.

There is **no proven plagiarism** in the submitted dissertation and scientific works under this procedure.

The publication *Ralitzza Stamenkova, DO WE NEED THE APPLICATION PROBLEMS IN MATH CLASSES, EDULEARN21 Proceedings, 2021, pages:11686-11694, ISBN:978-84-09-31267-2* presents the results of the first study, which is described in Chapter 5 and its results in Chapter 6.

The publication *Ralitzza Stamenkova, DISTANCE EDUCATION IN BULGARIA DURING COVID-19 IN A SMALL EDUCATIONAL ORGANIZATION – METHODOLOGY AND TOOLS, ICERI2020 Proceedings, editor/s:L. Gómez Chova, A. López Martínez, I. Candel Torres, Publisher:IATED Academy, 2020, pages:5523-5532, ISBN:978-84-09-24232-0, doi:10.21125/iceri.2020* presents the results of a pedagogical experiment which is not included as part of the dissertation; however, the publication is relevant to the research thesis and has been useful for the PhD student as a preliminary study of the difficulties and challenges faced by teachers during distance e-learning. Considering that a significant part of the experimental work was done during the Covid-19 pandemic and its related restrictions over the educational institutions, I believe that this experiment was useful for the subsequent work on the dissertation.

The publication *Ralitsa Stamenkova, Electronic education for the purposes of training future mathematics and informatics teachers, Electronic education in higher schools, publisher: University Publishing House "St. Kliment Ohridski", 2020, pp.:215-226, ISBN:978-954-07-5028-6* has the same spirit as the last one – it describes the challenges faced by teachers who have taught in an electronic environment after the restrictions imposed due to the Covid- 19. There is a focus on the training of future teachers. Although not directly related to the topic of the dissertation, this publication is also valuable to him because it highlights some directions of research.

#### 5. Qualities of the abstract

The abstracts follow the course of the dissertation and are written in the expected volume and style. They meet all the requirements. A significant issue in both abstracts (Bulgarian and English) is that the page with the publications which are related to the dissertation work is not included. They must be added before official publishing of the abstract.

#### 6. Critical notes and recommendations

My primary critical note is related to the list of contributions:

- Making a literature review (Contribution 1) does not contribute to an innovation in science – it can only support the foundations of a new discovery, but it is not a new discovery;
- The same applies to the comparison of documents (Contribution 2);
- Analyzing the place of applied tasks when combining classic and innovative didactic approaches (Contribution 3) is in the scientific-applied nature;
- The presented data and the analysis of the results of a pedagogical experiment (Contribution 4) have a completely applied nature, and are not a scientific contribution – they show that an already developed scientific-applied experimental model has been tested;
- The literature review of approaches to stimulation of student creativity, self-direction, self-discipline and motivation (Contribution 6) is an overview of existing methods and does not contribute to a scientific discovery;
- It is debatable to what extent the analysis of the teacher's role in the presentation, combination and upgrading of knowledge in parallel with the modern educational paradigm for lifelong learning (Contribution 9) includes an essential author's idea for the application of novelty in the scientific sphere – my opinion is that here again there is just a literature review, which is not followed by formulation and approbation of an innovative idea.
- I accept Contributions 5, 7, 8, 10, 11, 12, 13 and 14 as correct.

One critical note to the English language abstract is that the sources in Bulgarian are not translated or at least transliterated. This will undoubtedly make it difficult for foreign researchers to understand the text.

## 7. Conclusion

Having become acquainted with the PhD thesis presented in the procedure and the accompanying scientific papers and on the basis of the analysis of their importance and the scientific and applied contributions contained therein, **I confirm** that the presented PhD thesis and the scientific publications to it, as well as the quality and originality of the results and achievements presented in them, meet the requirements of the ADASRB, the Rules for its Implementation and the corresponding Rules at the Sofia University "St. Kliment Ohridski" (FMI-SU) for acquisition by the candidate of educational and scientific degree "Doctor" in the Scientific field 1. Pedagogy, Professional field 1.3. Pedagogy of learning in..., Doctoral program "Teaching Methodology of Mathematics and Informatics". In particular, the candidate meets the minimal national requirements in the professional field and no plagiarism has been detected in the scientific papers submitted for the competition.

Based on the above, **I recommend** the scientific jury to award Ralitzia Liubomirova Stamenkova with the educational and scientific degree "Doctor" in the Scientific field 1. Pedagogy, Professional field 1.3. Pedagogy of learning..., doctoral program "Teaching Methodology of Mathematics and Informatics".

Date: 23.02.2024

Reviewer: .....

Assoc. prof. Philip Petrov Petrov, PhD