

STATEMENT REPORT

under the procedure for acquisition of the educational and scientific degree “Doctor” by candidate Ralitsa Lyubomirova Stamenkova **of the PhD Thesis entitled:** "The Role of Applied Problems in the School Mathematics Course for Learning Objectives" in the Scientific field: **1. Pedagogical Sciences**; Professional Field: **1.3. Pedagogy of Teaching 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", Scientific Supervisor of the **PhD Student:** Prof. Dr. Ivan Tonov

The statement report has been prepared by Assoc. Prof. Dr. Yulia Dimitrova Ninova (FMI, SU, "St. Kl. Ohridski") as a member of the scientific jury for the defense of this PhD thesis, according to Order No. / RD-38-669/20.12.2023 of the Rector of the Sofia University.

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

The presented dissertation contains 187 pages. The content is presented in an introduction, 7 chapters, and a conclusion. A list of abbreviations, indexes of tables (15) and figures (81), and an author's reference to the PhD student's contributions are added. The bibliography contains a rich collection of Bulgarian (46 titles) and foreign (102 titles in English or German) literature, documents, syllabi, exam materials, and internet sites.

The relevance of the dissertation topic is undeniable. It is synchronized with the guidelines and recommendations for the development of education in our country. Based on the competences set out in the ECF, specific competences are listed that can be developed through solving applied problems.

The rich literature review, covering a wide period of time, is a prerequisite for a good and in-depth knowledge of the problem.

The introduction describes the *object of the research* - the use of knowledge of functions in solving practical mathematical problems in the upper secondary education stage; the *subject of the research* - to reveal the importance of applied problems for the development of cognitive and metacognitive skills and competences in upper secondary school students.

The *aim* of the dissertation is a broad-spectrum analysis of applied problems to establish their role in the development of students' mathematical thinking, skills, and competences. The aim of the research leads to the formulation of a large number of problems - 7. Problem No 1 is well formulated - a structural review of sources, analyzing the methods used; hypotheses and conclusions drawn from research on the topic of the dissertation. Comparison of normative documents, comparison of textbooks - local and foreign, systematization of good practices, analysis of the role of applied problems for the realization of interdisciplinary connections, the need to supplement the course with applied problems without reducing the problems that exercise the theory are the accents in the following problems, which I consider can be consolidated. I believe that Problem No 6 is central, as the solution of the previous problems prepares its solution, and the solution of the last one confirms or refutes the hypotheses set out in the PhD student's hypotheses.

Six *hypotheses* have been formulated, the verification of which is expected to confirm or refute: is it necessary to supplement the course with applied problems; does solving applied problems increase students' interest and motivation; are key competences developed according to the new educational paradigm; is analytical-heuristic thinking developed; is competitiveness and mobility of high school graduates ensured?

The *research methods* are: study of scientific literature, publications, research, and relevant statistics; study of various textbooks and syllabi - foreign and Bulgarian over the years; field research.

Description of Chapter 1 BASIC CONCEPTS

This chapter provides the most detailed development of point 1.3. The following aspects related to the concept of applied problems are considered: formulation, basic parts, structure of questions by difficulty (or complexity), process of creation, vocabulary, variety, criteria, features (some essential features of this type of problems are omitted, such as: obvious conditionality, describe the situation in a completed form, the modeling stage is simplified due to excessive formalism, which features were established as a result of another study).

At the end of 1.2. is given the description of the concept of applied problems, which the PhD student perceives and will use. The gradation of questions by difficulty (or complexity) is not of a generalizing character, because it is concretized on the basis of the theoretical means (the use of the concept of function as a means of modeling, indicated by the PhD student). Of interest are the ten criteria (p. 21) for recognizing a problem as practical. A successful addition is the third column of Table 3 on pp. 24 –25, which reveals the cognitive significance of the activities carried out and the goals set when solving problems related to the topic of the dissertation. An expanded and generalized algorithm (p. 26) of the stages involved in solving a practical problem is given. I believe that the first step of the first stage of the described algorithm (adopted by the PhD student) for solving applied problems should be a non-verbal presentation of information corresponding to the stages of cognitive processes described later and to the capabilities and specifics of working memory.

The summary at the end of this chapter should contain a description of the basic concepts used in the research, which the PhD student adopts.

Description of Chapter 2 MATHEMATICS IN EDUCATION

This chapter provides a brief historical overview of the influence of education on the development of mathematical thinking, the role of motivation for the sustainability of acquired knowledge, and changes in the educational paradigm. The PhD student finds good ideas from the sources studied. The presentation in Chapter 2 is mainly based on citations.

Description of Chapter 3 CONTEXT OF THE PROBLEM

This title suggests a description of the current state of the problem from different aspects (presence/absence of applied problems at different levels/stages of education, comparison with foreign practices, research results, etc.) and then, based on this analysis, to follow in another chapter with specific proposals for overcoming the identified problems.

The development of the content places a serious emphasis on the contradiction between the expected results and the role of assessment and the influence of extracurricular activities on the achievement of this quantitative result. The PhD student demonstrates a good knowledge of forms and means of extracurricular activities through the extensive and critical review made, through the expressed personal opinion about their role and achievements. In 3.4. a request is made for an analysis of the applied problems used in the training at the lower secondary level (perhaps in our country). Two of the criteria adopted by the PhD student are indicated. The conclusion that practical problems are widely used (p. 61) does not sound convincing without the presence of specific data from the study itself, without the presence of specific examples, in order to establish whether these problems meet the adopted criteria. The description of the analyses made with remote citation of the characteristics of the questions and the criteria for recognizing an applied problem makes reading much more difficult.

Description of Chapter 4 INTERNATIONAL ASPECT, ANALYSIS, PARALLELS

Individual similar extreme problems from local and foreign practice (at different educational levels or stages) are considered and compared in terms of approaches to solution and preparation for their solution. There is no single set of criteria for comparison. The commentary texts refer to various techniques, criteria, stages or other characteristics discussed in the cited sources.

The most significant contribution in this case is the description of the mathematical essay (as an educational tool) and its comparison with applied problems from the point of view of creativity. It is not clear from the presentation who is the author of the comparative table on pp. 98 – 99, which is closely related to the topic and could serve as a model of experimental activity. The comparison of the cognitive levels according to Anderson's taxonomy (described with behavioral verbs) with the activities related to the formation of skills (in the context of the competence approach) for solving applied problems is a good idea.

Description of Chapter 5 FIELD RESEARCH

A description of an experiment is given, limited in terms of the number of problems used as a tool to confirm hypotheses. The experiment should track, on the one hand, reading and functional literacy, and on the other hand, the acquisition of the desired competences. A good impression is made by the breakdown of the indicators formulated on p. 10 and their detailing and concretization according to the topics of the experimental pair of problems.

The formulation of the first of the two problems on p. 106 needs corrections. The bottleneck is visualized with the graph of the fractional-linear function $g(x) = \frac{15}{x}$, $x \in [5;15]$ and its symmetrical image about the abscissa axis. This perhaps explains part of the students' difficulties in interpreting the information and indicating the answer to the question about the diameter of the bottleneck. Similar comments should be made for the quadratic function as well.

Description of Chapter 6 ANALYSIS OF RESULTS

A quantitative and qualitative analysis of the accumulated empirical facts is made. The purpose of the focus group is to obtain feedback on new products, topics or ideas, which information is also obtained from the control group. The significant difference in

achievements, presented with the results in Tables 8 and 9, on the one hand, can be explained by the different conditions of the experiment, and on the other hand, the second study was not done entirely in the same environment.

Description of Chapter 7 LOOKING BACK

This chapter discusses several specific examples of applied problems suitable for the second stage of high school (profile training). The proposed solutions are considered, commented and described in the context of the competence approach. Applied problems created by students are also indicated, as an assignment for additional assessment, which contradicts the conclusion (p. 163) that quality applied problems can be created with the joint work of mathematics teachers with other specialists. The expectations here are to provide a serious set of applied problems as an appendix to help teachers.

2. Short CV and personal impressions of the candidate

PhD student Ralitsa Stamenkova graduated from the German Language High School, Sofia, and then majored in Computer Science (Master) at the FMI of Sofia University "St. Kl. Ohridski" with a second major in Teacher of Computer Science and Teacher of Mathematics.

I have known PhD student Ralitsa Stamenkova more closely for about two years in connection with the preparation of the course Modern Educational Technologies in Mathematics Education at MP6 Innovations and Multidisciplinarity in Compulsory Mathematics Education, Computer-Aided Modeling and Information Technologies as a result of the work on the project MODERNization in Partnership through Digitization of the Academic Ecosystem, contract number: BG05M2OP001-2.016. As a member of the course team, she showed responsibility, initiative, accuracy and tolerance.

In the master's program and in courses at the SDC, the PhD student teaches classes as a paid lecturer.

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 described contributions and confirmation of the hypotheses are convincingly defended in the conclusion mainly through the studied literature.

Of practical importance are the scientific-applied contributions 7-9 and the applied contributions, which can serve as a basis for subsequent practically significant developments in the field of mathematics education.

The well-structured and concise presentation in the publications (included in the procedure) is impressive - the description of the problem, the search for means and proposals for its solution and the formulated conclusions from the specific development.

4. Approbation of the results

There are 3 publications. The PhD student is an independent author. The article *Do we need the application problems in math classes?* was reported and included in the proceedings of the

13th International Conference on Education and New Learning Technologies, held online. This is the article whose content is most closely related to the content of the dissertation. The article describes a comparative study aimed at testing the hypothesis that even well-prepared mathematics students have difficulty extracting information from a more complex problem formulation. In the article *Distance education in Bulgaria during COVID-19 in small educational organization - methodology and tools*, reported and published in the proceedings of the 13th annual International Conference of Education, Research and Innovation (held online), an analysis of the possibilities of this training is made in three aspects - methods and technologies, social (rarely addressed in research) and formation of competences in students. The problems related to the search for opportunities and means for continuing effective mathematics education in an electronic environment during a pandemic in different forms and levels of education are considered. In the article *Electronic Education for the Purpose of Training Future Mathematics and Computer Science Teachers*, published in the collection *Electronic Education in Higher Education*, University Publishing House "St. Kliment Ohridski", describes problems and solutions in the practices of students during the pandemic.

The sum of the points (30 points) from the publications meets the minimum national requirements (according to Art. 2b, para. 2 and 3 of the Law on the Academic Ranks and Scientific Degrees) and respectively the additional requirements of Sofia University "St. Kliment Ohridski" for obtaining educational and scientific degree "doctor" in the scientific field and professional field of the procedure.

No citations were noted. The publications have not been used in previous procedures for obtaining a scientific title. There is no proven plagiarism in accordance with the law.

5. Qualities of the Abstract

The abstract attempts to present the ideas of the dissertation in a concise and informative manner. The presentation of the content and the presentation of the results meet the requirements for the preparation of an abstract.

The numbers of chapters, paragraphs, tables, etc. in the abstract must correspond to their numbers in the dissertation. The omission of criteria and indicators used in descriptions or comments (e.g. pp. 15 –16) and the violation of the previous requirement for compliance with the numbering limit the possibility of its independent reading and obtaining a more complete picture of what was done in the dissertation.

On the second page of the abstract, the following are missing: date of the meeting of the scientific unit that admitted the dissertation to defense; date, time and place of the public defense; composition of the scientific jury; brief description of the content of the dissertation - volume, tables, figures, appendices and number of cited sources.

6. Critical Notes and Recommendations

The *object of research* is that to which human scientific or practical activity is directed, and the *subject of research* is a side, aspect, point of view of the researcher, from which he cognizes the object. From the point of view of this description, I believe that the object of the research is to reveal the role of applied problems (this is the title of the dissertation) for the formation of the indicated competencies, and the subject is to reveal the role of applied problems modeled with functions for the development of these competencies.

When comparing implementations of content in different sources, it is expected to have a set of criteria/indicators by which to perform this comparison.

I believe that the consolidation of the hypotheses would lead to a more concentrated and focused study.

The conducted experiment is limited and rather has a diagnostic character

The sources from which the problems included in the dissertation were taken should be indicated, so that it becomes clear to whom the comment is addressed. Thus, it is not clear from the presentation to what extent the personal contribution of the doctoral student is and to what extent someone else's experience is being transferred. When "transforming" a mathematical problem into a practical problem, it should be borne in mind to what extent the described "real" situation is close to the experience of students (see problem 2, p. 136 and problem B of the experiment).

A critical approach should be taken to the opinions expressed in the cited sources. Some of them are based on a lack of knowledge of the philosophy of creating the respective document. The uncritical transfer of ideas from other forms of education or from other educational systems leads to a violation of the identity of the original.

The dissertation uses an incorrect identification of: text problems with applied problems, solution with solving, course with stage or degree, study plan with curriculum, competence with competency. It is necessary to clarify and correctly use the normatively accepted terminology.

The following are unacceptable: the replacement of the words analysis with section and aspects with axes; the frequent use of the words addressing and communicating; an admitted terminological inaccuracy - equation of a function instead of analytical form of a function.

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 Act on Development of the Academic Staff in the Republic of Bulgaria, 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. Pedagogical Sciences, Professional field 1.3. Pedagogy of Teaching in 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 **strongly recommend** the scientific jury to award Ralitsa Lyubomirova Stamenkova, the educational and scientific degree "Doctor" in the Scientific field 1. Pedagogical Sciences, Professional field 1.3. Pedagogy of Teaching in Mathematics.

Date: March 8, 2024

Signature:
(Assoc. Prof. Dr. Yulia Ninova)