REVIEW

under the procedure for acquisition of the educational and scientific degree "Doctor"
by the candidate **Iliana Ivanova Tsvetkova,**
of the PhD Thesis entitled: "The Extracurricular Work in Mathematics in the Primary and Lower Secondary School Stage – An Important Factor for Discovering and Developing Mathematical Talent",
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 № РД38-677 / 22.12.2023 of the Rector of the Sofia University.

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

The dissertation contains the necessary components of a doctoral dissertation and is developed in accordance with the requirements for a scientific and methodological research. The volume is small: 82 pages in A4 format with Times new roman font size 12 pt and about 2300-2400 characters per page. In that count it includes 3 appendices, a declaration of originality and a similarity report, all totaling 12 pages. There are 3 tables in the main text. Figures are also 3. The table of contents consists of an introduction, five chapters, a conclusion, a list of references, a statement of originality, a statement of similarity and appendices. The literature review includes only 32 sources, 15 of which are in Bulgarian and 17 in English. Among these cited sources, the doctoral student is an author or co-author in 11. There are 8 references to Internet sites. Total of 8 contributions of a scientific-applied and applied nature were highlighted.

The number of publications related to the dissertation work is impressive. The dissertation shows a list of 21 publications, of which 16 are scientific publications in journals and conference proceedings, and 5 are textbooks and proceedings in which the doctoral student was a co-author (in 3 is the main author first). Among the scientific publications:

- in 11 the PhD student is the first and only author;
- one is a chapter of a collective monograph in English indexed in Springer;
- the rest are co-authors (in 3 of them the PhD student is the first author) and among them 1 is indexed in Web of science;

Textbooks and problems collections do not carry points on the national scientometric indicators, but even without them, the presented publications exceed the minimum number of points multiple times. A third list of publications allegedly related to the dissertation is

attached in a separate file in the documents for the procedure. They include the list from the dissertation plus 5 additional teaching aids for secondary schools in which the PhD student was a co-author.

The list in the dissertation does not correspond to the Reference for the fulfillment of the minimum national requirements presented in the defense documents. In the reported document, the doctoral student indicated only 5 of the scientific publications, which are correctly counted as carrying 65 points. This is double the minimum of 30 points. That way **the dissertation covers the minimum scientometric indicators**.

The PhD student did not mark any participations in scientific projects and seminars, Spring scientific session of the Faculty of Mathematics and Informatic, etc. I am witness that the student did have such activities and they were related to work over the dissertation. It is worth noting that.

2. Short CV and personal impressions of the candidate

Iliana Tsvetkova graduated from Sofia University with a specialization in Mathematics in 1984. She started working at the 85. ESPU, and since 1991 she has been a teacher at the Sofia Mathematics High School, where she passed through the three levels from teacher to leading teacher. In 1995, she already obtained the 2nd level professional qualification, and in 2011 she also received the 1st, highest level.

Iliana Tsvetkova has a great authority in the teachers' guild. Her results are considered excellent not only by the success her students achieve in competitions and Olympiads, but also by the deep respect from her colleagues. Mrs. Tsvetkova has been a long-term base teacher at the Faculty of Mathematics and Informatics and annually helps with the training of students during their practices. Because of her erudition, she has distinguished herself as one of our preferred base teachers for group math practices in Mathematics. She was a member of the executive committee of the World Federation of National Mathematical Competitions (WFNMC), and since 2022 she has been a member of the program committee of the federation. She was twice awarded as teacher of the year - 2005 and 2013. She is a recipient of the honorary award "Neofit Rilski" of the Ministry of Education and Science in 2020. She participated in numerous scientific forums, led a large number of math olympic students and teams in various international competitions, most of whom have returned to Bulgaria with medals. This review shows very high professionalism and rich practical experience, which fully corresponds to the subject of the dissertation.

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 Introduction begins with a brief outline of the so-called "STEM" as part of the modern trends in the world education. The PhD student motivates her research work around the need to implement such concepts in the practice of the school where she works. I think the topic is relevant. On the other hand, the dissertation also includes a retrospective review from many years back in time, which perhaps should also be noted in the summary, because these serve as a solid foundation for the modern trends. The Introduction can be extended a bit in this direction.

The aim of the dissertation is *to show that the development of mathematical talent should start from the last grades of the primary stage or at the latest in the lower secondary stage of education*. This corresponds to the hypothesis, which states that *early discovery and purposeful development of mathematical talent is a prerequisite for its successful realization*. The sentence defining the aim of the dissertation can be slightly refined.

The object of the study is defined as *extracurricular work (organization, amount, content and methods) in mathematics with students from 8 to 14 years of age*. I accept this, because it fully reflects the practical applicability of the obtained results.

The subject of the research is defined as *creating interest in extracurricular activities in mathematics, methods of formation of cognitive skills, discovering, developing and training mathematical talents*. That sounds more like a goal rather than a subject of a research. In principle, the subject of the study should be the point of view from which the doctoral student investigated the object, i.e. it is expected to describe specific classes and students with which the pedagogical experiments were conducted. I suspect that the problem is due to usage of a vague definition of the term "subject of research".

The set tasks are 5 in number and correctly reflect the aim. The research methods are listed and an adequate chronological plan for the implementation of the tasks is presented. The introductory part of the dissertation ends with a general description of the titles of the chapters of the dissertation work, which by themselves correspond correctly to the tasks set.

Chapter One is entitled as *The role of extracurricular training and competitions for discovering and developing mathematical talent*. Essentially, it includes a literature review for as a basis for the highlight of the author's ideas. Unfortunately, this literature review is too short and incomplete. Without a doubt, I would accept that everything written is true, but the theses could have been supported by many more scientific sources. It is noted that part of the text was published in a 2023 article; which is correctly quoted as related to the dissertation.

At the beginning of the chapter, the concept of mathematical talent is defined, after which methods for early diagnosis and detection of talented students are discussed. The popular math competitions for primary school students that are held in Bulgaria are listed, and a strong opinion is expressed that *they are the best places where talented and gifted students can be discovered*. I am inclined to accept such a statement, but with the caveat that I personally believe that there are quite a few potential talented students who, for various reasons, do not go to competitions. The thesis does not address the issue of searching for mathematical talent in alternative ways.

Some methods of preserving and developing mathematical talent are considered. The extremely important role of teachers as mentors of talented students is highlighted. The importance of placing talented students in a competitive environment is discussed. Part of the experience of the Bulgarian mathematics high schools and the Sofia Mathematics High School, in particular, for the early admission of talented students from the 5th grade, which is already an established tradition in Bulgarian education, is described. I think this historical overview is done correctly, but it could also be considerably more thorough and comprehensive.

The chapter discusses the estimated amount of academic hours with which the mathematical talent can be adequately developed. Specific numbers are shown based on statistical processing from many years of experience. The thesis is undoubtedly interesting, but it could be investigated much more. It would be nice if more data and significantly more detailed information were presented – not only from the personal experience, but also by looking at different Bulgarian schools, as well as some experience from abroad.

At the end of the chapter, different types of math competitions are presented. The advantages of different formats are highlighted. The chapter ends by the share of the personal experience from the role of the PhD student as a long-term teacher-mentor in the training of mathematical talents from the Sofia Mathematical High School. More data can also be shared here, such as a comparison between her work and that of her colleagues. The small volume of the dissertation work is mainly due to gaps in this direction.

Chapter Two is entitled *Analysis of mathematics curricula in elementary and lower secondary school*. The doctoral student reviews the current curricula and very correctly notes

one major omission, which is present not only in Mathematics, but also in many other subjects: in junior high school, a very small percentage of the study time is devoted to exercises. The traditionally difficult transition between 4th and 5th grade, which has been the subject of long-standing discussions in the Bulgarian education system, is also highlighted. A hypothesis has been put forward as to why mathematical talent often begins to be lost during this transition. I tend to accept this statement based on personal observations, but the matter should be studied in much more detail so that the hypothesis can be not only declaratively presented, but also verified.

Some shortcomings of the study programs in the initial stage are correctly indicated and analyzed. The experience of solving these problems from the Sofia Mathematical High School was shared and the author's teaching materials used in them were briefly presented. The author describes a model for expansion of knowledge and for the propaedeutics for the smoother transition to the junior high school stage. This part of the chapter is described correctly.

Chapter Three is entitled *Pedagogical experiment of the research*. The text begins with a literature review of the types of pedagogical research and their characteristics. It serves as a basis for a motivated selection of specific methods. The pedagogical experiments of the dissertation are presented. They make a very good impression because they are long-term. The PhD student worked with three batches of students from 2004, 2012 and 2020. She observed the development of students from the first two batches in the period from 5th to 12th grade, which is very long-term analysis and is rare for PhD dissertations. From this part of the research I would determine that she shared very valuable practical experience.

Methods for competitions preparation are described. In relation with the aim of the research, the results of a survey are shared. It was concluded that early inclusion in mathematics schools had a significant impact on educational achievements, professional and life realization. I accept the conclusion as correct.

Chapter Four is entitled *Systems of tasks*. It shows two didactical collections of math problems. They are focused on work with talented students from 2^{nd} to 5^{th} grade are they are substantial contribution from the author. Most of the problems are already published in different books. The PhD student is a first author on these collections and they are among those cited as related to the dissertation. Solutions are also shown for some of the tasks, in which stands out the author's aspiration to purposeful support of logical thinking.

The special emphasis on the stimulation of mathematical modeling in the second system makes a very good impression. Although the author does not emphasize in the text, I have the opinion that precisely such tasks help a lot to overcome some of the problems in the transition between 4th and 5th grade, which are outlined in the second chapter. I believe that the didactic systems of tasks are structured correctly, fully respecting the methodical principle of gradual (stepwise) complexity. It would be appropriate if the tasks were accompanied by methodical notes for the teachers who will eventually use them. Unfortunately, such methodological notes are not provided within the dissertation.

Chapter Five is entitled *Assessment of mathematical talent*. One of the focuses that is set is the evaluation of the individual contribution of participants after teamwork. This is interesting problem which is being worked on by numerous researchers. I would recommend that it should be highlighted in the Introduction – this chapter was not properly announced anywhere before this, which leaves it a bit disjointed from the rest of the dissertation. At the same time this chapter is innovative and important for the thesis. I consider this part of the dissertation to be very valuable. It is no coincidence that the article, which is published in an IEEE publication and is indexed in Web of Science, is the one related to it. I consider the proposed model for internal redistribution of points in teamwork according to the personal contribution of the participants as appropriate. It is described very well. I believe that the conclusions drawn from the conducted experiment are presented correctly.

The Conclusion correctly reflects the overall experiment. Total of 8 contributions are listed which are almost entirely applied-type by their nature. I generally agree with them, but I think there could use some fine tuning. For example, contribution 6 has a large intersection with contributions 2 and 3. This should not occur. Regarding contribution 7, I am convinced that methodological developments around didactic systems of tasks are indeed practically realized (at least because these tasks were used in practice), but such are not shown in the text of the dissertation and therefore such contribution should not be highlighted. I would recommend that the dissertation be expanded with the addition of the mentioned methodological developments – possibly as an additional appendix.

4. Approbation of the results

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

There is no proven plagiarism in the submitted dissertation and scientific publications.

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. I would like to point out that in the English version it is proper to translate or transliterate the Bulgarian bibliography, then add the clarification "In Bulgarian...". When citations are placed in the text, the author's transliterated name must be used.

6. Critical notes and recommendations

The dissertation is often written in the first person, for example when the author shares a personal experience. This is common for English and it is not necessarily bad, because it contributes to an easier highlighting of the personal opinion; however in Bulgaria it is generally accepted that scientific texts are written in an impersonal form, i.e. the text could be edited in this regard.

On the first page, in the Introduction, a text from the Ministry of Education and Science website is quoted and the link is noted in brackets. It is more appropriate to make a reference to used literature. Immediately after, there is another similar reference.

On page 5 a reference is made to a book entitled "Test Your Child's Intelligence" but it is not marked as a bibliography. It should be added.

For the source "Gospodinov, B., Sarieva, J., etc." the year of the publication is missing (I think it is 2013). It is also not indicated when cited. In addition, this book contains many texts which are borrowed from *Bizkov, G. H., & Kraevski, V. V. (2002). Methodology and methods of pedagogical research. University Press "St. Kliment Ohridski"*. I think that referencing that source must be considered as well.

In the approbation of the proposed method in Chapter 5, it is said that the teamwork scores were compared with other student scores and they *did not differ much*. Such a description is very unsatisfying – it would be good to compare the estimates using a statistical hypothesis testing method to see if they are statistically the same.

The quality of the raster images in Appendix 2 is not good.

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 Iliana Ivanova Tsvetkova 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: 06.03.2024 Reviewer: .....

Assoc. prof. Philip Petrov Petrov, PhD

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