SHORT REVIEW

on a PhD thesis for awarding an educational and scientific degree "Doctor of Phylosophy"

higher education field: 1. Pedagogical sciences

professional field: 1.3 Pedagogy of teaching ...

doctoral program; Methodology of Physics education,

according to the procedure of the Faculty of Physics, Sofia University "St. Kliment Ohridski"

The review has been prepared by associate professor Ginka Kalcheva Exner, PhD, Plovdiv University Paisii Hilendarski, city of Plovdiv, as a member of the scientific jury, according to Order No. РД 38-617 / 20.11.2023 of the Rector of Sofia University.

PhD topic: **Comparative analysis of atomic physics educational content in different countries**

Author: **Konstantin Plamenov Ilchev**

I. General description of the presented materials

1. Description of the submitted documents

The candidate Konstantin Plamenov Ilchev has submitted a Dissertation and an Abstract (in Bulgarian and English languages), as well as the mandatory tables, required by the Faculty of Physics (2) according to the Regulations on the terms and conditions for awarding scientific degrees and holding academic positions at Sofia university "St. Kliment Ohridski". There 7 other documents (application for admission to preliminary defence, protocol preventing from plagiarism and originality of the dissertation, orders for enrolment and end of the PhD study, CV, document for successfully passed exams). Full texts of all scientific papers, concerning the PhD thesis, are also available.

The documents presented by the candidate meet the requirements of the Law on the development of the academic staff in the Republic of Bulgaria, the Regulations for the implementation of the Law on the development of the academic staff in the Republic of Bulgaria and the Regulations for the terms and conditions for awarding scientific degrees and occupying academic positions at SU "St. Kliment Ohridski".

2. Information about the candidate

Konstantin Plamenov Ilchev is awarded an IBO in Sweden. Then he became Bachelor and Master in theoretical physics in Austria. He also holds a second master degree - in Metodology of teaching physics and astronomy, with a qualification “teacher”. In 2000 he stared his PhD study.

The education and language skills in English and German of Mr. Ilchev show the potential for successful work on his PhD thesis.

3. General characteristic of the scientific achievements of the candidate

Curriculum content and teaching methods are the essential components for achieving effective education. The change in our way of life related to the introduction of new technologies; the vast amount of knowledge about the world; and the labour market require continuous updating of the educational content and in finding pedagogical approaches to achieve optimal educational results. In addition, the downward trend of the Bulgarian students’ performance in some international studies on the level of competences puts the focus on reconsidering the educational content and teaching methods in Bulgarian schools.

Guided by the above mentioned, the doctoral student aims to make an international analysis, from which to draw conclusions about the volume and content of the educational content and to find applicable pedagogical methods to achieve an effective educational process in atomic and subatomic physics in Bulgaria. The object of the research is mainly high school students from a general education school (in this case a private language school) studying atomic and subatomic physics within the subject "Physics and Astronomy" as a compulsory or elective.

The goal has been achieved by means of:

• **Comparative analysis of the educational content** through the approaches in "Comparative Education" finding certain content indicators, key features, and specific aspects of the analysis. A mainly statistical approach has been used. The comparisons made are mostly of a horizontal type. Available programs in our country and in different countries, international studies and scientific publications have been included in the research;

The candidate performs a deep and critical analysis of PISA and TIMSS research results. Thanks to the wide scale and representativeness of these studies, a real opportunity is given to compare the educational results of students from a large number of countries in the context of building scientific literacy. Based on this initial analysis, 9 countries have been selected for comparison, for which sufficient data have been collected on all analysed aspects and which meet certain criteria, such as being in the top rankings in the PISA and/or TIMSS studies and being comparable to Bulgaria (by geographical location, population, or economic level of development). These criteria, according to the author, are met by: Bulgaria, Slovenia, Poland, Estonia, Singapore, Lithuania, Norway, Canada (Alberta), Australia (Queensland) and Japan.

In the course of the presentation, it becomes clear how complex the problem of comparative analysis is, considering the peculiarities of the educational programs, the name of the subject and its type (compulsory or optional), the types of schools, the presence or absence of optional subjects, etc. in the countries studied. However, Mr. Ilchev skilfully handles the available information and manages to systematize it well and present it in an appropriate way.

Based on the analysis, it was concluded that in the other studied countries, some of the topics of atomic and subatomic physics, presented in the Bulgarian school, are either not included or additional hours are provided for them. It has been hypothesized that perhaps the goal is to cover fewer topics, but to deepen or build upon certain concepts and permits more time for practice or consolidation of what has been learned. The hypothesis is also based on formulation of the expected learning outcomes;

• **Analysis of proactive pedagogical methods and techniques that engage students' attention and have a positive effect on their results**. An appropriate search in different scientific databases has been performed. The analysis includes publications that meet 6 criteria, identified by Mr. Ilchev. 17 different methods of student engagement have been defined, the presence of which has been tracked in the selected scientific articles.

Here, trends are drawn and specific engaging techniques (games, experiments, model building, data analysis, etc.) are listed. Attention has been drawn to the fact that statistical evaluation of results has rarely been done in the scientific researches;

• **planning and conducting a practical study in a Bulgarian school, the main purpose of which is to confirm the hypothesis of a connection between the variety of teaching methods on the success of students in studying topics on atomic and subatomic physics**. The survey has been extended to search the answers of 7 different questions. The final number of participants has been 48, from the 10^{th} grade of a private English high school, studying “Physics and astronomy” as a general education subject, with a norm of 2 hours per week. It is based on 4 lessons delivered with the same combination of methods, in 4 classes.

Here, properly is described the complete toolkit for conducting the research: developed learning content, teaching methods, student evaluation methods, methods for evaluating the achieved results.

The comparative analysis of the students' achievements have been made based on the results of a student test group before and after the classes (at each lesson, as well as in total after the training), using parametric and non-parametric statistical evaluations.

The author concludes that the hypothesis is confirmed, but the sustainability of knowledge is short-lived, and some concepts still remain unclear. It was speculated that extending the time to work on them would have a positive effect.

In conclusion, Mr. Ilchev expresses the opinion that, based on the obtained results, a revision of some relatively abstract and conceptually difficult topics, which require more time to be mastered, can be considered. He is of the opinion that more in-depth consideration of fewer topics should be preferred. He makes a proposal for the introduction of interdisciplinary "modules" within the physics program, in the first lower secondary school stage, during which proactive teaching methods would be implemented.

Mr. Ilchev correctly acknowledges that the research done here is limited, especially in terms of participants' number and research duration and considers it necessary that his hypothesis and results need to be confirmed by further large-scale researches.

4. Analysis of the content of the scientific and applied research achievements of the candidate, as given in the materials for participation in the competition

The dissertation thesis is structured according to the general requirements for such a scientific work, containing: introduction, 3 main chapters, conclusion, contributions of the author, list of publications and participations in conferences, literature, and one appendix.

The research is based on 86 primary and 8 additional literary sources, and shows thoroughness in the development of the topic and the author's ability for independent scientific research.

The dissertation has scientific and applied-scientific contributions. They can be summarized as follows:

1) Development of a methodology and preparation of a comparative analysis of educational content in atomic and subatomic physics in different countries;
2) Creating a methodology and conducting an analysis for proactive pedagogical practices in the teaching of atomic and subatomic physics;
3) Design of a complete toolkit and implementation of a study in a Bulgarian school to confirm the hypothesis of an influence of the variety of teaching methods on the educational achievements in the study of atomic and subatomic physics.

The author of the dissertation presented a list of 8 publications, of which:

- 2 in journals with an impact factor (*Bulgarian chemical communications*);
- 6 in journals, included in the National reference list.

According to the requirements, 30/n points are awarded for publications in a journal with an impact factor, and 10/n points are awarded for publications from the National reference list, where n is the number of co-authors. The national requirements are to collect 30 points, and the calculation shows that the final total of the candidate's points is 61.43 points, which significantly exceeds the requirements.

The author of the dissertation is the first author in 5 of the publications, and in three of them he is the sole author. All 5 publications represent papers with a significant contribution of the candidate. According to this criterion the candidate considerable exceeds the requirement of 1 publication with a substantial contribution.

Mr. Ilchev has presented a list of 8 participations in conferences, with a requirement imposed by the faculty of 1 number of participations.

From the analysis, it is clear that the scientific publications included in the dissertation work meet the minimum national requirements (according to Art. 2b, paras.2 and 3 of the Law on the development of the academic staff in the Republic of Bulgaria) and, accordingly, the additional requirements of SU "St. Kliment Ohridski" for awarding an educational and scientific degree "Doctor of Phylosophy" in the scientific field and the professional direction of the PhD work.

According to the materials presented in the doctoral procedure, no plagiarism has been proven in the submitted dissertation and abstract.

5. Critical remarks and recommendations

I have no critical remarks on the scientific part of the dissertation. I would recommend the doctoral student to improve the style and to use the terminology, as it is established in the Bulgarian scientific community.

6. Personal impressions about the candidate

I do not know the candidate in person.

7. Conclusion

After having familiarized myself with the Dissertation, the Abstract and the other materials presented to me, and based on the analysis of their significance and the scientific and applied-scientific contributions contained in them, **I confirm** that the scientific achievements meet the requirements of the Law on the development of the academic staff in the Republic of Bulgaria and the Regulations for its application and the relevant Regulations of the SU "St. Kliment Ohridski" **for awarding the educational and scientific degree "doctor".** In particular, the candidate Konstantin Plamenov Ilchev meets the minimum national requirements in the respective professional field and no plagiarism has been found in the Dissertation, Abstract and scientific works, submitted for the competition.

I give my **positive** assessment of the dissertation.

II. FINAL DECISION

Based on the above statement, I recommend the scientific jury **to award** the educational and scientific degree "**Doctor of philosophy**" in Professional field 1.3. Pedagogy of teaching ... (DP: Methodology of Physics education teaching physics) of **Konstantin Plamenov Ilchev.**

14 / 01 / 2014 Reviewer: .....

Associate professor Ginka Exner, PhD

Note: *In case of discrepancies between the Bulgarian and English versions of the review, the Bulgarian version is to be considered.*