R E V I E W

on the dissertation of Lyudmila Marincheva Marinova-Boyadzhieva,
PhD student at the Department "Methodology of Biology Teaching" at the Faculty of Biology of Sofia University "St. Kliment Ohridski"

PhD Thesis: *A Concept of Developing Practical Skills in Teaching Biology in a Foreign Language* for the award of the educational and scientific degree "PhD", professional field 1.3. Pedagogy of Education in..... (Methodology of Biology Education)
Supervisor: Assoc. Prof. Dr. Aneliya Kremenska
Reviewer: Assoc. Prof. Dr. Stoyan Stefanov Stoyanov, Institute of Biodiversity and Ecosystem Research (Bulgarian Academy of Sciences), Department of Plant and Fungal Diversity and Resources

This review has been prepared and submitted on the basis of the Decision of the Faculty Council of the Faculty of Biology (Protocol 05/27.02.2024) and the Order RD-38-138/12.03.2024 of the Rector of Sofia University "St. Kliment Ohridski". It was prepared in accordance of the Development of Academic Staff in the Republic of Bulgaria Act (DASRBA), the Regulations on the Implementation of the DASRBA and the Rules on the Conditions and Procedure for Acquiring Science Degrees and Holding Academic Positions in Sofia University "St. Kliment Ohridski".

1. General characteristics of the dissertation

The dissertation has a total length of 331 pages, of which the main text is presented on 242 pages, structured as follows: Introduction (9 pages), Chapter 1 Methodological framework of the study (27 pages), Chapter 2 Review of existing literature on foreign language biology teaching and skill formation (79 pages), Chapter 3 Design for the formation of practical skills through practical tasks in biology in English (63 pages), Chapter 4 Analysis and interpretation of the results (56 pages), Chapter 5 Conclusion – findings, summaries, and contributions of the dissertation (5 pages).

The main text is well balanced, with the Introduction, Chapter 1 and Chapter 2 sections accounting for 47% of its volume. Chapter 3 and Chapter 4, together with the findings and conclusions, which are the original results and contributions of the PhD student, represent 53% of the main text.

The dissertation is well structured and amply illustrated, following the logic and methodology of pedagogical research. An extensive bibliographic reference was used in its development, including 239 titles (95 in Bulgarian, 139 in foreign languages and 5 internet sources). The literature data have been thoroughly analyzed and interpreted, focusing on the problems of the Dissertation, which is a prerequisite for the qualitative performance of the set tasks. A total of 60 figures and 12 tables are used to illustrate the results and practical tasks. The appendices to the Dissertation total 78 pages.

The abstract attached to the defense documentation is 56 pages and includes: table of contents, presentation of the main stages and results of the dissertation, conclusions, contributions, conclusion, bibliography and list of publications related to the dissertation.

2. Analysis and discussion of the main results of the dissertation

The development of the current subject of the Dissertation is stimulated both by the growing need for rapid mastery of foreign languages and by the need for change in traditional forms of learning associated with the entry of new technologies and the possibilities of working in an electronic environment. This calls for the development of a new type of learning environment, which requires the improvement and adaptation of teaching concepts and methods and changes in the training and motivation of teachers. Last but not least, successful teaching of Biology is also linked to the modernization of facilities in schools, as experimental tasks arouse high interest in high school students and have the greatest educational effect.

In the Introduction, the PhD student Lyudmila Marinova-Boyadzhieva convincingly motivates the choice of the topic by analyzing the existing shortcomings in the teaching of Biology and notes that the emphasis is usually placed on the theoretical part. She highlights as the most important challenge the integration of practical tasks in biology teaching, which, according to her, has the following advantages: Improving language skills, Stimulating international education and career development, Integration in world scientific achievements, Better understanding of biological processes and Increasing motivation and interest in Biology.

In Chapter 1 *Methodological framework* of the study, the theoretical and practical objectives are clearly structured and defined to answer the main research question: *How can practical skills in biology, taught in English, be developed in students at the first high school stage, with a focus on their scientific literacy?* This sets the framework and relevance of the problem that is the object of the research and formulates the working hypothesis. This chapter also describes the basic skills that are expected to be acquired by the high school students, which defines the *Subject and Tasks* of the doctoral student in the process of methodological research.

In Chapter 2, the PhD student conducts an in-depth review of the existing literature in relation to biology education, in particular the formation of practical skills and science literacy, as well as the existing experience of teaching in a digital environment. The critical analysis of the educational process and the assessment of advantages and disadvantages is an important starting point for the implementation and achievement of the aims and objectives of the dissertation.

The main results, analyses and interpretations are presented in Chapter 3 and Chapter 4. The dissertation focuses on the application of best practices and innovative approaches in teaching biology in English, aimed at forming practical skills in students and increasing their interest in the discipline of Biology and in natural sciences in general. The PhD student has skillfully used the COVID-19 situation in the period 2020-2022 to create and test several practice-oriented exercises, one part of which adapted for implementation in an electronic environment. She has been able to stimulate student activity, both in their participation in independent work tasks and those for class work.

Each of the practical tasks is accompanied by instructions in English, which helps to increase students' scientific literacy, including their understanding and interpretation of scientific information. The acquisition and application of scientific terminology by high school students is a key element in their further development and continuation of their education in universities with biology majors. In the biological sciences, experimentation, skills in analyzing scientific information, and critical thinking are important in the formation of science literacy. It is these elements that are addressed in the educational concept of the PhD student Marinova-Boyadzhieva. Her creative approach to teaching biology is a first step towards awakening and retaining interest in science, as the formation of scientists is a long process and it should begin in high school.

The PhD student has introduced a variety of practical tasks in the training, and those with an experimental focus have the greatest success. The task "Home Laboratory - Mini Ecosystem" has aroused the interest of both students and parents. This task develops the students' observational skills to describe the state, observe and analyse the natural processes of the mini ecosystem. Moreover, in this experiment students can learn about plants found in Bulgaria and select suitable species to introduce into their mini ecosystem. The task creates skills in students to work individually, in a home environment and is particularly suitable in emergency situations. Experimental work in class, as the PhD student pointed out, is usually conducted in groups, whereas in this experiment each student is given the opportunity to participate and learn the issues of the research. The practical task "DNA extraction" also provides an opportunity for solitary work. Through it, students acquire competences related to the application of specific methods in the process of scientific research. In addition, in the process of the experiment, students are encouraged to seek further information about the structure of chromatin and the structure of the cell nucleus, where DNA is stored in eukaryotic organisms. Thus, they learn to handle different sources of scientific information, learn scientific terms and get into the details of the experiment, which then helps them to interpret the results.

The task "Microscopy with a compact digital microscope" allows students to observe specific biological structures, learn specific scientific terms and at the same time use specialized software and present the results in a digital environment.

The tasks "Modeling a biological object", "Crossword puzzle" and "Comic" are also very well chosen in the context of education in Biology. With their help, students learn scientific terminology and increase their scientific literacy. Crossword puzzles require the ability to explain a particular word in an appropriate way, and in this case students learn the essence of the scientific term and enrich their language skills in defining the questions. Modeling biological objects helps to recognize and analyze different structural components of living organisms and to identify cell types: prokaryotic, eukaryotic, plant, animal. In addition, modelling forms creative thinking about the selection of materials and the way of presenting the results.

3. Contributions of the dissertation

The PhD student demonstrates significant research skills, both in the selection and application of appropriate and contemporary pedagogical methods, and in the analysis and

interpretation of data. She has skillfully combined theoretical principles and the implementation of specific practical tasks. The results are presented in a convincing manner, reflect the objectives and research question, are well structured and carry an element of originality. The dissertation presented, the conclusions drawn and the contributions that summarize the results achieved are entirely the work of the doctoral candidate.

The results of the dissertation work provide a large number of contributions, both of theoretical-methodological and practical-applied significance, some of them are original and others confirm and improve the pedagogical approaches used. As the most important can be singled out the following:

- A conceptual framework for experimental learning has been established, effectively integrating the 4Cs model for CLIL into the educational context of the competency-based approach, with a focus on the development of practical skills.
- A design of practical activities for experimental biology teaching in a foreign language has been constructed for students in the first stage of secondary education to achieve competencies and enhance their scientific literacy.
- Twelve variations of six types of heuristic tasks have been developed to foster practical skills and achieve competencies in biology in English.

4. Critical comments, recommendations and questions

In Annex 2. Instructions for the practical task "Home Laboratory – Membrane Transport" (page 246) to Experiment 1, the following is stated:

Materials - a few flowers (stem and flower) of a plant with white petals...

I believe it is more correct to use the term "flowering stems", ie:

Materials - a few flowering stems (stem and flower) of a plant with white petals...

Similarly, in Annex 15 (page 271) instead of "a few flowers" it is better to use "a few flowering stems".

I would like to put the following questions to the PhD student:

- Which plant species are most suitable OR most used by students in the practical task "Home Laboratory – Mini Ecosystem"?

I would recommend that the practical task “Home Laboratory – Mini Ecosystem” be conducted under different conditions (in two versions) – under a natural lighting rhythm and under constant lighting (using artificial light at night), and to observe and analyze the differences in plant development.

- What other practical tasks with an experimental focus are you planning to introduce into biology education?

5. Published articles and participation in scientific conferences

On the the subject of the dissertation Lyudmila Marinova-Boyadzhieva has 3 articles published in non-refereed peer-reviewed journals or published in edited collective volumes and one published chapter of a collective monograph, which fulfills and exceeds the Minimum National Requirements in professional field 1.3. Pedagogy of Education..... In three of the publications the PhD student is an independent author. She has participated in one international and two national conferences, where she has also presented results of her thesis.

Conclusion

The analysis of the dissertation of Lyudmila Marincheva Marinova-Boyadzhieva reveals that the doctoral candidate has a thorough theoretical and analytical-applied knowledge in the scientific specialty “Methodology of Biology Education”, has the abilities and qualities to carry out independent scientific and experimental research. The results she achieved are distinguished by their originality. On the basis of the different research methods applied by the PhD student, the correctly derived experiments, the made generalizations and conclusions, I consider that the presented dissertation fulfills the requirements of the DASRBA and the Rules on the Conditions and Procedure for Acquiring Science Degrees and Holding Academic Positions in Sofia University “St. Kliment Ohridski”, which gives me grounds to evaluate it POSITIVE. I therefore recommend that my esteemed colleagues on the scientific jury award the Lyudmila Marincheva Marinova-Boyadzhieva educational and scientific degree “PhD” in professional field 1.3. Pedagogy of Education in....., scientific specialty “Methodology of Biology Education”.

10.05.2024 Reviewer:

Sofia Assoc. Prof. Stoyan Stoyanov