

OPINION

by **Dr Todorka Stefanova, Professor at A. Kanchev University of Ruse**

of a dissertation for the award of a **doctorate**

by: field of higher education.1.Pedagogical sciences

professional field 1.3. Pedagogy of Education in....

Doctoral Program Methodology of Biology Education

Author: .**Kalina Emilova Ivanova**

Topic: Formation of practical knowledge and skills in students through STEAM training /Biology and Health Education - 7-th Grade/

Scientific supervisor: Prof. Dr. Delka Vasileva Karagyozeva-Dilkova, University of Plovdiv “P. Hilendarski” .

1. General presentation of the procedure and the doctoral student

By Order No PD-21 of 8 July 2024 of the Rector of Plovdiv University ‘Paisii Hilendarski’ (PU), I was appointed as a member of the scientific jury for the provision of a procedure for the defence of a dissertation on the topic ‘Formation of practical knowledge and skills in students through STEAM training / Biology and Health Education – Grade 7 for obtaining the educational and scientific degree ‘PhD’ in the field of higher education 1. The author of the dissertation is **Kalina Emilova Ivanova**, a full-time doctoral student at the Department of Botany and Biological Education headed by **Assoc. Prof. Dr. Delka Vasileva Karagyozeva**

The paper, presented by Kalina Emilova Ivanova, is in accordance with Article 36 (1) of the Rules for the Development of the Academic Staff of the University, includes the following documents:

- a request to the Rector of the University for disclosure of the procedure for the defence of the dissertation;
- Curriculum vitae in European format;
- protocol of the Departmental Council related to the reporting of the readiness to initiate the procedure and to the preliminary discussion of the dissertation;
- dissertation;
- autoreferat;
- a list and copies of the scientific publications on the topic of the dissertation;
- copies of scientific publications on the subject of the dissertation;
- a declaration of originality and authenticity of the attached documents;
- reference of compliance with the minimal national requirements

The submitted package of documents in its entirety guarantees transparency of the procedure and objectivity of the evaluations. .

The educational status of the PhD student is a relevant and reliable guide for choosing the topic of the dissertation research: from 1992 to 1997 she completed a Master's degree in Biology and Chemistry at the “Paisii Hilendarski” University of Plovdiv; follow-up trainings for the acquisition of fifth, fourth and third professional qualification degrees from 2015, 2018, 2019-2020 at Sofia University "Kl. Ohridski" and PU "Paisii Hilendarski". Kalina Ivanova's continuous pedagogical work experience after completing her master's degree is noteworthy – from a teacher-lecturer at vocational schools, a teacher at “Tsar Simeon Veliki” Secondary School (as a graduate of her secondary school) and a teacher and deputy director of educational activity at “Yane Sandanski” Primary School. The educational status, the accumulated direct pedagogical experience and her career development, as well as the foreseeable professional interests in the STEM paradigm are a convincing certificate for the fact, that in the presented doctoral dissertation, not only knowledge and experience are synthesized and summarized, but also the overall research vision of the candidate.

2. Relevance of the topic

The topicality of the topic is multi-layered - from global to private methodological nature, which is successfully perceived by the doctoral student in the introduction, in the content and in the appendix to the dissertation:

- the need for a workforce with competences for creativity and creative problem-solving abilities in the 21st century technology-driven economy and work environment;
- the need to compensate for deficits in the educational environment in all its components in order to shape 21st century skills;
- up-to-date methodological model and its deployment in STEAM units of scientific and applied nature for the education in Biology and Health Education - Grade 7

3. Knowledge of the problem - outputs in several aspects

- The first aspect - the doctoral student has understood the place of some real problems, on the basis of which should be the context of STEM learning situations: antimicrobial resistance and the search for a solution to treat bacterial infections; the methods used in microbiological research and the possibility of engineering design - a prototype model for a microbiological laboratory; issues of the 2021 Covid-19 pandemic critical situation. Knowledge of the cited real problems and others are implanted in the STEM lessons developed in the dissertation.
- Second aspect – knowledge of the normative documents for the educational process in Biology and Health Education – 7th grade; the indicative distribution of the lesson units in the approved textbooks in 2018 and in a comparative perspective conceptualizes the learning scenarios and its STEM lessons.
- Third aspect - analytical and separate reading by categories

- 27 definitions of STEAM training directs the doctoral student to an author's definition adequate for the purposes of the study. Points of reference in this definition: active learning process; application of integrated knowledge with the inclusion of technological engineering practices for the creation of abstract and concrete artifacts in solving real problems.

The knowledge of the problem is also proven by the list of 140 literary sources, of which 38 in Cyrillic, 78 in Latin and 24 Internet sources.

4. Methodology of the study

The research methodology derives from the correctly described design of the pedagogical research in two logically related components - organization, planning and conducting the research.

The research methodology is relevant to the constructed research hypothesis in its two parts. The first part restrains the pedagogical conditions, namely the application of a methodological model for STEAM training in biology and health education in 7th grade. The second part is in the expected results, namely increasing the level of formation of practical knowledge, skills in biology and health education, increasing motivation and developing 4 C skills of the 21st century. The proof of the hypothesis is in the third chapter of the dissertation.

The tools for measuring results (criteria tests / pre-test and post test/, surveys / attitude poll to STEAM lesson and self-assessment survey/) are based on a well-established system of criteria and indicators. At the heart of the system are the criteria with rank of categories from the taxonomy Bloom, as revised by Andersson and Kratoul: remembering, understanding, applying, analyzing, evaluating, creating. The construction of each of the questions in the 2 thematic tasks in the pre-test and the 4 thematic tasks in the post-test have semantics, synchronized with the 9 indicators, from which 7 summary indicators of success in terms of practical knowledge and skills are derived. Tables 11 and 12 in the text of the dissertation provide an overview of the focus of the tasks in the two tests and the surveys on the developed system of criteria and indicators, and in the annex to each test is supplemented as a test specification. The test toolkit has been implemented in several construction steps: aposterior analysis of the questions to the tasks by difficulty index; discriminatory force; and the efficiency of the distractors ; an assessment of the meaningful validity of expert judgements ; Approbation of the developed diagnostic tools in the preliminary experiment of conducting the study. It would be appropriate in chapter two to optimize the text for the theory of the test toolkit for difficulty index, discriminatory force, leaving only the result of their application, as is done in the analysis. The system of criteria and indicators is convincing in the evidence-based pedagogy of the dissertation for the results of the pedagogical impact of STEAM training, discussed in the third chapter of the dissertation.

With accurate statistical status for the study are the used specialized software product for social research IBL SPSS, version 27.0 , MS EXCEL, 2022 for accurate preparation of the data for

analysis and the assumed critical level of significance in checking the null hypothesis - 0.05 with a probability of 95%. The statistical methods used are descriptive, variational, graphical, single-factor dispersion analyses, non-parametric tests of Kolmogorov-Smirnov and Man Whitney, Kronbach alpha coefficient.

.5. Characteristics and assessment of the dissertation and the contributions

The structure of the dissertation is in introduction, three chapters, conclusion and outcomes, contributions, publications on the topic, bibliography and 6 annexes. The total volume is 245 pages, of which 166 are main text, of which 50 p. is the first chapter; 36 p. is the second chapter, 68 p. is the third chapter. 58 tables and 63 figures are included, as part of the tables are illustrated synchronously with their respective figures. The appendices are 55 pages long.

In terms of content, the three chapters of the dissertation are in a well-founded and clearly understandable logical connection. The first chapter outlines the theoretical framework for the training models for STEAM integration. In two of the paragraphs of the first chapter, phases are described in detail, the adaptation of which in Bulgarian methodology and practice is the basis for constructing a methodological model for the implementation of STEAM training in biology and health education for 7th grade. It is estimated that the model is influenced by the closest models justified in the theoretical framework.

The model with its stages - motivation, experiment/study, explanation, application of integrated STEAM knowledge and skills, evaluation is set out in Chapter 2 as a basic and final experiment for active pedagogical influence on the experimental and control groups studied in Primary School "Yane Sandanski", Plovdiv. The model is realized for the purpose of the experiment in a module of 6 combined STEAM lessons and 1 lesson - STEAM project. As a pedagogical practice in the specifics of the model, the doctoral student sparingly for the main text of the dissertation, but sufficiently presenting the stages of the model, presents one of the STEM lessons - "1,2,3 bacterium moves!" and the other 6 lessons are presented in Appendix 1. The attractive titles of the topics, the complete set of didactic materials for each of them and the detailed methodological developments, are reliable facts about the empirical dissertation research conducted and its commitment to the STEM idea as an emotion and essence and the contributions made.

The third chapter focuses on diagnostic measurements in order to identify the changes that have occurred as a result of the pedagogical impact, in order to establish the research hypothesis. With reliable tools are determined experimental / EG / and control group / CG / by testing their entry level / pre-test / in both the main and the final experiment. :

- For the questions - average point ball in the four classes - 7 grade; average number of points and success rate for both groups;

- by indicators and criteria: success rate on the 9 indicators, on the 7 aggregated indicators and on the criteria.

Using the non-parametric Mann Whitney method for all the instruments listed, the doctoral student proved, that there was no statistically significant difference between the two groups in the input measurement, which confirmed the correct choice of the two groups in both stages of the experiment.

With a post-test as a tool , but with applied measurements as for the pre-test, the results of the two baseline groups for the main experiment and the final one were reported. The Mann Whitney test demonstrated statistically significant differences in the results of the two groups, thus proving the research hypothesis. An interesting point of view in the final experiment was made about the results in the EG pre-test for 4 indicators with greater success rate compared to the CG, which are for skills with a higher cognitive rank. Comparative Figure 53 between the pre-test and the post-test of the EG shows an increase in the success rate of the aggregated indicators, despite the higher input values, and for the CG it is a decrease in all indicators except for the ability to analyse. This confirms the trend of the basic experiment in the direction of the research hypothesis.

While confirming the contributions that the doctoral student has made to p. 166 in her dissertation, here I am adding others as scientific and applied and applied contributions:

- built context of learning STEAM situations on real problems, significant in biological science such as history, theory, practice and implanted in STEAM lessons. Thus, authentic, open, unstructured real-world problems give sense to the content studied.
- An inherent ontodidactic approach to constructing a learning content module for STEAM training in biology and health education – a logical sequence of topics and their content. The approach is based on the integration of engineering design EDP (context and concepts) and scientific research to make informed design decisions about the real problem. Thus the approach corresponds to a key characteristics of the STEM idea for context and conceptuality.

6. Evaluation of publications and personal contribution of the doctoral student

The doctoral student has attached copies of 5 publications in full-text format, without overlapping their content. The two publications are independent and are published in the scientific journal ‘Pedagogy’, one in issue 1 of 2024 and the second in issue 1 of 2025. Two of the publications are co-authored with the scientific supervisor, one published in ‘Education and Technology’, Volume 13/2022, and the other in the 2nd National Conference STEAM Education and Innovation, also in 2022. In 2023, in a school collection of 51 Elisaveta Bagryana Secondary School, the doctoral student has a joint publication on an integrated STEAM lesson in biology and health education and information technology, co-authored by the information technology teacher.

The content of the five publications reflects the developed and conducted STEM lessons and project, applied in the dissertation and I evaluate as a personal contribution of the doctoral student.

7. Autoreferat

The booklet is 32 pages long and has been published in Bulgarian and English. It is structured according to the mandatory requisites: title page, a summary of the main chapters, contributions , a list of publications and a bibliography. Selectively and accurately the selection of texts, tables, graphs is made so that the essence, methodology and main results of the dissertation research are presented.

8. Recommendations for future use of the dissertation contributions and results

It would be useful to apply the approach of building the content of STEAM lessons in the context of real problems in the field of biological science to STEAM training at secondary level in the subject "Biology and Health Education".

CONCLUSION

The dissertation contains scientifically applied and applicable results, that represent an original contribution to science and meet all the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria (ZRASRB), the Rules for the Implementation of the ZRASRB and the corresponding Rules of the Paisii Hilendarski University. The dissertation work shows that the doctoral student Kalina Emilova Ivanova has in-depth theoretical knowledge and professional skills in the scientific specialty 05.07.03 "Methodology of training" by demonstrating qualities and skills for independent scientific research.

Due to the above, I firmly give my positive assessment of the research conducted, presented by the above-reviewed dissertation, autoreferate, results achieved and contributions, and ***I suggest to the honorable scientific jury to award the educational and scientific degree "Doctor" to Kalina Emilova Ivanova*** in the field of higher education: 1.Pedagogical Sciences, professional field 1.3. Pedagogy of Education in.... Doctoral Program Methodology of Biology Education

14.08 2024

Drafted the opinion:.....

(Signature)

Prof. Todorka Stefanova, PhD

(N.A., *first name, last name*)