ABSTRACT
to the dissertation of Mussakhan Nurken Parsakhanuly
for the degree of Doctor of Philosophy (PhD) in Physics

Research topic:

Methodology of teaching energy in the school physics course based on interdisciplinary connections

The purpose of the study:

To determine the scientific and methodological foundations for teaching the topic of "Energy" in the school physics curriculum through interdisciplinary connections and to develop an effective teaching methodology.

Research objectives:

- Analyze contemporary issues in teaching topics related to energy in the school physics curriculum;
- Identify opportunities for using innovative methods and interdisciplinary projects in physics education as tools for deepening students' understanding of the concept of energy;
- Develop a methodological system for teaching energy based on interdisciplinary connections;
- Clarify the goals and content of the school physics curriculum when teaching energy topics through interdisciplinary links;
- Identify methodological features for deepening students' knowledge of energy in describing natural phenomena, and experimentally prove the effectiveness of the developed methodology.

Research methods:

The research employed both theoretical and empirical methods. Theoretical methods included analysis of scientific literature, comparison, generalization, and systematization to define the theoretical basis of the study. Empirical methods included experimental work, questionnaires, observations, interviews, student knowledge diagnostics, and statistical data processing. Additionally, practical activities were conducted to integrate digital technologies and STEM elements. These methods made it possible to evaluate the effectiveness of methodologies aimed at shaping students' energy-based perspectives when describing natural phenomena.

Scientific novelty and theoretical significance:

1. For the first time, a comprehensive set of methodological approaches for implementing interdisciplinary connections in teaching energy in the school physics curriculum has been developed;

2. A methodological system for teaching energy topics based on interdisciplinary connections has been created;

3. Through a pedagogical experiment, the effectiveness of using interdisciplinary connections in teaching energy has been identified, and methodological features have been clarified.

Practical significance of the research:

The research results served as a basis for developing methodological recommendations and tools aimed at forming students' energetic perspectives when describing natural phenomena in the school physics course. The proposed methods make it possible to enhance students' cognitive activity, scientific thinking skills, and practical abilities by using digital technologies, virtual laboratories, and simulations in the learning process. In addition, the research outcomes are applied in the creation of methodological guides for school teachers, as well as practical tasks and projects designed to deepen students' knowledge. This study can be implemented into pedagogical practice to update the content of the school curriculum, increase students' interest in the subject, and improve their ability to apply the acquired knowledge in real-life situations.

The key points of the dissertation to be submitted:

1. Implementing interdisciplinary connections when teaching energy in the school physics curriculum is one of the key methods for forming students' scientific worldview and developing their cognitive abilities. Integrating digital technologies and virtual laboratories into teaching the laws of conservation and transformation of energy contributes to deeper understanding of the material, development of practical skills, and strengthening of interdisciplinary connections.

2. The methodology for teaching energy topics through interdisciplinary connections aims to improve students' scientific and mathematical literacy. It is implemented through interdisciplinary integration, STEM-education technologies, and project-based learning methods.

3. The research results demonstrate that methods aimed at developing students' ability to apply the concept of energy in practice increase the effectiveness of teaching physics. Implementing the developed methodological recommendations and tools into the educational process allows students to deepen their understanding of energy, enhance their scientific thinking skills, and increase their interest in physics.

Validity and reliability of the research results:

The validity and reliability of the research results are ensured by a solid theoretical and methodological foundation, reliance on scientific literature, and domestic and international experience. The methods used ensured objectivity and accuracy of the results. Experimental data confirmed the reproducibility of results and the effectiveness of the proposed methods. Moreover, the research results were tested in the educational process and supported by practical applications, which confirmed their applied significance.

The contribution of the doctoral student to the preparation of each publication (the contribution of the author of the dissertation is indicated, measured as a percentage of the total volume of the publication):

1. Effectiveness of Computer Modeling in the Study of Electrical Circuits: Application and Evaluation. *International Journal of Engineering Pedagogy (iJEP), 13*(4), pp. 93–112. https://doi.org/10.3991/ijep.v13i4.34921 (Percentile – 83). (Co-authors: Dosymov, Y. ., Usembayeva, I., Polatuly, S., Ramankulov, S., Kurbanbekov, B., Mintassova , A.) Share of doctoral student – 30%

2. Impact of Phenomenon-Based Learning on High School Physics Education in Shymkent, Kazakhstan. Qubahan Academic Journal, 4(4), 225–236. https://doi.org/10.48161/qaj.v4n4a1203 (Percentile – 79). (Co-authors: Ualikhanova , B., Ormanova, G., Berdaliyev, D., Anas , B., Güdekli, E.) Share of doctoral student – 30%.

3. Н.П. Мұсахан, «Білімгерлердің физикалық есептерді шығаруда «энергетикалық» әдісті қолдану қабілеттерін жетілдіру». «Қазақстанның ғылымы мен өмірі» №12/7 (153) 2020 ж. 351-354 бб. https://www.naukaizhizn.kz/index.php/journal/article/view/112/112 (Co-author: Тұрмамбеков Т.А.) Share of doctoral student – 80%.

4. «STEM жобалық оқытудың болашақ физика мамандарын даярлаудағы ерекшеліктері». ҚР ҰҒА Хабарлары. Физика-математика сериясы, (2), 2023 193–207. https://doi.org/10.32014/2023.2518-1726.193 (Co-authors: М.Нуризинова, К.Келесбаев, Ш.Раманкулов, А.Паттаев). Share of doctoral student – 30%.

5. «STEM - мектеп физика курсының «Энергия» ұғымын қалыптастырудың технологиясы ретінде». Абай атындағы ҚазақҰПУ Хабаршы «Физика-математика ғылымдары» сериясы. 83, 3 (Вер 2023), 237–245. https://bulletin-phmath.kaznpu.kz/index.php/ped/article/view/1491/901 (Co-authors: Раманкулов, Ш., Битибаева, Ж., Курбанбеков, Б., Паттаев, А.). Share of doctoral student – 30%.

6. «Білім, ғылыми орта және өндіріс интеграциясы: STEM зертханасында өнімдер әзірлеудің әдістемелік ерекшеліктері». Абай атындағы ҚазҰПУ Хабаршысы. Физика-математика ғылымдары сериясы. 87, 3 (Вер 2024), 287–295. DOI:https://doi.org/10.51889/2959-5894.2024.87.3.024 (Co-authors: Раманкулов, Ш., Битибаева, Ж., Курбанбеков, Б., Берди, Д.). Share of doctoral student – 80% .

7. «Teaching physics: developing students' problem solving skills» “International Association of publishers”, 3. Pearson Journal International Conference on Social Sciences & Humanities. October 26-27, 2021 y. Kapadokya – Turkey . p. 642-643. (Co-author: T.A. Turmambekov.). Share of doctoral student – 80%.

8. «Орта мектептерде ғылым тарихы мен философиясы тұрғысынан «Энергия» ұғымын оқытудың әдістемелік ерекшеліктері» «Физикадағы заманауи тенденциялар: Ғылым мен білім интеграциясы» Халықаралық ғылыми конференциясының материалдары 23 ақпан 2024 жыл. Share of doctoral student – 100%.

9. «Fen bilimleri ve mühendislik alanlarında STEM eğitiminin güncel durumu» «4. International Selçuk scientific research and innovation congress» ISARC International Science and Art Research Center 24-25 August 2024, Konya online presentations. P. 368-384. (Co-authors: B. Kurbanbekov, Ş. Ramankulov, A. CORUH). Share of doctoral student – 80%.

10. «Физикадан STEM тапсырмалар жинағы»-Шымкент: «Нұрлы бейне» баспасы. -2025. –Б. 96. (Co-authors: М.К. Түйебаев, К.Н. Келесбаев, Ш.Ж. Раманкулов.). Share of doctoral student – 60%.