ANNOTATION

dissertation on the topic «Methodological features of teaching the course «Alternative Energy Sources» to future physics specialists in the context of STEM education» for the degree of Doctor of Philosophy (PhD) in the specialty «6D011000 – Physics»
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Research topic: Methodological features of teaching the course "Alternative Energy Sources" to future physics specialists in the context of STEM education.

The purpose of the study: Theoretical justification for teaching the course "Alternative Energy Sources" to future physics specialists in the context of STEM education, development of a teaching methodology, and experimental verification of its effectiveness and specific features.

Research objectives:

1) Analysis of the current state of training future physics specialists for research activities;

2) Identification of the features of teaching the course "Alternative Energy Sources" in the context of STEM education;

3) Development of a methodological system for teaching the course "Alternative Energy Sources" to future physics specialists in the context of STEM education;

4) Analysis of the results of the pedagogical experiment aimed at proving the effectiveness of the developed methodological system.

Research methods:

The study employed a comprehensive approach using methods at theoretical, empirical, pedagogical, and statistical levels. Theoretical methods focused on identifying the theoretical foundations of teaching alternative energy sources and developing research activities of future physics specialists through the analysis of scientific literature, regulatory documents, and methodological materials. Empirical methods, such as observation, surveys, interviews, and pedagogical experiments, made it possible to collect data on the effectiveness of the methodology for forming students' research activities. Pedagogical methods ensured a modern organization of research activities by integrating the STEM approach and digital technologies into laboratory work and project-based assignments. Statistical methods were used to conduct quantitative and qualitative analysis of the collected data and to confirm the effectiveness of the methodology by comparing the results of the experimental and control groups.

The main provisions recommended for protection (proven scientific hypotheses and other conclusions that are new knowledge):

The results of the conducted research, as confirmation of the scientific hypothesis, showed that the systematic application of research-oriented methods and innovative pedagogical technologies in the context of STEM education, when teaching the course "Alternative Energy Sources," significantly enhances the quality of education, scientific thinking, and research activity of future physics specialists.

In addition, the extensive use of STEM education tools (STEM project-based learning, STEM laboratories and products, stands) enhanced creative and engineering

thinking and made the content of the "Alternative Energy Sources" course more practice-oriented and aligned with modern requirements.

The main results of the study:

1) Content-related features of teaching the course "Alternative Energy Sources" in the context of STEM education and its connection with the research activities of future physics specialists.

2) The methodological system for teaching the course "Alternative Energy Sources" to future physics specialists in the context of STEM education and its coherence between goals, content, methods, tools, and learning outcomes.

3) Results of the pedagogical experiment confirming the effectiveness of the methodology for organizing the teaching of the course "Alternative Energy Sources" in the context of STEM education.

4) The methodology for using developed STEM products, research-based learning tasks, and STEM projects in the course "Alternative Energy Sources," which contribute to the formation of research activities among future physics specialists, along with scientific and methodological recommendations.

Substantiation of the novelty and significance of the results obtained:

the novelty of the first result – The features of forming research activities among future physics specialists during the teaching of the course "Alternative Energy Sources" in the context of STEM education have been identified.

the novelty of the second result – A methodological system for teaching the course "Alternative Energy Sources" to future physics specialists in the context of STEM education has been developed.

the novelty of the third result– The scientific foundations of the methodology for using STEM products, research-based learning tasks, and STEM projects in accordance with the content of the course "Alternative Energy Sources" have been presented.

the novelty of the fourth result – The effectiveness of preparing future physics specialists for research activities in teaching the course “Alternative Energy Sources” within the framework of STEM education has been confirmed by the results of the pedagogical experiment.

The scientific and methodological works published based on the results of the research can be used in higher education institutions, pedagogical colleges, and general education schools.

Compliance with the directions of scientific development or government programs:

The research direction directly aligns with the United Nations Sustainable Development Goals: Goal 4 – "Quality Education" and Goal 7 – "Affordable and Clean Energy".

According to the Order of the Minister of Science and Higher Education of the Republic of Kazakhstan "On the Approval of State Compulsory Standards for Higher and Postgraduate Education" (dated July 20, 2022, No. 2), the training of future specialists includes requirements for collecting and interpreting information, knowledge of scientific research methods and academic writing, as well as their application in the relevant field of study.

In the Address of the President of the Republic of Kazakhstan, Kassym-Jomart Tokayev, to the people of Kazakhstan dated September 1, 2023, titled "The Economic Course of a Just Kazakhstan," it is stated: "Over the past five years, the share of renewable energy in the total volume of energy produced in the country has increased by almost 5 percent. The implementation of renewable energy projects will continue. By 2029, key indicators related to energy consumption and losses must be reduced by at least 15 percent".

The research results contribute to the training of future physics specialists as engineering personnel focused on the field of green energy and also make a contribution to sustainable development and the formation of environmental culture through increased energy efficiency.

Description of the doctoral student's contribution to the preparation of each publication:

All publications were prepared during the research.

In a scientific journal indexed on the basis of Scopus and Web of Science:

1. Evaluation of the Effectiveness of Using STEAM Projects in Teaching Physics: Student Interest in the Field of Solar Energy//Qubahan Academic Journal, 4(3), - 2024. P.678–693. (Scopus). Q1 (co-authored by Genc N., Ramankulov S., Polatuly S., Tuiyebayev M., Usembayeva I., Rizakhojayeva G. The contribution of the doctoral student –50%)

2. Assessment of Student Creativity in Teaching Physics in a Foreign Language // European Journal of Contemporary Education, 8(3), - 2019. – P.587–599. (Scopus). Q2 (co-authored by Ramankulov Sh. Dosymov E. Mintassova A. The contribution of the doctoral student - 30%)

In publications from the list of the Committee for Quality Assurance in Science and Higher Education of the MSHE RK:

3. STEM жобалық оқытудың болашақ физика мамандарын даярлаудағы ерекшеліктері//Известия НАН РК. Серия физико-математическая, №2, - 2023. - Б. 193–207. (co-authored by Келесбаев, Қ., Раманкулов, Ш., Нуризинова, М., Мұсахан, Н. The contribution of the doctoral student - 30%)

4. Болашақ физика мұғалімдерін даярлауда 3D модельдеу технологиясын қолданудың ерекшеліктері//Абай атындағы ҚазҰПУ-ң хабаршысы «Педагогика ғылымдары» сериясы, №2(78), - 2023. - Б.172-181. (co-authored by Курбанбеков Б, Раманкулов Ш, Битибаева Ж, Усембаева И. The contribution of the doctoral student – 40%)

5. Физиканы оқытуда оқушылардың зерттеушілік іс-әрекетін қалыптастыру – заман талабы//Қазақстанның ғылымы мен өмірі, №5/2, - 2019, - Б.213-216. (co-authored by Ахмедов А., Турмамбеков Т. The contribution of the doctoral student - 80%)

6. STEM - мектеп физика курсының «энергия» ұғымын қалыптастырудың технологиясы ретінде // Абай атындағы ҚазҰПУ-ң хабаршысы физика-математика ғылымдары сериясы, 83(3), - 2023. Б.237–245.(co-authored byРаманкулов, Ш., Битибаева, Ж., Курбанбеков, Б., Мұсахан, Н. The contribution of the doctoral student - 30%)

Materials of the international and republican scientific and practical conference

7. The effectiveness of stem in teaching physics: an example of teaching solar energy // Proceedings of International conference fundamental and applied research in physics, Toshkent, - 2024. P.234-235. (co-authored by Ramankulov Sh,, Yavidov B., Dosymov Y. The contribution of the doctoral student - 50%)

8. Necessity and Methodological Peculiarities of STEM Projects Implementation in the Solar Energy Sector//Full texts book of 12th International Mardin Artuklu scientific researches conference, IKSAD publishing house Mardin, Turkiye, - 2024. – P.336-343. (co-authored by Kelesbayev K., Polatuly S., Ramankulov Sh. The contribution of the doctoral student - 60%)

9. The use of STEM laboratory equipment in teaching solar energy: the impact of students on improving educational and research work // Modern problems of coherent optics and laser physics. Halqaro ilmiy – amaliy anjumani ma'ruzalar to'plami. Toshkent, –2024. P.287-291 (co-authored by Chorukh A, Kelesbayev K. Ramankulov Sh. The contribution of the doctoral student - 60%)

10. Болашақ физика мұғалімдерін STEAM білім беру негізінде ағылшын тілінде оқытудың мазмұны//«Уәлиев оқулары-2022» Халықаралық ғылыми-тәжірибелік конференция материалдары, Өскемен,-2022. 435-441 (co-authored by Раманкулов Ш., Досымов Е. The contribution of the doctoral student - 50%)

11. Possibilities of using STEAMtechnology in teaching the physics of solar panels in English // Collection of the International Scientific and Practical Conference, Almaty, - 2023. P.127-130. (co-authored by Kelesbaev K., Ramankulov Sh. The contribution of the doctoral student - 60%)

12. STEAM жобасы: білім алушылардың күнэнергетикасы саласындағы ғылыми-зерттеушілік іс-әрекеттерін дамыту // «Білім мен ғылымды трансформациялау –адами капитал сапасын арттырудыңнегізгі факторы» «Аманжолов оқулары-2023» Халықаралық ғылыми-тәжірибелік конференциясының материалдар жинағы -2023. Б.370-376. (co-authored by Раманкулов Ш., Naci Genc., Полатұлы С. The contribution of the doctoral student - 70%)

13. Күн энергетикасы саласындағы оқу-зерттеу жұмыстарын жүргізу стендін әзірлеу және оны қолдану мүмкіндіктері//«Индустрия 4.0: Креативті студент» Республикалық конкурс материалдары, Түркістан, –2024. Б.210-215. (co-authored by Раманкулов Ш., Шүкірбай Б. The contribution of the doctoral student - 70%)

14. Физикадан лабораториялық сабақтарда білімгерлердің зерттеушілік іс-әрекетін қалыптастырудың ерекшеліктері // Jas ǵalymdar, magistranttar, stýdentter men mektep oqýshylarynyń «xx Sátbaev oqýlary» atty halyqaralyq ǵylymi konferensiasynyń materialdary, павлодар -2020. (The contribution of the doctoral student - 100%)

Educational and methodical manuals:

15. STEM and CREATIVITY. Оқу құралы. Shymkent: «Nurly Beine», - 2024. – 100p. (co-authored by Dosymov Y., Kurbanbekov B., Ramankulov Sh. The contribution of the doctoral student - 30%)

16. Күн энергиясын электр энергиясына түрлендіргіштердің физикалық сипаттамаларын зерттеуге арналған оқу-ғылыми стенді: Пайдалы модельге патент: тіркеу номер №9616. - Берілген күні: 10.04.2024. (co-authored by Раманкулов Ш., Курбанбеков Б., Келесбаев К. The contribution of the doctoral student - 30%)