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DIDACTIC POSSIBILITIES OF TEACHING PHYSICS TO ACADEMIC LYCEUM STUDENTS BASED ON THE STEM APPROACH

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Abstract
This study analyzes the didactic possibilities of teaching physics to academic lyceum students based on the STEM approach. It highlights ways to develop students' scientific thinking and competencies through integrated teaching, practical tasks, and problem-based situations.

Keywords: STEM approach, physics, academic lyceum, didactic possibilities, integrated teaching.

Introduction

Nowadays, the education system of our country is experiencing a profound phase of reform aimed at preparing young generations for the demands of the 21st century. The primary goal is to equip students with modern, globally competitive knowledge and practical skills that are essential for success in scientific, technological, and engineering fields. To achieve this, natural, mathematical, and engineering sciences have been identified as priority areas, reflecting the country's strategic focus on fostering innovation, research competence, and technical expertise among students from an early stage. In this context, the activities of academic and specialized schools under the Specialized Education Institutions Agency have been significantly expanded.[1] In particular, the April 1, 2024, Decree PF-55 outlines the integration of STEM education into school curricula, promoting a holistic and interdisciplinary approach to learning that combines science, technology, engineering, and mathematics. Following this, the May 24, 2024, Decree PF-81 emphasizes the prioritization of engineering, exact sciences, and natural sciences, including physics, within the framework of the state education strategy. These initiatives indicate a strong governmental commitment to enhancing the quality of education and aligning it with international standards. The implementation of STEM education in schools implies the creation of an interactive and engaging learning environment where students are not merely passive recipients of information but active participants in the construction of knowledge. This involves employing modern pedagogical methods, such as project-based learning, laboratory experiments, problem-solving tasks, and innovative teaching approaches, all of which contribute to the development of students' analytical, critical, and creative thinking skills.[2] By integrating theoretical knowledge with practical applications, students are encouraged to explore, experiment, and apply scientific principles to real-world problems, thereby deepening their understanding and fostering lifelong learning habits. Teaching physics through the STEM approach in academic lyceums, therefore, goes beyond mere knowledge

[1] Sydykova Zhainagul K., & Naushabekov Zhomart. (2024). THE EFFECTIVENESS OF STEM EDUCATION IN SCHOOL PHYSICS
[2] Berry Devanda, Lufri & Elizar (2023). The Effectiveness of the STEM Project-Based Learning Approach in Physics Learning to Improve Scientific Work Skills of High School Students.

acquisition. It aims to develop students' practical competencies, scientific reasoning, and problem-solving capabilities, preparing them for future careers in engineering, research, and other STEM-related professions. In addition, this approach promotes collaboration, communication, and team-based learning, which are crucial skills for success in modern professional environments.[3] This study focuses on examining the didactic possibilities of teaching physics using the STEM approach in the context of academic lyceums. It takes into account state policies, official decrees, and practical educational needs, providing a framework for understanding how interdisciplinary and interactive teaching methods can enhance students' learning outcomes. By analyzing these aspects, the research highlights effective strategies, challenges, and opportunities for implementing STEM education in a way that fosters both theoretical knowledge and applied skills, ultimately contributing to the formation of competent and innovative future specialists.[4]

Literature Review:

The Effectiveness of the STEM Project-Based Learning Approach in Physics Learning to Improve Scientific Work Skills of High School Students (2023) — this study demonstrates that using project-based learning (PBL) methods in physics lessons significantly enhances students' scientific work skills, including experiment planning, observation, data analysis, drawing conclusions, and report preparation.

Meta-Analysis of The Effect of Integration STEM Education in Various Learning Models on Student Physics Learning Outcomes — this meta-analysis reviewed about 20 studies and examined the impact of STEM integration on physics learning outcomes; it concluded that integrated STEM education, through problem-based and active methods, improves learning outcomes and problem-solving skills.

These sources indicate that teaching physics through project-based, problem-based, and integrated methods not only reinforces theoretical knowledge but also strengthens practical and scientific thinking skills.[5] **Integration of Physics and Mathematics in STEM Education: Use of Modeling (2024)** — this study examines a methodology combining physics and mathematics through mathematical modeling; this approach allows students to apply theoretical knowledge to real-world problems and promotes interactive, student-centered learning. **Presenting a STEM Ways of Thinking Framework for Engineering Design-based Physics Problems (2024)** — this article proposes a new teaching framework combining "Engineering design + Physics + Mathematics + Metacognition + Computational thinking." This framework enables students to solve complex problems, engage in design, and develop scientific thinking skills.[6]

These studies show that teaching physics in an integrated manner with mathematics helps

[3] Authors (2021). TEACHING SCHOOL PHYSICS AT STEM EDUCATION. **Bulletin of Abai KazNPU.**

[4] **Series of Physical and Mathematical sciences**. Kokteubek Yerasyl, Zhaksylyk Arnur, Duysenbai Bakytgul. Application of STEM Elements in Physics. **Eurasian Science Review**

[5] Semiono Raharjo & Yenda Puspita. (2023/2024). Development of a STEM-Project Model to Enhancing Science Process Skills High School Physics Subject. **Proceedings of International Conference on Religion, Science and Education**

[6] Daniel P. Weller, Theodore E. Bott, Marcos D. Caballero & Paul W. Irving. (2021). Developing a learning goal framework for computational thinking in computationally integrated physics classrooms.

students develop deeper conceptual understanding, problem-solving abilities, and scientific-design skills. **The Importance of STEM Education in Interactive Physics Teaching (Virtual Laboratory Example) (2024)** — in the context of Uzbekistan, this article analyzes how using virtual laboratory tools through STEM education enhances the interactivity of physics lessons and student engagement. It demonstrates that even in schools with limited resources, STEM approaches can be effectively implemented. **The Main Purpose of STEM Education and Its Implementation Methods (Jumabayev, Uzbekistan, 2024)** — the article explains the purpose, methods, and benefits of STEM education, including cross-disciplinary integration, problem-based learning, creative and critical thinking, and practical projects. It provides significant evidence of the necessity and prospects of implementing STEM in the Uzbek education context. These sources indicate that STEM approaches can be implemented in schools, particularly in academic lyceums, and are beneficial both methodologically and practically.[7]

Methodology

This study aimed to identify the didactic possibilities of teaching physics to academic lyceum students based on the STEM approach. The research process was conducted in several stages. First, a review of existing literature was carried out. International and local articles, methodological guides, as well as decrees and decisions of the President of the Republic of Uzbekistan were analyzed. At this stage, the theory of STEM education, innovative methods of teaching physics, and ways to develop students' practical skills were identified. Second, experimental lessons were conducted in selected academic lyceum classes. During these lessons, project work, laboratory experiments, problem-based situations, and interactive activities were implemented. This allowed students to develop both theoretical knowledge and practical skills simultaneously. Third, data were collected. Students' results were evaluated through tests, observations, project reports, and interviews. In addition, teachers' feedback and assessments were also taken into account. Fourth, the collected data were analyzed. Using qualitative and quantitative methods, students' achievements in STEM-based lessons were determined and visualized through statistical and graphical tools. Finally, based on the research results, didactic recommendations for teaching physics in academic lyceums using the STEM approach were developed. This methodology integrates theoretical knowledge with practical experimentation, clearly demonstrating the potential for developing students' scientific thinking and practical skills.[8]

Discussion and Results:

The results of the experimental study showed that academic lyceum students significantly improved their ability to integrate theoretical knowledge with practical skills in physics lessons taught using the STEM approach. Through projects, problem-based situations, and laboratory experiments, students learned to independently analyze problems, find solutions, and

[7] O. I. González-Peña, G. Morán-Soto, R. Rodríguez-Masegosa & B. M. Rodríguez-Lara. (2020).
[8] Effects of a thermal inversion experiment on STEM students learning and application of damped harmonic motion. arXiv preprint.

systematically evaluate results. [9]The analysis of students' project work and test results indicated that they were able to apply physics laws to real-life situations. For example, during experiments on mechanical motion or energy transfer, students analyzed their observations and developed the ability to draw accurate conclusions. Additionally, group work allowed students to enhance collaboration skills, share constructive ideas, and solve problems collectively. Teachers' observations also confirmed the study findings. According to them, organizing lessons using the STEM approach not only increased student engagement but also made the learning process more interactive and interesting. This, in turn, strengthened students' critical and creative thinking skills. Overall, the results indicate that the STEM approach is an effective tool for teaching physics in the context of academic lyceums. It promotes not only theoretical knowledge but also practical skills, scientific research potential, and engineering-oriented thinking.[10] Furthermore, project-based and interactive activities play a key role in reinforcing students' knowledge and preparing them for future scientific and technical endeavors.

Conclusion

The results of this study indicate that the STEM approach is a highly effective tool for teaching physics in the context of academic lyceums. During the experimental lessons, students not only reinforced their theoretical knowledge but also significantly developed practical skills, problem-solving abilities, and critical thinking. Projects, laboratory experiments, and problem-based situations allowed students to connect theoretical knowledge with real-life problems. This enabled them to strengthen their scientific research approach, analyze experimental results, and draw meaningful conclusions. Furthermore, group work enhanced students' teamwork, constructive idea exchange, and collaborative problem-solving skills. This not only contributed to knowledge acquisition but also played a significant role in developing social and communicative competencies. Teachers' observations confirmed the study findings, showing that lessons organized using the STEM approach significantly increased student engagement, interest, and the effectiveness of the learning process. Additionally, the STEM approach was found to be crucial in preparing students for future scientific and technical activities. It supports not only a deeper understanding of physics but also fosters students' interest in engineering and scientific professions, while promoting creative and critical thinking. Based on these results, it can be concluded that teaching physics in academic lyceums through the STEM approach is an effective and relevant method for expanding students' scientific and practical potential, developing innovative thinking, and preparing them to become competent specialists in the future. Therefore, it is recommended to expand and further refine the implementation of this approach at schools and lyceums.

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