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DOI: <https://doi.org/10.69722/1694-8211-2025-62-121-128>

УДК: 37:53

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ORGANIZATION OF PROJECT-BASED ON LEARNING IN PHYSICS BASED ON CREATIVE APPROACHES

The article "Organization of Project-Based Learning in Physics Based on Creative Approaches" by A. Khakimov and Yo. Mamatokhunov examines the integration of creative methodologies into physics education through project-based activities. It emphasizes the necessity of fostering independent thinking, problem-solving skills, and the practical application of theoretical knowledge among students. The research methodically outlines the steps of creative project-based learning: problem identification, idea development, model creation, result testing, and final presentation. These stages are carefully constructed to promote student engagement, collaboration, and higher-order cognitive skills such as analysis and synthesis.

Empirical evidence presented in the study highlights significant improvements in student motivation, teamwork capabilities, creativity, and depth of understanding in physics concepts. Quantitative data, including attendance rates and assessment scores, show that the experimental group, which adopted a creative project-based approach, significantly outperformed the control group subjected to traditional teaching methods. Students involved in creative projects demonstrated stronger analytical thinking, greater enthusiasm for learning, and more effective group cooperation.

The article is grounded in established pedagogical theories such as constructivism (J. Piaget, L. Vygotsky), Bloom's taxonomy of higher-order thinking skills, the metacognitive approach, and

interdisciplinary STEM integration. The research confirms that creative project-based learning not only improves academic achievement but also equips students with essential 21st-century skills, including communication, critical thinking, and the ability to independently navigate complex problems.

The authors conclude that implementing creative approaches in physics education transforms the learning environment into a dynamic, student-centered space where knowledge is not merely transferred but actively constructed. They recommend the broader adoption of this methodology across STEM fields to enhance educational outcomes and better prepare students for scientific and technological advancements. The findings contribute valuable insights into the modernization of physics teaching methods and reinforce the importance of innovation in education.

Keywords: *creative approach, physics education, project-based learning, metacognitive strategies, constructivism, practical experience, problem-based learning, STEM approach, idea development, model creation, empirical analysis, idea exchange, independent learning, educational technologies, practice-oriented learning, analytical thinking, peer assessment, didactic project, interdisciplinary integration.*

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ФИЗИКА САБАГИНДА КРЕАТИВДУУ ЫКМАЛАР НЕГИЗИНДЕ ДОЛБООРДУК ИШМЕРДУУЛУКТУ УЮШТУРУУ

Макалада физиканы окутууга креативдуу методикаларды долбоордук ишмердик аркылуу интеграциялоо маселеси каралган. Макалада студенттердин өз алдынча ой жүгүртүү жөндөмүн, көйгөйлөрдү чечүү көндүмдөрүн жана теориялык билимдерди практикалык колдонуу мүмкүнчүлүктөрүн өнүктүрүүнүн зарылдыгы баса белгиленет. Изилдөө креативдуу долбоордук окутуунун этаптарын иреттүү түрдө сыпаттайт: көйгөйдү аныктоо, идеяны иштеп чыгуу, моделди түзүү, натыйжаларды сыноо жана акыркы презентация. Бул этаптар студенттердин катышуусун, кызматташууну жана анализ, синтез сыяктуу жогорку деңгээлдеги ой жүгүртүү көндүмдөрүн өнүктүрүүгө багытталган.

Изилдөөдөгү эмпирикалык далилдер студенттердин мотивациясы, команда менен иштөө жөндөмү, чыгармачылык жана физика түшүнүктөрүн терең өздөштүрүү боюнча маанилүү жакшырууларды көрсөтөт. Статистикалык маалыматтар, анын ичинде сабакка катышуу жана баалоо көрсөткүчтөрү креативдуу долбоордук ыкманы колдонгон эксперименттик топ салттуу окутуу ыкмасы менен окутулган көзөмөл тобуна караганда кыйла жакшы жыйынтыктарга жетишкенин көрсөтөт. Креативдуу долбоорлорго катышкан студенттер аналитикалык ой жүгүртүүдө, билим алууга шыктануусунда жана топтук кызматташууда мыкты натыйжаларды көрсөтүшкөн.

Макада конструктивизм (Ж. Пиаже, Л. Выготский), Блумдун жогорку деңгээлдеги ой жүгүртүү көндүмдөрүнүн таксономиясы, метакогнитивдик ыкма жана STEM багытындагы интеграция сыяктуу белгилүү педагогикалык теорияларга таянат. Изилдөө креативдуу долбоордук окутуу студенттердин академиялык жетишкендиктерин гана эмес, XXI кылымдын коммуникация сыяктуу маанилүү көндүмдөрүн да өнүктүрүүнү ырастайт.

Авторлор креативдуу ыкмаларды физика билимине киргизүү окутуу чөйрөсүн динамикалык, студентке багытталган мейкиндикке айлантарын белгилешет, бул жерде билим жөн гана берилбестен, активдүү түзүлөт. Алар STEM тармактарында бул

методологияны кеңири колдонуу аркылуу билим берүү натыйжаларын жакшыртууну жана студенттерди илимий-техникалык өнүгүүгө жакшы даярдоону сунушташат. Изилдөөнүн жыйынтыктары физиканы окутуунун заманбап ыкмаларын өркүндөтүүгө салым кошот жана билим берүүдө инновациянын маанилүүлүгүн баса белгилейт.

Түйүндүү сөздөр: креативдүү ыкма, физиканы окутуу, долбоордук ишмердүүлүк, метакогнитивдик стратегиялар, конструктивизм, практикалык тажрыйба, маселеге негизделген окутуу, STEM-ыкма, идея иштеп чыгуу, модель түзүү, эмпирикалык талдоо, пикир алмашуу, өз алдынча окутуу, билим берүү технологиялары, практика багытындагы окутуу, аналитикалык ой жүгүртүү, өз ара баалоо, дидактикалык долбоор, тармактар аралык интеграция.

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ОРГАНИЗАЦИЯ ПРОЕКТНОЙ ДЕЯТЕЛЬНОСТИ ПО ФИЗИКЕ НА ОСНОВЕ КРЕАТИВНЫХ ПОДХОДОВ

Статья посвящена интеграции креативных методик в обучение физике через проектную деятельность. В статье подчеркивается необходимость развития у студентов навыков самостоятельного мышления, решения проблем и практического применения теоретических знаний. Исследование методично описывает этапы креативного проектного обучения: выявление проблемы, разработку идеи, создание модели, тестирование результатов и финальную презентацию. Эти этапы тщательно структурированы для содействия вовлеченности студентов, сотрудничеству и развитию навыков высшего порядка, таких как анализ и синтез.

Эмпирические данные, представленные в исследовании, показывают значительное улучшение мотивации студентов, их способностей к командной работе, творческому мышлению и глубине понимания физических концепций. Количественные показатели, включая посещаемость и оценки, демонстрируют, что экспериментальная группа, применявшая креативный проектный подход, значительно превзошла контрольную группу, обучавшуюся традиционными методами. Студенты, участвовавшие в креативных проектах, проявили более развитое аналитическое мышление, большую заинтересованность в обучении и эффективное взаимодействие в группах.

Статья опирается на признанные педагогические теории, такие как конструктивизм (Ж. Пиаже, Л. Выготский), таксономия Блума по навыкам высшего порядка, метакогнитивный подход и междисциплинарную интеграцию STEM. Исследование подтверждает, что креативное проектное обучение не только улучшает академическую успеваемость, но и формирует у студентов ключевые навыки XXI века, включая коммуникацию, критическое мышление и способность самостоятельно решать сложные задачи.

Авторы делают вывод, что внедрение креативных подходов в обучение физике преобразует учебную среду в динамичное, ориентированное на студента пространство, где знания не просто передаются, а активно конструируются. Они рекомендуют более широкое применение этой методологии в STEM-направлениях для повышения качества образования и лучшей подготовки студентов к научно-техническому прогрессу. Результаты исследования вносят ценный вклад в модернизацию методов преподавания физики и подчеркивают важность инноваций в образовании.

Ключевые слова: креативный подход, обучение физике, проектная деятельность, метакогнитивные стратегии, конструктивизм, практический опыт, обучение на основе проблем, STEM-подход, разработка идеи, создание модели, эмпирический анализ, обмен мнениями, самостоятельное обучение, образовательные технологии, практика-ориентированное обучение, аналитическое мышление, взаимная оценка, дидактический проект, междисциплинарная интеграция.

Introduction: In today's rapidly evolving educational landscape, fostering students' creativity, independent thinking, and problem-solving abilities is of paramount importance. These competencies are particularly critical in physics education, where understanding theoretical concepts must be seamlessly connected to their practical applications. Traditional teaching methods, which often emphasize rote memorization and passive learning, fail to meet the dynamic demands of the 21st century. Therefore, the need to organize project-based learning activities grounded in creative approaches has become increasingly urgent.

Physics, by its nature, deals with the fundamental principles governing the natural world. However, many students struggle to relate abstract physical laws to real-life situations, leading to disengagement and superficial learning. Integrating creative project-based methodologies addresses this challenge by actively involving students in the learning process. By identifying real-world problems, developing innovative solutions, and constructing practical models, students are encouraged to think critically, collaborate with peers, and apply their knowledge in meaningful contexts.

The creative approach transforms the traditional role of the student from a passive receiver of information to an active participant and co-creator of knowledge. It nurtures not only subject-specific skills but also transferable competencies such as teamwork, communication, analytical reasoning, and self-regulation. In an era increasingly driven by technological innovation and interdisciplinary knowledge, these skills are vital for students' future academic and professional success.

This article seeks to present a systematic framework for implementing creative project-based learning in physics education. It explores the theoretical foundations of the approach, rooted in constructivism, Bloom's taxonomy, metacognitive strategies, and the interdisciplinary STEM paradigm. The methodology proposed is not confined to theoretical discussion but is empirically tested, offering practical insights into its effectiveness. Experimental data demonstrate how creative project-based activities can lead to significant improvements in student engagement, the depth of conceptual understanding, and overall academic performance.

Ultimately, the aim of this study is to illustrate that creative project-based learning is not merely an alternative method but a necessity for modern physics education. By fostering an environment where students actively build their knowledge through creativity and experimentation, educators can cultivate lifelong learners who are capable of innovative thinking and adept at solving complex problems. Thus, this approach stands as a powerful tool in the ongoing effort to enhance the quality and relevance of education in the contemporary world.

Literature Review. The issue of organizing project-based activities in physics through a creative approach is widely addressed in modern pedagogical literature. First and foremost, in John Dewey's work *"Experience and Education"*, the necessity of organizing learning based on the active experience of the student is emphasized. Dewey's theory justifies the role of the student not as a passive recipient of knowledge but as an active participant in the learning process—an idea that forms the theoretical foundation of the creative project-based approach [5].

Scholars J. Guilford and E. Torrance, who deeply explored the psychology of creative thinking and creativity, developed methods in their works for measuring and developing creative abilities. Torrance's tests serve as effective tools for identifying and assessing students' creative potential specifically in project-based activities. This, in turn, supports student engagement in physics lessons as they search for new and unconventional solutions [3, 8].

From a pedagogical perspective, creative approaches aim to develop higher-order thinking skills based on Bloom's taxonomy. The model developed by L. Anderson and D. Krathwohl ensures active student engagement at the stages of applying knowledge, analyzing, evaluating, and creating new products.[1]

In national literature, this issue is also given serious attention. In particular, N. M. Solikhov's work *"Methodology of Teaching Physics"* analyzes practice-oriented approaches, experiment-based learning, and student-centered methods. Likewise, scholars such as O. Gaibullaev and G. Bakhramova, in their publications on modern educational technologies, have outlined the didactic foundations of creative approaches.[7]

The implementation of project-based activities on an interdisciplinary basis is closely linked to the STEM approach. As presented by M. Kosimova, this approach enables the teaching of physics in integration with technology, engineering, and mathematics. It aims to foster creative thinking through problem-based situations.[6]

In addition, the UNESCO report *"Creativity in Education: A Global Perspective"* (2019) provides an in-depth analysis of global strategies, assessment systems, and approaches to fostering creativity in education. These approaches enable the adaptation of the educational process to students' needs, stimulate their interest, and help unlock individual potential.[9]

In conclusion, it can be said that in the literature, creative approaches in education—especially when combined with project-based learning—are justifiably regarded as effective tools for developing students' independent, deep, and creative thinking. The approaches presented in this article are also grounded in this scientific and literary foundation.

Methodology. Organizing creative project-based activities in physics lessons contributes to increasing students' interest in the subject, promoting deeper understanding of physical phenomena in real life, and developing skills in independent thinking and practical application of knowledge. This approach enables students not merely to absorb ready-made information but to gain experience and draw conclusions through their own exploration. Creative project-based learning is implemented through a step-by-step methodology, with each stage designed to achieve a specific pedagogical objective.

The first stage – Identifying the problem. At this stage, students are presented with a physical or technical problem drawn from real life. For example, generating electricity using solar panels, determining the most effective material for thermal insulation, or increasing vehicle efficiency through the analysis of forces acting on moving bodies. The problem should be relevant and relatable to students' everyday lives. The teacher may formulate the problem themselves or create conditions that allow students to identify the problem independently.

The second stage – Developing the idea. After analyzing the problem, students propose various solutions, exchange ideas, and select the most acceptable, effective, and creative option. Creative techniques such as small group work, brainstorming, mind mapping, and the SCAMPER strategy are employed during this process. The main objective of this stage is to stimulate students' free thinking and strengthen social collaboration among them.

The third stage – Designing a model or experiment. At this stage, based on the chosen idea and grounded in physical laws and theoretical knowledge, students create a practical model or develop an experimental plan. They select the necessary materials, determine how to

use them, set up experimental conditions, and design functional diagrams. For example, students may build a simple generator, design a device to measure temperature, or create a model to assess thermal insulation through measurements.

The fourth stage – Testing and evaluating results. The constructed model or experiment is tested, and the results are verified in practice. Students assess the performance of the device, conduct measurements, and compare expected outcomes with actual results. At this stage, errors are identified, levels of accuracy are calculated, and modifications are made if necessary. Students are given the opportunity for self-assessment and peer evaluation based on assessment criteria or specific rubrics, which contributes to the development of metacognitive skills.

The fifth and final stage – Presentation and discussion. At this stage, students present their projects to their classmates, explaining the project's objective, its stages, technological solutions, results, and conclusions. After the presentation, a discussion takes place that includes questions and answers, exchange of opinions, and debate, during which the strengths and weaknesses of the project are analyzed. This process helps students develop communication culture, the ability to defend their point of view, think critically about others' opinions, and speak confidently in front of an audience.

In conclusion, it should be noted that creative project-based activity in physics is not merely about building a device, but rather an integrated approach that involves acquiring knowledge, applying it in practice, expressing ideas, and evaluating them. This methodology reveals students' creative potential and prepares them for entering the world of science and technology.

Theoretical Foundation. Creative approaches in physics education comprise a set of methods aimed at developing students' ability for creative thinking, problem analysis, and the generation of new ideas. When these approaches are combined with project-based learning, students' interest in the subject increases, and a deeper and more lasting understanding of knowledge is achieved.

From a theoretical perspective, creative approaches are based on the following pedagogical foundations:

- Constructivist Theory (J. Piaget, L. Vygotsky): the student actively constructs knowledge by making sense of it through personal experience;
- Development of higher-order cognitive skills based on Bloom's taxonomy (analysis, creation, evaluation);
- Metacognitive approach: the student plans, monitors, and reflects on their own learning process;
- STEM approach: solving creative problems through interdisciplinary integration.

By its very nature, physics as a science requires problem-based thinking and model-building activities. Therefore, creative approaches are naturally and effectively integrated into the process of learning physics.

In 8th-grade physics lessons where the creative project-based approach was implemented through hands-on experimental activities, the following outcomes were observed:

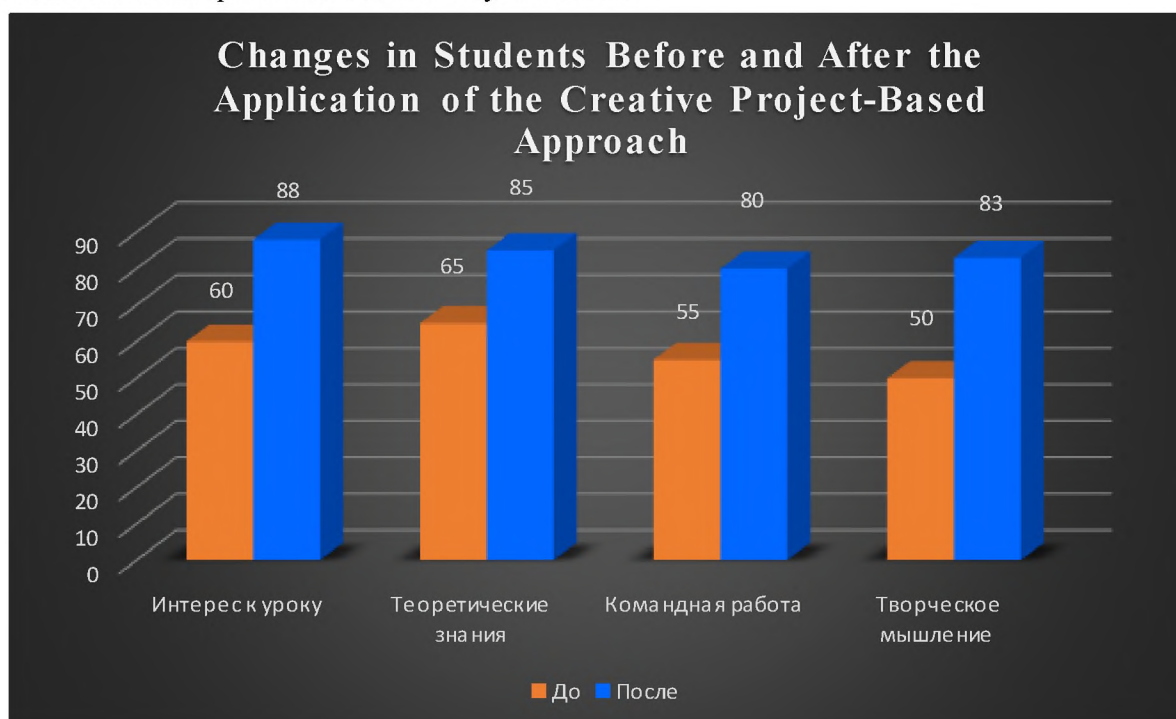
1. **Increased student interest in lessons** – they saw opportunities to apply their knowledge in practice.

2. **Enhanced teamwork skills** – collaboration and interaction developed through group project work.

3. **Reinforced theoretical knowledge** – students gained a deeper understanding of physical laws through model creation.

4. **Improved independent thinking and creativity** – students learned to approach problem-solving in new and innovative ways.

Chart: Positive Changes in Student Activity. The chart titled “*Changes in Students Before and After the Application of the Creative Project-Based Approach*” illustrates the level of student development across four key indicators.



The chart shows that project-based activities organized using creative approaches significantly increased students’ interest in lessons, contributed to a deeper understanding of theoretical knowledge, and enhanced their creative and collaborative engagement.

Table: Comparative Results of Students’ Grades and Active Participation

Indicators	Experimental Class (Creative Approach)	Control Class (Traditional Approach)
Average Lesson Attendance	96%	82%
Independent Work Assessment	4.7 / 5.0	3.9 / 5.0
Group Work Participation	High	Moderate
Thinking Skills	Analytical, Creative	Reproductive

The table “Comparative Results of the Experimental Class (Based on the Creative Approach) and the Control Class (Traditional Instruction)” shows the differences between the students of the two groups:

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Indicator	Description
Lesson Attendance	In the class taught using the creative methodology, attendance reached 96%, while in the traditional class it was 82%. This indicates increased motivation.
Independent Work Scores	Students in the experimental class performed well on independent tasks, averaging 4.7 points, compared to 3.9 points in the control class.
Group Work Activity	Students in the creative class actively participated, demonstrated teamwork, and effectively found solutions.
Thinking Skills	Students in the experimental class demonstrated analytical and creative thinking, while the control class primarily showed reproductive (memorization-based) thinking.

Based on the data in the table, it can be concluded that lessons organized using a creative approach significantly contributed to the development of high student engagement, as well as their independent and creative work skills.

Conclusion: The results of the study demonstrated that project-based learning organized through a creative approach increases students' interest in the lesson, reinforces theoretical knowledge through practical activities, and develops skills in independent thinking, communication, teamwork, and critical reasoning. This methodology is recommended as one of the universal educational approaches that can be effectively applied not only in physics but also in other natural sciences. The outcomes presented in the chart and table clearly confirm the practical value of this approach.

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