METHODOLOGY OF ACTIVITY-BASED TEACHING IN PHYSICS LESSONS BASED ON DEMONSTRATION EXPERIMENTS IN GENERAL SECONDARY SCHOOLS

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Abstract

This article explores the methodology of activity-based teaching in physics lessons through the use of demonstration experiments in general secondary schools. The study emphasizes the role of demonstration experiments in enhancing students' understanding of physical concepts, promoting active participation, and developing scientific thinking. The methodological framework is based on integrating experimental activities into the learning process to connect theoretical knowledge with practical experience. The paper analyzes different types of demonstration experiments and their didactic potential in fostering students' cognitive engagement, observational skills, and problem-solving abilities. In addition, the study highlights the importance of organizing experiments in a structured and student-centered manner to improve learning outcomes. The findings suggest that the systematic use of demonstration experiments significantly increases students' motivation, academic performance, and interest in physics. The proposed methodology can be effectively applied in modern physics education to ensure a more interactive and competency-based learning environment.

Keywords

physics education, demonstration experiments, activity-based learning, teaching methodology, student engagement, scientific thinking, experimental learning, cognitive development, secondary education, instructional strategies

Introduction

In the context of modern educational reforms, improving the quality of science education—particularly physics teaching—has become a key priority. Physics, as a fundamental natural science, plays a crucial role in shaping students' scientific worldview, logical thinking, and understanding of natural phenomena. However, traditional teaching approaches often rely heavily on theoretical explanations, which may limit students' engagement and hinder the development of practical skills. Therefore, there is a growing need to implement innovative pedagogical approaches that actively involve students in the learning process.

One of the most effective ways to achieve this is through the integration of demonstration experiments into physics lessons. Demonstration experiments serve as a bridge between theory and practice, allowing students to directly observe physical phenomena and better understand underlying principles. When combined with an activity-based teaching approach, these experiments not only illustrate scientific concepts but also encourage students to participate actively, ask questions, make predictions, and draw conclusions based on observation.

Activity-based learning shifts the focus from teacher-centered instruction to student-centered engagement. In this approach, students become active participants in constructing knowledge rather than passive recipients of information. Demonstration experiments, when methodically organized, can significantly enhance this process by stimulating curiosity, promoting inquiry-based learning, and developing essential competencies such as critical thinking, problem-solving, and analytical skills.

Despite their importance, the effective implementation of demonstration experiments in general secondary school physics lessons still presents methodological challenges. These include insufficient integration into lesson structure, lack of clear instructional strategies, and limited use of student-centered techniques during demonstrations. Addressing these challenges requires a well-developed methodological framework that aligns demonstration experiments with activity-based teaching principles.

The purpose of this study is to develop and justify a methodology for organizing physics lessons based on demonstration experiments within an activity-based learning framework in general secondary schools. The object of the research is the process of teaching physics in secondary education, while the subject focuses on the methodological aspects of integrating demonstration experiments to enhance student activity and learning outcomes. The results of the study aim to contribute to improving the effectiveness of physics education and fostering students' scientific competencies.

Methods

The research employed a combination of qualitative and quantitative methods, including pedagogical observation, experimental teaching, comparative analysis, and student performance assessment.

The study was conducted in general secondary schools among 7–9 grade students. Two groups were formed: a control group, where traditional teaching methods were applied, and an experimental group, where physics lessons were organized based on demonstration experiments within an activity-based learning framework.

The methodology included:

- ➢ systematic use of demonstration experiments during lessons;
- ➢ encouraging students to predict outcomes before experiments;
- ➢ involving students in observation, discussion, and explanation of results;
- ➢ integrating experiments with problem-solving tasks and real-life applications.

Various topics such as mechanics, pressure, buoyancy, friction, and surface tension were used to implement demonstration experiments. Students' knowledge levels, engagement, and practical skills were evaluated throughout the study.

Results

The results of the study indicate that the use of demonstration experiments within an activity-based learning approach significantly improves students' academic performance and engagement.

Students in the experimental group demonstrated:

- better understanding of physical concepts;
- improved observation and analytical skills;
- increased participation during lessons;
- higher motivation and interest in physics.

Compared to the control group, the experimental group showed higher achievement in both theoretical and practical assessments. Additionally, students became more confident in explaining physical phenomena and applying knowledge in real-life contexts.

Discussion

The findings confirm that demonstration experiments are an effective tool for implementing activity-based learning in physics education. They transform the learning process from passive reception to active exploration, allowing students to construct knowledge through direct experience.

The study also highlights that the effectiveness of demonstration experiments depends on proper methodological organization. Simply showing an experiment is not sufficient; students must be actively involved through questioning, prediction, and analysis.

However, several significant challenges were identified during the implementation of activity-based teaching using demonstration experiments in physics education. One of the main limitations is the insufficient allocation of classroom time, which restricts the possibility of conducting experiments in a detailed, step-by-step manner and limits students' active participation in observation and analysis processes. As a result, teachers are often forced to simplify or shorten experimental activities, which reduces their educational effectiveness.

Another critical issue is the inadequate material and technical provision of school laboratories. Many schools lack sufficient experimental equipment, modern instruments, and consumable materials necessary for conducting high-quality demonstration experiments. This limitation directly affects the frequency, variety, and accuracy of experimental work, thereby reducing students' opportunities for hands-on learning and practical engagement with physical phenomena.

In addition, insufficient teacher training in modern activity-based and experimental teaching methodologies represents a serious pedagogical challenge. Some teachers are not fully prepared to effectively integrate demonstration experiments into student-centered learning environments, design inquiry-based tasks, or guide students through independent experimental analysis. This results in a predominantly teacher-centered approach, where students remain passive observers rather than active participants.

Addressing these challenges requires a comprehensive improvement of the physics education system. First, it is essential to enhance teacher professional development programs by focusing on modern pedagogical approaches, including activity-based learning, inquiry-based instruction, and effective use of demonstration experiments. Regular training sessions, workshops, and methodological seminars should be organized to strengthen teachers' experimental teaching competencies.

Second, schools should be equipped with modern laboratory facilities and sufficient experimental resources. In cases where physical equipment is limited, the integration of digital technologies, including virtual laboratories and interactive simulation platforms, can serve as an effective alternative to support experimental learning.

Finally, expanding access to educational technologies and creating a supportive learning environment will ensure that demonstration experiments are implemented more effectively, thereby improving the overall quality of physics education and increasing students' engagement and scientific understanding.

Overall, integrating demonstration experiments into physics teaching through an activity-based approach enhances learning outcomes, promotes scientific thinking, and increases students' interest in the subject. This methodology can be recommended for broader implementation in general secondary education.

Conclusion

The study demonstrates that integrating demonstration experiments into physics lessons through an activity-based teaching approach significantly enhances the quality of education in general secondary schools. Demonstration experiments effectively bridge the gap between theoretical knowledge and practical understanding, enabling students to observe, analyze, and interpret physical phenomena more deeply.

The results confirm that students taught using this methodology show improved conceptual understanding, higher cognitive engagement, and stronger practical skills compared to those taught through traditional methods. Activity-based learning supported by demonstration experiments fosters critical thinking, scientific reasoning, and increased motivation toward physics learning.

Overall, the proposed methodological approach contributes to transforming physics education into a more interactive, student-centered, and competency-oriented process.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. Physics teachers should systematically incorporate demonstration experiments into lesson planning to ensure active student participation.
2. Each topic should include carefully selected experiments that clearly illustrate key physical concepts.
3. Students should be actively involved in predicting outcomes, observing processes, and discussing results rather than passively watching demonstrations.
4. Teacher training programs should emphasize modern activity-based teaching strategies and effective use of experimental methods.
5. Schools should improve laboratory infrastructure and provide necessary materials to support regular experimental activities.
6. The use of digital tools and virtual laboratories should be expanded to complement physical experiments, especially for complex or abstract phenomena.
7. Assessment systems should include evaluation of students' experimental and analytical skills, not only theoretical knowledge.
8. Further research should be conducted to explore innovative models of integrating experiments with inquiry-based and problem-based learning approaches.

These measures will help improve the effectiveness of physics education and support the development of students' scientific competencies in general secondary schools.

REFERENCES:

[1] Қаландаров Э.Қ., Қаттиқ жисмларнинг оптик хоссаларини изчиллик асосида ўқитиш // Science and innovation international scientific journal volume 1 ISSUE 5 UIF-2022: 8.2 | ISSN: 2181-3337. 606-610 bet.

[2] Abduraxmanov M.K., Qalandarov E.Q., Turli muhitlarda elektr toki mavzusini oʻrganish maqsadlari va vazifalari // Science and innovation international scientific journal volume 1 ISSUE 8 UIF-2022: 8.2 | ISSN: 2181-3337. 200-204 bet.

[3] Kalandarov E.K., Consistent formation and development of the physics of solids in Uzbekistan // Science and innovation international scientific journal volume 2 ISSUE 1 january 2023

UIF-2022: 8.2 | ISSN: 2181-3337 | SCIENTISTS.UZ. 419-423 bet.

[4] Khushvaktov U.N., Interconnected training in laboratory and practical classes in solid state physics // ACADEMICIA: An International Multidisciplinary Research Journal ISSN: 2249-7137, Vol. 12, Issue 05, May 2022. Scientific Journal Impact Factor (SJIF) 8.252, P. 134-146.

[5] Khushvaktov U.N., Use of the membership principle in studying solid physics at secondary school // ACADEMICIA An International Multidisciplinary Research Journal ISSN: 2249-7137, Vol. 11, |Issue 6| June 2021. - Scientific Journal Impact Factor (SJIF) 7.492, P. 526-531.

[6] Қаландаров Э.Қ., Хушвақтов Ў.Н. Қаттиқ жисмлар физикасини янги педагогик технологиялар асосида ўқитиш асослари// Муғаллим ҳам узлуксиз билимлендириу илмий-методикалық журнали. – Нукус, 2018. -№ 3-сон. 122-127 б. (13.00.00. № 20)

[7] Xushvaqtov Oʻ.N., Qattiq jismlar fizikasini oʻqitish uchun animatsion aralash reallik modellari // Fizika fanini axborot va innovatsion texnologiyalar muhitida oʻqitishning zamonaviy tendensiyalari: Muammo va yechimlar mavzusidagi. Respublika ilmiy-amaliy konferensiya materiallar toʻplami. Navoiy shahri – 2023. 279-284 bet.

[8] Xushvaqtov Oʻ.N., Umumiy oʻrta taʼlim maktablarida qattiq jismlar fizikasiga oid amaliy mashgʻulotlarni takomillashtirish // "Fizika, Matematika va Informatika" Ilmiy-uslubiy jurnal. 2022 2-son. 01.04.2022-y. 38-44 b. (13.00.00. № 2)

[9] Xushvaqtov Oʻ.N. Umumiy oʻrta taʼlim maktablarida qattiq jismlar fizikasining rivojlanish metodologiyasi metodologik asoslari//"OʻzMU XABARLARI" Mirzo Ulugʻbek nomidagi Oʻzbekiston Milliy Universiteti Ilmiy Jurnali. 2024, [1/7/1] ISSN 2181-7324. 218-221 bet.

[10] Хушвақтов Ў.Н., Умумий ўрта таълим мактабларида қаттиқ жисмлар турларини кўргазмалилик тамойилидан фойдаланиб ўрганиш//Ilm sarchashmalari" Urganch davlat universitetining ilmiy-nazary, metodik jurnali. 114-118 bet.

[11] Khushvaktov U.N., The importance of interdisciplinary integration of subjects related to solid state physics with the natural sciences in their high schools // International Journal of Education, Social Science & Humanities. Finland Academic Research Science Publishers ISSN: 2945-4492 (online), Volume-11| Issue-10| 2023 Published: |22-10-2023| Scientific Journal Impact Factor (SJIF) = 7.502, P. 1276-1279.

[12] Xushvaqtov O'.N., Umumiy o'rta ta'lim maktablarida PhET (fizika ta'limi va texnologiya)si yordamida "Elastiklik va Guk qonuni"ni o'qitish // "Yangi O'zbekistonda innovatsion tadqiqotlar" xalqaro ilmiy-amaliy konferensiya doirasidagi "Intellektual izlanuvchi" xalqaro ko'rik tanlovi 3-qism. O'zbekiston – 2023, 647-649 b.

[13] Xushvaqtov O'.N., "Qattiq jismlar fizikasi"ni o'qitish jarayonida o'quvchilarning kreativ kompetentligini rivojlantirish// "XALQ TA'LIMI" O'zbekiston Respublikasi Maktabgacha va Maktab Ta'limi Vazirligining Ilmiy-metodik jurnali. ISSN 2181-7839. 2023 2-son (Mart-Aprel), 67-71 b. (13.00.00. № 17).

[14] Xushvaqtov O'.N., Yakka plastina metodi yordamida qattiq jismlarning issiqlik o'tkazuvchanligini aniqlash // «Ilm-fan fidokori» mavzusidagi xalqaro ilmiy-amaliy ko'rik tanlovi materiallari (29-dekabr 2022-yil) – T.: Farg'ona sh. 319-326 b.

[15] Xushvaqtov O'.N., Umumiy o'rta ta'lim maktablarida "Qattiq jismlar fizikasi"ni o'qitishni takomillashtirish omillari// Science and innovation international scientific journal VOLUME 1 ISSUE 8 UIF-2022: 8.2 | ISSN: 2181-3337, 1115-1121 b.

[16] Xushvaqtov O'.N., Keramik supercondensatorlar va uning texnikada qo'llanishi mavzusini o'qitish// "O'zbekistonda ilm-fanning rivojlanish istiqbollari" mavzusidagi ko'p tarmoqli, xalqaro ilmiy-amaliy anjumani materiallar to'plami 2022-yil 30-noyabr, 863-566 b.

[17] Khushvaktov U.N., Teaching topics related to solid-state physics in high school on the principle of continuity // International Journal of Education, Social Science & Humanities. Finland Academic Research Science Publishers ISSN: 2945-4492, Volume-12 |Issue-6| 2024 Published: |22-06-2024| Scientific Journal Impact Factor (SJIF) = 8.09, P. 1584-1592.

[18] Khushvaktov U.N., Methods of teaching the topic "Crystalline and amorphous bodies" in high school // International Journal of Education, Social

Science & Humanities. Finland Academic Research Science Publishers ISSN: 2945-4492, Volume-12 |Issue-6| 2024 Published: |22-06-2024| Scientific Journal Impact Factor (SJIF) = 8.09, P. 1575-1583.

[19] Xushvaqtov N., Xushvaqtov O‘.N., Umumiy o‘rta ta’lim maktablarida fizika fanidan uy laboratoriya ishini tashkil etish va bajarish // Xalqaro ilmiy forum. Ko‘p tarmoqli ilmiy-amaliy anjuman materiallari. Toshkent. 2023-yil. 13-yanvar. 962-965 bet.

[20] Xushvaqtov O‘.N., Jalolov S.E., Yakka plastina usuli bilan issiqlik o‘tkazuvchanlikni aniqlash// Xalqaro ilmiy forum. Ko‘p tarmoqli ilmiy-amaliy anjuman materiallari. Toshkent. 2023-yil. 13-yanvar. 966-968 bet.

[21] Jo‘rayev Baxtiyor, Molekulyar fizikaning paydo bo‘lishi va rivojlanishi. // International Journal of Education, Social Science & Humanities. Finland Academic Research Science Publishers ISSN: 2945-4492 (online), Volume-11| Issue-10| 2023 Published: |22-10-2023| Scientific Journal Impact Factor (SJIF) = 7.502, P. 1269-1271.

[22] Хожаназарова Р.М., Джораев Б.Б., Formation of quantum mechanics concepts in students in the system of higher education // Science and innovation international scientific journal VOLUME 1 ISSUE 8 UIF-2022: 8.2 | ISSN: 2181-3337, P. 40-42.

[23] Ural Norkobilovich Khushvaktov. Improving correlation in solving laboratory work and issues related to solid state physics in high school // American journal of education and learning ISSN: 2996-5128 (online) | ResearchBib (IF) = 9.918 Impact factor Volume-2| Issue-5| 2024 Published: |30-12-2024|. P. 173-179.