EXPERIENCE IN APPLYING INNOVATIVE TECHNOLOGIES IN THE EDUCATIONAL PROCESS OF TECHNICAL UNIVERSITIES

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Abstract. *This article analyzes the issues of developing research activities of students in technical universities under the conditions of innovative teaching technologies. In particular, the role of engineering competitions and hackathons in the educational process is scientifically substantiated, highlighting their importance in developing students' independent inquiry skills, creative abilities, and practical competencies. The study examines international experience, modern pedagogical approaches, and the effectiveness factors of innovative educational technologies. The results indicate that engineering competitions and hackathons encourage students not only to acquire theoretical knowledge more deeply but also to apply it in practice. At the same time, these processes serve as an important foundation for the sustainable development of research activities.*

Keywords: *innovative teaching technologies, technical universities, research activity, engineering competitions, hackathons, educational effectiveness.*

Introduction

In today's era of globalization, one of the main tasks facing the education system is to train competitive specialists with creative and innovative thinking skills. In this regard, technical universities occupy a special place in preparing personnel who meet the demands of modern science, industry, and the innovative economy. From this perspective, the effective organization of students' research activities and their development based on new pedagogical approaches has become a pressing issue. In recent years, leading higher education institutions around the world have accumulated significant experience in implementing innovative teaching technologies, creating a creative learning environment, and equipping students with practice-oriented knowledge. In particular, engineering competitions and hackathons are recognized as effective tools for developing students' independent inquiry, research activity, and teamwork skills.

In the Republic of Uzbekistan, fundamental reforms are also being carried out in the higher education system. Specifically, presidential decrees and resolutions emphasize the introduction of innovative approaches into the educational process, the broad involvement of young people in scientific activities, and the support of their startup projects. In this context, the development of students' research activities in technical universities and the realization of their creative potential through engineering competitions and hackathons are of great importance. The relevance of this article lies in the fact that it examines effective methods for engaging students in scientific activity under conditions of using innovative teaching technologies in technical universities. In addition, international experience is analyzed, and recommendations adapted to the education system of Uzbekistan are developed.

Main Part

The issue of innovative pedagogical technologies and their application in higher education has been widely studied worldwide in recent years. In particular, reports by international organizations such as UNESCO and the OECD emphasize the importance of directing students toward independent inquiry and engaging them in innovative activities as a key challenge of modern education. The theoretical foundations of the development of pedagogical technologies have been explored in the works of scholars such as V.P. Bespalko, B.L. Farberman, N.S. Saidakhmedov, and Sh.S. Sharipov. According to their views, pedagogical technology is based on a systematic approach to designing, organizing, and monitoring the effectiveness of the educational process. Innovative technologies, in particular, encourage students to be active, think creatively, and make independent decisions.

Among foreign scholars, the scientific works of J. Dewey, P. Freire, H. Gardner, and T. Bates have laid the theoretical foundations for new approaches in education. For example, Dewey's pragmatic pedagogy prioritizes practical activity in the learning process, while Gardner, through his theory of multiple intelligences, places special emphasis on developing students' individual abilities. Among Uzbek scholars, the works of N.A. Muslimov, A.A. Abduqodirov, U.N. Nishonov, and M. Jo'rayev are devoted to the application of innovative technologies in education, improving the quality of education, and directing students toward scientific activity. Their studies particularly emphasize the necessity of organizing the educational process in an integrated manner in the field of engineering.

In recent years, the number of scientific publications devoted to modern educational formats such as hackathons and engineering competitions has increased. For instance, the study by A. Briscoe and J. Mulligan (2019) highlights the role of hackathons in developing students' creative thinking, teamwork, and rapid decision-making skills. Similarly, J. Smith (2021) concludes that engineering competitions accelerate the application of theoretical knowledge in practice and prepare students to solve real industrial problems. In global practice, the main innovative approaches used in technical education include:

- **STEM education (Science, Technology, Engineering, Mathematics)** – integration of technical and natural sciences through interdisciplinary approaches;
- **Problem-based learning** – directing students toward solving real industrial problems;
- **Project- and startup-based learning** – developing students' scientific and innovative ideas in the form of practical projects or startups;
- **Gamification** – incorporating elements of competition, games, and motivation into the educational process;
- **Distance and hybrid learning** – integrating traditional classroom instruction with online platforms.

Turning to local experience, higher education institutions of the Republic of Uzbekistan, particularly technical universities, have also widely implemented hackathons and engineering competitions. Institutions such as Inha University in Tashkent, Tashkent University of Information Technologies, and Tashkent State Technical University actively involve students in hackathons, where they implement their projects in cooperation with industrial enterprises. Through these competitions, students not only propose new ideas but also gain opportunities to provide technical justification, calculate economic efficiency, and develop practical prototypes. This contributes to the development of young specialists' research activities and enhances their innovative potential.

Foreign studies also indicate that hackathons and engineering competitions are considered effective forms of engaging students in research activities. For example, participants of the

"Engineering Education Hackathon" project held in Canada successfully implemented three startup projects as a result of their research activities. This experience demonstrates that hackathons can be applied not only as short-term competitions but also as a permanent element of the educational process. International experience further shows that leading technical universities worldwide (MIT, Stanford, Tsinghua, KAIST, etc.) place significant emphasis on hackathons, engineering competitions, hack labs, and makerspace environments in student research activities. This approach creates substantial opportunities for the emergence of technological innovations and startups. Universities such as MIT, Stanford, and Texas A&M have made hackathons and engineering competitions an integral part of the educational process, serving as important tools for fostering technological innovation, startup development, and stronger industry integration.

Examining European experience, engineering education is often organized through real industrial projects. Students begin developing mini-prototypes from their first year of study and spend two to three days a week in engineering departments of factories. In the United States, universities such as MIT, Stanford, and Georgia Tech apply blended learning models, where 30–40% of theoretical instruction is delivered online, while the remaining portion focuses on practical laboratory-based activities. Hackathons and engineering competitions are considered mandatory components, supported by makerspaces, 3D printers, IoT, and robotics laboratories.

The Finnish model (Aalto University) emphasizes project-based learning and interdisciplinary teams as core methods. The Design Factory serves as a collaborative center where students, faculty, and companies work together. Startup and prototyping culture is strong, placing Aalto startups among the top ten most developed in Europe. In Germany, dual education models (TU Munich, RWTH Aachen) involve students spending two to three days a week in industrial engineering departments, conducting course projects and research based on industrial orders, and working in digital laboratories focused on Industry 4.0.

In South Korea, approximately 95% of graduates enter practical employment immediately after graduation. In Japan, advanced virtual laboratories in mechatronics and materials science are widely used, and Lean Engineering methodologies are integrated into the educational process. In China (Tsinghua University, Zhejiang University, Harbin Institute of Technology), real production line models are developed in 5G, IoT, and AI laboratories, with strong industrial collaboration (Huawei, BYD, Alibaba Cloud). Hackathons and innovation competitions are held more than 100 times annually. In Russia (Bauman Moscow State Technical University, ITMO University, Skoltech), integration with the Skolkovo Innovation Center, smart campuses, digital simulators, virtual laboratories, and preparation centers for international engineering competitions such as ICM, RoboCup, and Eurobot are established.

Technical universities in Tashkent, including TUIT, TSTU, and TIQXMMI, have implemented the following innovative technologies:

- Digital education platforms (Moodle, Canvas);
- Virtual laboratories (physics, mechanics, automation);
- CAD/CAE software for design and drafting (AutoCAD, SolidWorks, ANSYS).

Presidential resolutions have approved the following innovations:

- The "Innovative Ideas, Technologies, and Projects" platform;
- Establishment of innovation development laboratories in higher education institutions;
- Introduction of a cluster model for engineering and IT disciplines;
- Grant and incubation programs for startups.

The main global trend in technical universities is practice-oriented, competency-based education enriched with digital technologies. Hackathons, engineering competitions, and industrial projects have become integral components of education.

Conclusion

Thus, the use of innovative pedagogical technologies in technical universities significantly engages students in research activities. Engineering competitions and hackathons play a crucial role in developing students' practical knowledge and skills, directing them toward independent inquiry, and preparing them for the modern labor market. Education in technical universities requires not only the delivery of theoretical knowledge but also the preparation of students for participation in a scientific environment. Therefore, technical universities have increasingly focused on innovative teaching technologies in recent years.

Compared with foreign higher education institutions, hackathons and engineering competitions in Uzbekistan have not yet been fully systematized. While hackathons in the United States and Canada are regularly included in curricula, in Uzbekistan they are often conducted on an initiative basis and on a limited scale. Consequently, systematizing and conducting these activities on a regular basis could significantly enhance educational effectiveness.

REFERENCES

1. Lavado-Anguera, S.; Velasco-Quintana, P.-J.; Terrón-López, M.-J. (2024). Project-Based Learning (PBL) as an Experiential Pedagogical Methodology in Engineering Education: A Review of the Literature. Education Sciences, 14(6), 617.
2. Flus, M., & Hurst, A. (n.d.). Hackathons as a Novel Pedagogy in Engineering Design Education. (IJEE)
3. "Hackathons in Software Engineering Education: Lessons Learned from a Decade of Events." (2026). ACM / IEEE Conference paper.
4. Integrating Generative AI in Hackathons: Opportunities, Challenges, and Educational Implications. (2024).
5. Lab Hackathons to Overcome Laboratory Equipment Shortages in Africa: Opportunities and Challenges. (2019).
6. Problem-Based Learning in Engineering Education: Reflections, Practices and Challenges. (2021).
7. Babanskiy, Yu.K. Optimizatsiya uchebno-vospitatelnogo protsessa: Metodicheskiy aspekt. – M.: Pedagogika, 1982. – 192 b. [maqolada: 2–3-betlar]
8. Zagvyazinskiy, V.I. Metodologicheskiye osnovy pedagogicheskoy innovatsii. – M.: Logos, 2004. – 248 b. [maqolada: 3–4-betlar]
9. Tretyakov, P.I. Pedagogicheskiye innovatsii v obrazovatelnoy sisteme. – SPb.: Rech, 2003. – 224 b. [maqolada: 5–6-betlar]
10. Slastyonin, V.A., Isaev, I.F., Mishchenko, A.I. Pedagogika. – M.: Akademiya, 2002. – 512 b. [maqolada: 6-bet]
11. Bordovskiy, G.A. Innovatsionnaya deyatelnost v obrazovanii: Teoriya i praktika. – SPb.: Piter, 2006. – 304 b. [maqolada: 7-bet]
12. OECD. Education at a Glance 2022: OECD Indicators. – Paris: OECD Publishing, 2022. – 500 p. DOI: https://doi.org/10.1787/69096873-en [maqolada: 8–9-betlar]
13. UNESCO. Rethinking Education: Towards a Global Common Good? – Paris: UNESCO Publishing, 2015. – 120 p. [maqolada: 9-bet]

14. Muxamadiyev.A.Sh, Nomozova.N “Texnika sohasida o‘qiyotgan talabalarda kreativ fikrlash va yechim topish rivojlantirishda xakatonlarning o‘rni” Жамият ва инновациялар – Общество и инновации – Society and innovations Special Issue – 05 (2025) / ISSN 2181-1415. 364-372 betlar. https://inscience.uz/index.php/socinov/index
15. Bekmurodov, A. B. (2022). Xakatonlar orqali talabalar innovatsion salohiyatini oshirish. Pedagogik ta’limda zamonaviy yondashuvlar, 4(1), 89–95.
16. Muxamadiyev.A.Sh, Nomozova.N “MUHANDISLIK MUSOBAQALARI VA XAKATONLARNING TA’LIMDAGI AHAMIYATI” Oriental Journal of Education ISSN: 2181-2764. 84-92 betlar. https://www.supportscience.uz/index.php/oje.
17. Muxamadiyev.A.Sh, Nomozova.N “ Increasing Scientific Research Activity Of Students Of Technical Universities Through Engineering Competitions And Quizzes, The Path To Innovative Educational Technologies” Eurasian Journal of Research, Development and Innovation. ISSN:2795-7616, Volume 43, aprel 2025. www.geniusjournals.org.
18. Temirova Z. A. TEACHING MEDICAL INFORMATION TECHNOLOGIES USING MODERN ELECTRONIC LEARNING PLATFORMS //Лучшие интеллектуальные исследования. – 2025. – Т. 58. – №. 5. – С. 382-385.
19. Temirova Z. A. et al. THE USE OF DISTANCE LEARNING IN MEDICAL EDUCATION //Экономика и социум. – 2023. – №. 11 (114)-1. – С. 424-426.
20. Temirova Z. A. et al. IMPROVING THE METHODOLOGY OF TEACHING INFORMATICS TO FOREIGN STUDENTS //Экономика и социум. – 2023. – №. 12 (115)-2. – С. 513-515.
21. Temirova Z. A. THE MAIN FEATURES OF INNOVATIVE PEDAGOGICAL TECHNOLOGY //Экономика и социум. – 2022. – №. 11-2 (102). – С. 218-221.
22. Temirova Z. A. SOME ISSUES OF THE FORMATION OF THE SUBJECT AREA OF BIOPHYSICS //Экономика и социум. – 2021. – №. 11-1 (90). – С. 552-555.
23. Xudayberdieva X. U., Komilova D. T., Temirova Z. A. PROBLEM SITUATION AS BASIC ELEMENT TECHNOLOGY OF PROBLEM EDUCATION //Экономика и социум. – 2022. – №. 11-2 (102). – С. 272-275.
24. YULCHIYEVA Z., TEMIROVA Z. RAQAMLASHTIRILGAN TA’LIM SHAROITIDA KASB-HUNAR TA’LIMI O ‘QUVCHILARINING MEDIASAVODXONLIK KO ‘NIKMALARINI RIVOJLANTIRISH METODIKASINI TAKOMILLASHTIRISH //«ACTA NUUz». – 2025. – Т. 1. – №. 1.10. – С. 223-226.