AN EVIDENCE-BASED MODEL FOR DEVELOPING RESEARCH COMPETENCIES THROUGH BIOCHEMISTRY CLUB ACTIVITIES IN HIGHER EDUCATION

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Abstract. This paper addresses the problem of forming research skills in higher education students through the activity of subject clubs, using the biochemistry club as a case study. Despite the recognized pedagogical potential of subject clubs, a systematic, discipline-specific methodology for cultivating research competencies in biochemistry education remains underdeveloped. The study proposes an improved methodical model integrating laboratory, experimental, and project-based work, and verifies its effectiveness through a three-year pedagogical experiment (2023–2026) involving 394 students from three universities. Statistical analysis of the experimental and control group outcomes shows that the research-competency development level in the experimental group exceeded that of the control group by a factor of approximately 1.17 (about 17%), confirming the effectiveness of the proposed methodology. The findings offer practical recommendations for integrating innovative pedagogical technologies, digital assessment tools, and project-based learning into subject-club activities at higher education institutions.

Keywords: research skills, research competencies, subject club, biochemistry education, higher education pedagogy, methodical model, pedagogical experiment, student-centered learning.

Introduction. One of the central tasks facing contemporary higher education is preparing graduates capable of independent scientific thinking and systematic research activity. In this context, subject clubs are recognized as an effective pedagogical mechanism for realizing students' scientific potential, allowing them to deepen theoretical knowledge, integrate it with practice, and develop critical and creative thinking. In biochemistry — a discipline that requires rigorous analytical reasoning and hands-on laboratory competence — the role of subject clubs is particularly significant, since practical experimentation is inseparable from theoretical mastery.

While prior research has examined subject-club activity within biology, chemistry, and the natural sciences broadly, comprehensive studies devoted specifically to the methodology of research-skill formation through biochemistry clubs remain scarce. This gap motivates the present study, which builds on and extends earlier pedagogical work by proposing a discipline-specific, theoretically and methodologically grounded model.

Methods. The study employed a combination of theoretical analysis, pedagogical observation, expert evaluation, modeling, and a three-stage (ascertaining, formative, and summative) pedagogical experiment, complemented by mathematical-statistical analysis of the results. The experiment was conducted at the National University of Uzbekistan, Gulistan State University, and Qarshi State University across three academic years (2023–2024, 2024–2025, 2025–2026), involving third-year biology students. Participants were assigned to experimental and control groups of comparable initial proficiency. The experimental group followed the newly developed methodology within the "Young Biochemists" subject club, including individually oriented learning technologies, non-standard research-oriented tasks, and digital interactive assessment (including the Kahoot platform), while the control group continued under traditional instructional arrangements.

Results. A comparative assessment of the two groups before the intervention showed close initial performance levels across the three universities, confirming methodological comparability of the samples (n = 394). Table 1 summarizes group sizes across the three-year experimental cycle.

Following implementation of the improved methodology, the experimental groups demonstrated a consistent upward trend in research-related performance indicators across all three academic years,

with the digital platform-based assessments (Kahoot) contributing markedly to increased engagement and more transparent monitoring of learning dynamics.

Table 1

Distribution of Students in the Experimental and Control Groups during the Three-Year Pedagogical Experiment (2023–2026)

Group	2023–2024	2024–2025	2025–2026	Total (n)
NUUz — Control	68	68	66	66
NUUz — Experimental	70	68	68	68
GulSU — Control	68	66	66	66
GulSU — Experimental	66	64	64	64
QarSU — Control	66	66	64	64
QarSU — Experimental	68	66	66	66

Comparative statistical analysis of the final data confirmed that the level of research-competency development in the experimental group exceeded that of the control group by a factor of approximately 1.17 (around 17%), a statistically reliable result attributable to the systematic application of the proposed methodical model.

Discussion and Conclusion. The findings confirm that a systematically designed, discipline-specific methodology — combining laboratory and experimental work, project-based tasks, and digital interactive assessment within the framework of a subject club — meaningfully strengthens students' research competencies. Compared to traditional instructional formats, the proposed model provides a more structured pathway from motivational and cognitive engagement through to independent research activity, supported by explicit assessment criteria and stage-based monitoring.

Based on the study's outcomes, the following recommendations are proposed: (1) expand freely accessible instructional video materials for subject-club activities, developed using interactive modern methods; (2) institutionalize regular scientific seminars, master classes, and training sessions for students, incorporating recognition of instructors' contributions into performance evaluation; (3) systematically connect club activities to current social, economic, and cultural issues to broaden students' scientific outlook; and (4) expand the use of project-based learning, case-study methods, and digital technologies within club sessions. The proposed methodology and its accompanying instructional materials have been implemented in the educational process of the Faculty of Biology and Ecology at the National University of Uzbekistan and are recommended for wider application at other higher education institutions.

References

1. Law of the Republic of Uzbekistan "On Education", 2020.
2. Decree of the President of the Republic of Uzbekistan No. PF-6097, "On approval of the Concept for the Development of Science until 2030", October 29, 2020.
3. Abdullayeva M.M., Fuzailova G.S., Sadikova K.A., Qo'ziyev Sh.N. Methodology of Teaching Biology. Tashkent, 2022.
4. Hamroyev S.H. Improving the methodology of forming research skills in students through subject clubs (a case study of the biochemistry club): PhD Dissertation. National University of Uzbekistan, Tashkent, 2026.