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Improving the Methodological Training of Future Primary School Teachers to Teach Technology

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ABSTRACT

The purpose of this article is to present the improvement of the methodological training of future primary school teachers to teach technology. The method used to improve methodological training is a combination of such methods as pedagogical observation, comparative analysis, generalization, sociological methods (questionnaires, question-and-answer, interviews, expert assessment). Practical results include the content of improving the methodological training of teachers of future elementary schools to teach technology, a form, method and tools have been developed, based on the "STEAM education" approach, methodological support for technological science has been developed, as well as a state educational standard, qualification requirements, curricula and an educational and methodological complex, scientifically based methodological recommendations have been formulated to improve the methodological readiness of future primary school teachers to teach technology. The results obtained in the practical significance of the study are determined by the task of improving the programs of higher educational institutions, drawing up improved work plans for future primary school teachers, creating textbooks, teaching aids, improving the effectiveness of educational seminars organized in higher educational institutions and primary schools, as well as providing methodological assistance to parents.

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1. INTRODUCTION

The main goal of the Science of Technology in primary education is to cultivate creative individuals who are capable of making informed decisions across a variety of life contexts. This goal is closely linked to the foundational learning processes that take place during elementary school (Sholihah *et al*., 2024; Fadjarajani *et al*., 2025). Early exposure to technology education not only fosters creative thinking and adaptability but also lays the groundwork for lifelong learning and practical application of skills (Kerans *et al*., 2024; Khusaini *et al*., 2023).

In the early grades, students begin developing critical qualities such as imaginative thinking, motor coordination, problem-solving, and the ability to adapt to changing environments (Azzahra *et al*., 2022; Rahmadani *et al*., 2024). The Technology subject encourages students to engage with real-world scenarios and explore basic design, construction, and problem-solving concepts (Ogundele *et al*., 2023; Arifiani *et al*., 2025). Through these experiences, students are introduced to professional fields, enabling them to understand the kinds of skills, knowledge, and personal attributes required for various careers (Farxod, 2023; Khaliljanovna & Muhabbat, 2024).

The Science of Technology program plays an essential role in strengthening the motivational aspects of learning among elementary school students. It offers opportunities for career orientation, including site visits to production facilities and interaction with professionals. These engagements serve as early forms of vocational guidance and self-discovery (Akinoso, 2023; Alhassan *et al*., 2024).

For primary school teachers, it is essential to contextualize technology lessons using familiar materials that reflect students' everyday experiences—whether from reading, play, or social activities (Viorennita *et al*., 2023). This hands-on approach encourages students to actively participate in preparing didactic materials not only for their own classes but also for peers across other grade levels, enhancing collaboration and practical learning (Bugarso *et al*., 2021).

Research and pedagogical analysis confirm that adapting technology instruction to the developmental and psychological characteristics of young learners enhances learning outcomes (Glushchenko, 2024). Effective teaching of technology at the primary level must align with children's cognitive and emotional development to nurture personal qualities such as resilience, autonomy, and innovation (Jadhav *et al*., 2022).

Moreover, in an era where 21st-century competencies are increasingly prioritized, there is a pressing need to enhance the methodological training of future teachers (Mohammed, 2023; Ibrahim *et al*., 2024). Skills such as critical thinking, creativity, collaboration, and communication—collectively known as the "4Cs"—have become the new pillars of literacy in the digital age. The ability to navigate complex problems, work effectively in teams, and innovate are now essential components of a future-ready workforce (Pablo *et al*., 2022). **Table 1** shows comparison of traditional vs. modern approaches in teaching technology.

Modern methodological training programs should be designed around STEAM (Science, Technology, Engineering, Arts, and Mathematics) principles (Ibarrientos, 2024). **Table 2** previous research on methodological training for technology education. These programs foster interdisciplinary thinking, the application of scientific knowledge in real-life situations, and the development of technical curiosity and innovation from an early age.

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This study is situated within the framework of the applied project titled "Creation of a Complex of Multimedia Developments of Lessons in Subjects for Primary School Teachers" (2022–2024), part of the research agenda of Tashkent State Pedagogical University. The project emphasizes that effective student outcomes depend not only on teacher instruction but also on students' active participation in the learning process.

Therefore, teachers must manage and guide students' educational and cognitive activities through deliberate planning, organization, motivation, and evaluation. Methodological training must include strategies that foster both instructional efficiency and student engagement in the evolving digital education landscape.

To that end, improving the methodological training of future primary school teachers requires integrating modern educational technologies, student-centered pedagogies, and continuous professional development to ensure alignment with global educational standards.

Table 1. Comparison of traditional vs. modern approaches in teaching technology.

Aspect	Traditional Approach	Modern Approach (21st-Century Based)
Learning Objective	Memorization of facts and content	Development of problem-solving and design thinking
Teaching Method	Lecture-based, teacher-centered	Project-based, student-centered
Content Delivery	Textbooks and blackboard	Multimedia, interactive platforms, real-world tasks
Student Role	Passive knowledge recipient	Active explorer and co-creator
Assessment	Tests and written exams	Portfolios, presentations, performance-based assessments
Use of Technology	Minimal or none	ICT tools, Web 2.0 platforms, simulations, educational apps
Teacher Competency Focus	Subject knowledge only	Pedagogical knowledge + digital literacy + facilitation skills

Table 2. Previous research on methodological training for technology education.

Title	Ref.
Improving the methodological preparation of future primary school teachers	(Khimmataliyev *et al.*, 2024)
Improving quality and efficiency in primary education and physical culture	(Buriyeva & Omonovich, 2024)
Methodical training of primary school teachers in technology teaching	(Leysa *et al.*, 2022)
Methodological training of primary school teachers on the technology subject	(Rohaan *et al.*, 2012)
Methodical Training of Elementary School Teachers in Technology Subject	(McCannon & Crews, 2000)
Preparing future elementary school teachers to lead student design activities	(Bencze, 2010)
Ways and means of preparing the educational sphere "technology" for lifelong learning	(Mohammed & Kinyo, 2020)
Preparing future elementary school teachers for teaching the subject "technology"	(Albee, 2003)

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2. LITERATURE REVIEW

Research in the field of methodological training for primary school teachers has gained significant momentum in recent years. The focus has shifted from traditional approaches to more dynamic, learner-centered methods that emphasize active engagement and the integration of modern pedagogical technologies (Dębiec, 2017). Methodological training is no longer limited to theoretical knowledge but extends to the development of practical skills necessary for designing, implementing, and evaluating effective classroom instruction (Kraiger *et al*., 1993).

Several studies have highlighted the importance of aligning teacher training programs with contemporary educational demands. These include fostering critical thinking, creativity, adaptability, and the ability to use digital tools effectively in the learning process. A comprehensive understanding of subject matter content, combined with pedagogical content knowledge, has been emphasized as essential for developing competent and confident educators (Deluca & Bellara, 2013).

Furthermore, international perspectives on teacher education underscore the role of contextualized and culturally responsive pedagogy. There is a growing consensus that methodological training should be reflective, practice-oriented, and closely connected to real classroom settings. Models that incorporate microteaching, simulation, and peer collaboration have shown promise in preparing future teachers to navigate the complexities of modern education systems (Budnyk, 2021).

In addition, the integration of interdisciplinary approaches in teacher education is gaining relevance. This includes the blending of subject knowledge with educational psychology, classroom management strategies, and technology integration. Emphasis is placed on continuous professional development, inquiry-based learning, and the use of formative assessment to monitor and guide teacher growth (Lasaiba, 2024).

Overall, the literature suggests a paradigm shift from rigid instructional methods toward more flexible, student-centered pedagogies, requiring robust and contextually adapted methodological training for pre-service teachers.

3. METHODS

This research employed a qualitative and developmental approach aimed at enhancing the methodological training of future primary school teachers for teaching the subject of Technology. The study was grounded in the psychological and pedagogical characteristics of primary school students, with a specific focus on their age-related cognitive, emotional, and social development. Accordingly, the Technology curriculum was adapted to meet the developmental needs of young learners by integrating principles that foster creativity, problem-solving, and hands-on engagement.

The methodological framework centered on the integration of general education and specialized scientific knowledge. Core subjects within the teacher training program—such as pedagogy of primary education, general psychology, methods of educational work, natural science methodology, and information technology—were closely examined to ensure alignment with the competencies required for effective Technology instruction. These subjects were further enriched through their integration with the STEAM education model, which emphasizes science, technology, engineering, arts, and mathematics in a holistic, interdisciplinary format.

A competency-based approach was adopted to structure the methodological readiness of future teachers. The study identified and implemented a system of competencies that

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included social, personal, technological, and professional domains. These competencies were cultivated through coursework in the subject "Technology and Methods of Its Teaching," which served as the central academic discipline for training. The STEAM-based modular program was introduced as a targeted intervention to foster intellectual development and enhance students' engagement with scientific and technical creativity.

The methodology included the implementation of educational modules such as "Froebel's Didactic System," which encouraged exploration of mathematical and spatial relationships through manipulation of geometric objects, and "Experiments with Living and Non-living Nature," which fostered ecological awareness and experimental thinking. Other modules, like "LEGO-Constructivism," promoted planning, design thinking, and problem-solving through hands-on construction and project-based learning. Each module was designed to develop skills such as cause-and-effect reasoning, critical reflection, verbal articulation, and cross-disciplinary awareness.

Student-led project work was a critical component of the methodology. These projects required pre-service teachers to explore the Technology curriculum in depth, analyze its structure, identify key instructional objectives, and design meaningful learning experiences accordingly. Project implementation allowed them to practice literature review, curricular alignment, material selection, and evaluation of student engagement.

Classroom instruction during lectures and practicum sessions on "Technology and Its Teaching Methods" emphasized the creative project method. Future teachers learned how to plan, organize, and assess educational projects with a focus on innovation and student participation. Active teaching methods—such as role-play, simulation, and educational design—were systematically applied to promote reflective practice and methodological competence.

Ultimately, this methodology aimed to prepare future teachers not only to deliver content effectively but also to foster technological creativity in their students. By integrating STEAM principles, the program enabled personalized learning pathways, accommodated diverse learner profiles, and promoted lifelong learning skills. This methodological structure was evaluated using operational, cognitive, motivational, and social criteria to assess the growth in professional readiness. The results confirmed that the developed model effectively cultivated a cohort of competent, adaptive, and innovation-oriented primary school teachers, fully prepared to meet the demands of 21st-century education.

3. RESULTS AND DISCUSSION

The experimental study was conducted among undergraduate students enrolled in the 5111700 – Primary Education and Sports and Educational Work program at three institutions: Tashkent State Pedagogical University, Kokand State Pedagogical Institute, and Jizzakh State Pedagogical Institute. A total of 850 students participated, comprising 418 students in the experimental group and 432 in the control group. Their institutional distribution is presented in **Table 3**.

The study aimed to evaluate the impact of STEAM-based educational design on students' methodological preparation for teaching the "Technology" subject in primary education. The assessment relied on established indicators and criteria, including activity-based performance, incentives, cognitive development, and especially social engagement. The effectiveness of the intervention was measured through a statistical comparison of academic performance levels between experimental and control groups, as shown in **Table 4**.

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Table 3. Distribution of students who participated in the experimental work by institution.

No	Higher educational institution	The number of students who participated in the experiment		
		Total	Experimental group	Control group
1.	Tashkent State Pedagogical University	284	140	144
2.	Kokand State Pedagogical Institute	280	138	142
3.	Jizzakh State Pedagogical Institute	286	140	146
	Total	**850**	**418**	**432**

A comparative analysis using the student's t-test revealed a statistically significant difference in academic achievement between the experimental and control groups across all four performance criteria. Students in the experimental group, who received instruction based on the STEAM-integrated methodology, consistently achieved higher results—particularly in the middle and high-performance categories—compared to their control group counterparts who were taught using traditional methods.

Table 4. Levels of learning (academic performance) in the experimental and control groups.

Criteria	groups / high educ	Experimental group			Control group		
		low 55-70%	middle 71-85%	high 86-100%	low 55-70%	Middle 71-85%	high 86-100%
Activity - based	TSPU	18	103	19	6	44	94
	JSPU	15	99	24	4	42	96
	KSPU	16	101	23	5	43	98
	Total	49	303	66	15	129	288
Incentives	TSPU	21	101	18	5	43	96
	JSPU	16	101	21	5	41	96
	KSPU	15	104	21	5	40	101
	Total	52	306	60	15	124	293
Cognitive	TSPU	19	105	16	6	41	97
	JSPU	18	104	16	5	42	95
	KSPU	17	101	22	4	41	101
	Total	54	310	54	15	124	293
Specially social	TSPU	21	100	19	5	42	97
	JSPU	19	103	16	4	43	95
	KSPU	20	101	19	4	45	97
	Total	60	304	54	13	130	289

A comparative analysis using the student's t-test revealed a statistically significant difference in academic achievement between the experimental and control groups across all four performance criteria. Students in the experimental group, who received instruction based on the STEAM-integrated methodology, consistently achieved higher results—particularly in the middle and high-performance categories—compared to their control group counterparts who were taught using traditional methods.

The findings of this study demonstrate a notable positive impact of implementing STEAM-based teaching strategies on the methodological readiness of prospective primary school teachers to deliver instruction in the "Technology" subject (Anisimova *et al*., 2020; Xefteris, 2021). The experimental group's outcomes significantly surpassed those of the control group

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across all measured criteria. In terms of activity-based learning, the experimental group exhibited a higher degree of student engagement, as evidenced by 303 students reaching a moderate level of performance and 66 students attaining high performance. In comparison, only 129 and 288 students from the control group achieved moderate and high performance, respectively. This suggests that STEAM-oriented tasks effectively captured students' interest and encouraged active participation in learning (Aktulun *et al*., 2024).

Moreover, the superior performance in the incentives criterion within the experimental group indicates that the STEAM approach contributed to stronger intrinsic motivation and a sustained commitment to learning (Aktulun *et al*., 2024). The integration of real-life contexts, project-based activities, and creative tasks likely played a role in fostering students' persistence and enthusiasm. In terms of cognitive development, the experimental group showed clear advancements in analytical and problem-solving capabilities—skills that are essential in technological education and were less evident in the control group (Bédard *et al*., 2012; Omelianenko & Artyukhova, 2024). This confirms that the interdisciplinary nature of STEAM not only enhances content understanding but also nurtures higher-order thinking skills.

Social competence also improved significantly among students in the experimental group, which may be attributed to the collaborative structure of STEAM projects. Working in teams, sharing responsibilities, and engaging in cross-disciplinary communication likely contributed to stronger interpersonal skills and cooperation (Lin & Tsai, 2021). Collectively, these findings reveal that the STEAM-based methodology resulted in an overall performance increase of approximately 13–15% compared to the traditional approach used with the control group.

These outcomes align with contemporary educational research that underscores the value of STEAM education in preparing future educators to navigate the demands of modern classrooms. By fostering deep learning, creativity, and practical application of theoretical knowledge, STEAM-based training equips future teachers not only with pedagogical competencies but also with the capacity to cultivate innovation, critical thinking, and collaboration among their own students (Omelianenko & Artyukhova, 2024). Thus, integrating STEAM into teacher education programs represents a vital step toward enhancing both teaching quality and learner outcomes in primary education.

4. CONCLUSION

The results of this study confirm that improving the methodological training of future primary school teachers in the subject of Technology requires an integrated approach that emphasizes both theoretical foundations and practical applications within the framework of "STEAM education." The development of students' pedagogical competencies—such as problem-solving, independent thinking, responsibility, teamwork, self-assessment, and adaptive learning—is essential for ensuring that prospective teachers are capable of addressing the diverse needs of primary school learners. These skills are further cultivated through the inclusion of collective creative tasks, developmental learning strategies, and activities that promote critical reflection and resilience when encountering complex challenges. The refinement of qualification standards and their alignment with the hierarchical levels of STEAM education has helped structure training programs more effectively and systematically.

Moreover, this study validates the need to integrate methodological training within the broader academic curriculum of the bachelor's program in Primary Education and Sports and Educational Work. The proposed model not only fosters interdisciplinary connections across

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subject areas but also supports the seamless inclusion of technology education into the general pedagogical framework. By applying the STEAM approach, the educational process is transformed into a dynamic learning environment where students are not merely passive recipients of knowledge but become active participants engaged in inquiry, design thinking, experimentation, and real-world problem-solving.

The adoption of STEAM-oriented methodologies has also enabled the development of specific strategies that connect technological literacy with fundamental scientific concepts, engineering logic, mathematical reasoning, and artistic design—bridging theory and practice in ways that are meaningful to both learners and future educators. Additionally, the study has presented an innovative pedagogical design for individualized learning trajectories, which enhances the personalization of teacher training and contributes to improved quality and outcomes in methodological instruction.

Using Bloom's taxonomy as a foundational framework, a comprehensive set of assessment tools and level indicators has been created to evaluate the methodological preparedness of future teachers in teaching Technology. These tools offer a systematic way to measure and support the growth of essential instructional skills, particularly within the domain of geometry and spatial reasoning. Furthermore, the development of educational and methodological resources tailored to the STEAM approach provides future educators with concrete guidance and materials for effectively delivering Technology content in primary classrooms. In conclusion, the integration of STEAM principles into methodological training ensures a more holistic, innovative, and future-ready education for both teachers and their young students.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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