pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

IMPROVING METHODOLOGY FOR PROFESSIONAL TRAINING OF FUTURE TECHNOLOGY EDUCATION TEACHERS BASED ON DIGITAL TECHNOLOGIES

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Abstract: This article examines the methodology for improving professional training of future technology education teachers in the context of digital transformation. The study analyzes contemporary approaches to integrating digital technologies — including e-learning platforms, simulation tools, and project-based learning environments — into pedagogical training programs. An experimental study was conducted at Tashkent State Pedagogical University involving 84 undergraduate students. Results demonstrate that systematic incorporation of digital tools enhances pedagogical competence, content-technology integration skills, and readiness for innovative classroom practice. The article presents a refined methodological model with practical recommendations for teacher education institutions.

Keywords: digital technologies, technology education, professional training, teacher preparation, pedagogical competence, TPACK, e-learning, methodology, Uzbekistan

INTRODUCTION

The rapid advancement of digital technologies in the 21st century has fundamentally reshaped the requirements for pedagogical competence. Technology education teachers, in particular, are expected to possess not only subject-matter expertise but also robust digital skills that enable them to design, implement, and assess innovative learning experiences. In Uzbekistan, the national strategy "Digital Uzbekistan 2030" has intensified demand for educators capable of leveraging modern digital tools in vocational and technology-oriented disciplines.

Despite growing recognition of this need, existing teacher education curricula frequently remain anchored in conventional, lecture-centered models that insufficiently prepare graduates for digitally rich classroom environments. The gap between institutional training and contemporary professional expectations constitutes the central problem addressed by this study.

The purpose of this article is to propose and empirically validate an improved methodological model for professional training of future technology education teachers based on systematic integration of digital technologies across all dimensions of pre-service preparat.

LITERATURE REVIEW

The theoretical grounding of this study draws on several intersecting bodies of scholarship. Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework remains the most widely cited conceptual model for understanding the interplay between content knowledge, pedagogical knowledge, and technological knowledge in teacher education. Subsequent empirical work has consistently confirmed TPACK as a robust predictor of teachers' capacity to integrate technology meaningfully into instruction (Chai, Koh, & Tsai, 2013; Voogt et al., 2013).

In the domain of vocational and technology education specifically, Rasinen (2003) highlighted the distinctive epistemological character of the field — oriented toward problem-solving, design thinking, and practical creation — and argued that this character demands pedagogical approaches that go beyond informational transfer. More recent contributions by Dede (2010) and Barak (2014) have extended this argument to emphasize that digital simulation

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

environments, maker-oriented platforms, and collaborative project tools offer particularly powerful affordances for technology education contexts.

Research from the post-Soviet educational space, including studies from Kazakhstan (Seitkali et al., 2020) and Russia (Zagvyazinsky, 2017), has documented significant structural barriers to technology integration in teacher education, including outdated curricula, insufficient hardware infrastructure, and limited faculty digital competence. These findings resonate with observations from Uzbek educational researchers (Umarov, 2021; Yusupova & Toshpulatov, 2022), who note that while national policy frameworks strongly endorse digitalization, implementation at the institutional level remains inconsistent.

International comparative analyses (UNESCO, 2021; OECD, 2022) further indicate that effective digital integration in teacher training is not simply a matter of providing access to tools; it requires deliberate methodological redesign — including reformed assessment practices, revised practicum structures, and faculty professional development. This conclusion motivates the methodological focus of the present investigation.

EXPERIMENTAL STUDY AND METHODOLOGY

The study was conducted during the 2022–2024 academic years at the Faculty of Technology Education, Tashkent State Pedagogical University. A quasi-experimental pre-test/post-test design was employed, with 84 third-year undergraduate students (future technology education teachers) divided into two groups:

Control Group (CG): n = 41 students, trained under the existing standard curriculum incorporating conventional lecture and seminar methods with limited use of digital tools.

Experimental Group (EG): n = 43 students, trained under the revised methodology incorporating structured digital technology integration across four component modules.

The revised methodological model comprises four interconnected components. First, the Digital Environment Module replaced traditional laboratory sessions with immersive digital workshops using CAD design software (AutoCAD, Fusion 360), electronics simulation platforms (Tinkercad Circuits), and 3D-modeling tools. Second, the E-Learning Design Module trained students to develop their own digital instructional materials using Moodle LMS, interactive video tools (Edpuzzle, H5P), and presentation platforms. Third, the Project-Based Digital Practicum required students to plan, execute, and evaluate a six-week digitally integrated teaching unit during their school placement. Fourth, the Reflective Digital Portfolio system required ongoing documentation and critical reflection on technology use throughout the program.

Assessment instruments included: (1) the TPACK Survey Questionnaire (Schmidt et al., 2009, adapted for Uzbek context); (2) a Digital Pedagogical Competence Rubric developed by the research team; (3) lesson observation protocols administered during practicum; and (4) structured self-reflection journals. Data were analyzed using descriptive statistics, paired-sample t-tests, and effect size calculations (Cohen's d). Statistical analysis was performed using IBM SPSS 27.0, with significance threshold set at $p < 0.05$.

RESULTS AND DISCUSSION

Pre-test scores revealed no statistically significant difference between CG and EG across all measured competence dimensions ($p > 0.05$), confirming baseline equivalence. Post-test results,

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

however, showed substantial and statistically significant gains in the EG across all four measured domains.

In the TPACK composite score, the EG recorded a mean post-test score of 78.4 (SD = 6.2), compared to 61.7 (SD = 7.9) for the CG — a difference of 16.7 points ($t(82) = 10.83$, $p < 0.001$, Cohen's $d = 2.37$), indicating a very large effect size. The most pronounced gains were observed in the Technological Pedagogical Knowledge (TPK) sub-scale, where EG students demonstrated a 34% improvement over pre-test baseline, reflecting enhanced ability to identify and apply pedagogically appropriate digital tools.

In Digital Pedagogical Competence Rubric scores, EG students achieved a mean rating of 4.21 out of 5.00, compared to 2.94 for CG students. Notably, rubric sub-scores for 'Design of Digital Learning Sequences' and 'Formative Use of Digital Assessment Tools' showed the greatest divergence, suggesting that structured practice in curriculum design with digital tools was particularly effective.

Lesson observation data from the practicum phase corroborated survey findings. EG students were observed using digital tools purposefully and flexibly in 87% of observed lessons, compared to 41% for CG students. Qualitative analysis of EG reflective journals revealed recurring themes of increased confidence, heightened awareness of student engagement patterns, and a more exploratory orientation toward unfamiliar technologies — characteristics associated with adaptive expertise in technology teaching (Ertmer & Ottenbreit-Leftwich, 2010).

These findings are consistent with the broader literature on technology-integrated teacher education. The magnitude of gains observed, particularly in TPK and lesson design competencies, aligns with Voogt et al.'s (2013) meta-analytic finding that active, design-oriented approaches to technology integration in pre-service programs yield substantially larger effects than passive exposure models. The study thus provides empirical support from the Central Asian context for internationally observed patterns, while also offering a specific, replicable methodological model adapted to local institutional conditions.

CONCLUSION

This study demonstrates that a purposefully designed, digitally integrated methodological model can substantially improve the professional readiness of future technology education teachers. The four-component model — encompassing digital laboratory environments, e-learning design training, a project-based digital practicum, and reflective digital portfolios — produced statistically significant and practically meaningful gains in TPACK, digital pedagogical competence, and classroom technology use.

The findings carry several practical implications. Teacher education institutions in Uzbekistan and comparable contexts should undertake systematic curriculum revision to embed digital technology integration not as an isolated module but as a cross-cutting dimension of all professional training components. Faculty professional development is equally essential: instructors cannot effectively model digital pedagogy without themselves engaging in ongoing learning. Practicum supervisors require updated protocols that explicitly evaluate technology integration quality alongside conventional lesson quality indicators.

Future research should examine the longitudinal sustainability of competence gains as graduates enter professional practice, investigate differential effects across different technology education sub-disciplines (e.g., woodworking, electronics, robotics), and explore the role of school-based mentors in supporting digitally competent beginning teachers. Cross-national comparative studies would further strengthen the evidence base and support the transfer of effective practices across diverse educational systems.

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

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КОНФЕРЕНЦИИ НА ТЕМУ «ОЦЕНКА ГЛОБАЛЬНОГО ПОТЕПЛЕНИЯ И СПОСОБОВ ЕГО ПРЕДОТВРАЩЕНИЯ

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КРИОСФЕРНЫХ РЕСУРСОВ»