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INTERNATIONAL EXPERIENCE OF AN INTEGRATIVE APPROACH IN THE TRAINING OF TECHNOLOGY TEACHERS AND ITS ADAPTATION TO THE EDUCATION SYSTEM OF UZBEKISTAN

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Abstract

This article provides a comparative analysis of the international experience of an integrative approach in training technology teachers (USA, Finland, Germany, Japan, South Korea, Great Britain) and substantiates the possibilities of its adaptation to the pedagogical education conditions of Uzbekistan. The general principles of foreign models are highlighted, and an adapted model with four components (content, technological, practical, and evaluative) is proposed. The conclusion defines the conditions for implementing the model and the directions for further empirical research.

Keywords: Integrative approach, technology education, teacher training, STEAM, comparative pedagogy, pedagogical education, competence.

Introduction

The development of modern production, the digital economy, and engineering technologies is fundamentally changing the content of school technology and the requirements for teachers. In the traditional approach, the science of technology was primarily focused on the formation of labor skills. Today, this subject must

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be studied in close connection with mathematics, physics, computer science, art, and entrepreneurship. Therefore, an integrative approach that ensures interdisciplinary connectivity in the teacher training process is becoming increasingly relevant. In Uzbekistan, issues of improving the quality of education, raising the prestige of the teaching profession, and bringing education closer to international standards have been identified as priority areas of state policy. In particular, the Law "On Education" (2020), the Concept for the Development of the Public Education System until 2030 (PF-5712, 2019), and the Development Strategy of New Uzbekistan (PF-60, 2022) outline the tasks of implementing the competency-based approach, practice-oriented approach, and innovative pedagogical technologies. The foundations of the theory of the integrative approach are highlighted in the research of J. Bin (Beane, 1997), R. Fogarty (Fogarty, 1991), S. Drake, and R. Burns (Drake & Burns, 2004). Issues regarding the integration of STEM and STEAM have been thoroughly analyzed by J. Sanders (2009), G. Yakman (2008), T. Kelly, and J. Knowles (Kelley & Knowles, 2016), as well as in the report of the American National Research Council (Honey, Pearson & Schweingruber, 2014). L. Shulman's concept of pedagogical content knowledge (PCK) and the TPACK model proposed by P. Mishra and M. Kohler (2006) are widely used in structuring teacher knowledge. Nevertheless, there is insufficient work dedicated to the systematic adaptation of international experience to the conditions of Uzbek pedagogical education. Most existing studies consider integration at the level of the school educational process, while the mechanisms at the teacher training stage have been little studied. The aim of the research is to analyze the international experience of an integrative approach in training technology teachers and to substantiate a model for its adaptation to the education system of Uzbekistan. To achieve the goal, the following tasks were defined: (1) to determine the theoretical foundations of the integrative approach; (2) a comparative analysis of the experience of the selected countries according to general criteria; (3) assessment of regulatory documents and curricula in

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Uzbekistan from an integrative perspective; (4) development of an adapted model.

Main part:

In the modern education system, the process of training technology teachers is not limited to acquiring pedagogical knowledge, but also requires the harmonization of technical, natural science, mathematical, information-communication, and engineering knowledge. This is because today the subject of technology performs multifaceted tasks such as forming students' labor skills, developing technical thinking, solving problem situations, and organizing design and practical activities. From this perspective, an integrative approach to the professional training of technology teachers is of great pedagogical and methodological importance.

An integrative approach is a pedagogical approach aimed at forming holistic knowledge, skills, and competencies through the interconnected organization of educational content, methods, tools, and types of practical activities. In this approach, knowledge acquired within the framework of individual disciplines is combined based on a single educational goal. As a result, future teachers develop the ability to apply theoretical knowledge in practical tasks, identify interdisciplinary connections, and design the educational process based on modern requirements.

Integration in the training of technology teachers primarily involves harmonizing the content of pedagogical and specialized disciplines. For example, in the process of designing a product or technical device, future teachers use mathematical calculation methods, mechanical and energy laws in physics, digital design tools in computer science, composition and design principles in fine arts, and teaching methods and evaluation criteria in pedagogy. Such an organized educational process serves to understand the interdependence of professional knowledge and its practical application.

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The methodological basis of the integrative approach consists of systemic, competency-based, activity-oriented, and problem-based educational approaches. While a systems approach helps organize the components of educational content as a whole, a competency-based approach directs the application of acquired knowledge in real professional situations. The activity-oriented approach activates the activities of future teachers in independent design, conducting experiments, and performing practical tasks. The problem-based educational approach develops skills in finding independent solutions to existing problems, critical thinking, and creative decision-making.

Thus, the integrative approach is an effective methodological basis that allows for the improvement of the content and organizational aspects of technology teacher training, the formation of professional competencies, and the organic connection of education with production, innovation, and digital technologies.

Methods used in the study:

The study is theoretical and comparative in nature, based on a qualitative approach, and was conducted in four stages (Fig. 1). At the first stage, scientific sources were selected and systematized. At the second stage, a comparative analysis of foreign experience was conducted. In the third stage, a content analysis of Uzbekistan's regulatory documents, curricula, and programs was conducted. Based on the results obtained in the fourth stage, an adapted model was designed.

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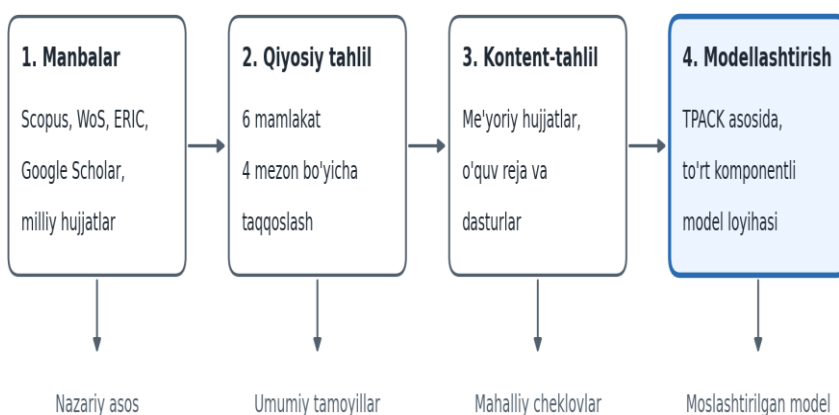


Figure 1. Research design: each stage provides input information for the next stage, and the final result is a tailored model.

Sources were searched through international scientific databases (Scopus, Web of Science, ERIC, Google Scholar) and the national database of regulatory legal acts. Selection criteria: (a) direct relevance to the topic (technological education, teacher training, interdisciplinary integration); (b) published within the last fifteen years (2009-2025); (c) the status of the judged publication or official document. Countries were selected for comparative analysis on two grounds: having recognized experience in integrating technology education and the possibility of studying the education system as a model for Uzbekistan.

Criteria for comparative analysis. The experience of each country was reviewed based on four criteria: form of integration (interdisciplinary, intra-disciplinary, project-based); teacher training structure; practice and collaboration with industry; and an evaluative approach.

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Content analysis. Regulatory documents, state educational standards, and curricula for training technology teachers in Uzbekistan were analyzed based on the concepts of "integration," "competence," "practice," "digital technologies," and "project-based education."

Modeling. At the final stage, the analysis results were summarized based on the TPACK and competency-based approach, and a model diagram was developed.

Comparative analysis of international experience

The results of the analysis are summarized in Table 1.

Table 1. An integrative approach to training technology teachers in selected countries

Country	Integration form	Specifics in teacher training
USA	Based on interdisciplinary, engineering projects within STEM/STEAM	The process of engineering design and STEM integration is integrated into the teacher training course; many programs combine technology and engineering education.
Finland	Phenomenon-based learning, handicraft science	The 2014 National Curriculum (current from 2016) provides for interdisciplinary multidisciplinary training modules; teachers are trained as researchers at the master's level.
Germany	Technical/labor sciences, professional orientation	Two-stage training (university and practical training - Referendariat); close contact with the vocational education system
Japan	Technology and household block, "Sogo" (integrative learning) stages	A tradition of collaborative lesson analysis (jogyō kenkyū) focused on school practice.
South Korea	STEAM education (official policy since 2011)	Special STEAM teacher training and professional development programs, based on digital resources
United Kingdom	Design and Technology (D&T) Science	Emphasis on design process and materials practice; high proportion of school practice

Comparative analysis revealed the following general principles. **Firstly**, integration is built around project activities aimed at solving a real problem, rather than mechanical unification. **Secondly**, theoretical knowledge in teacher training

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programs is inextricably linked to school and industrial practice. **Thirdly**, the teacher themselves will gain experience in participating in an interdisciplinary project, meaning they will learn not by learning integration, but by experiencing it. **Fourthly**, evaluation takes into account not only knowledge but also the process, cooperation, and final product. Analysis of the situation in Uzbekistan: An analysis of regulatory documents showed that the tasks of developing a competency-based approach, practice-oriented approach, and digital education are firmly reflected in the documents. However, the following limitations are observed in teacher training curricula: technological, pedagogical, and interdisciplinary blocks are taught relatively separately from each other; interdisciplinary project work is not systematic in nature; pedagogical practice is often limited to observation, and cooperation with production and technology parks is limited; assessment is primarily focused on verifying theoretical knowledge.

Adapted model: Based on comparative analysis and analysis of the conditions of Uzbekistan, a four-component model is proposed (Figure 2):

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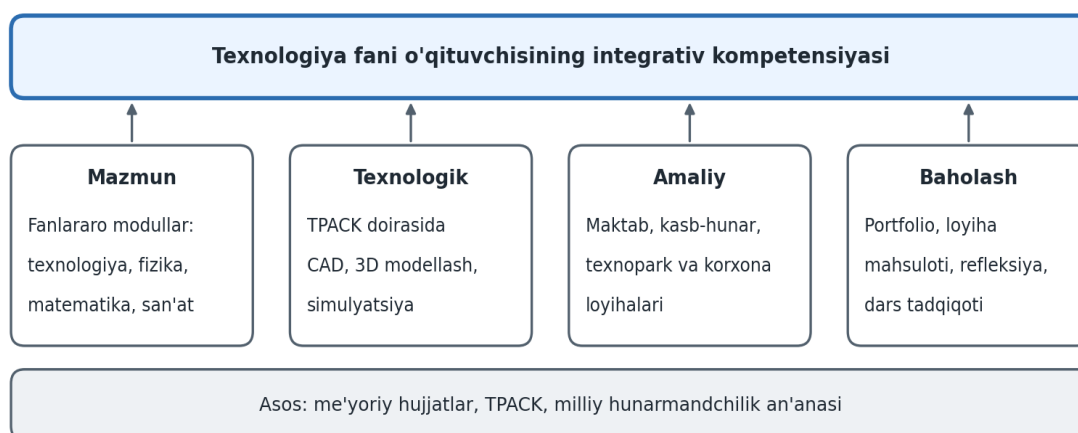


Figure 2. An adapted model: the four components are oriented toward general competence, based on a regulatory and theoretical foundation.

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- **Content component** - integrative modules that combine key concepts between technology, mathematics, physics, computer science, and art disciplines.
- **Technological component** - Competence in working with digital tools (CAD, 3D modeling, simple programming, simulation) within TPACK.
- **Practical component** - step-by-step internships in schools, vocational education institutions, technology parks, and enterprises, as well as interdisciplinary project work.
- **Evaluation component** - assessment based on portfolio, project product, reflection, and peer analysis (lesson research).

Discussion

The research results show that the effectiveness of an integrative approach depends on its systematic integration into the teacher training process. This conclusion aligns with the views of Kelly and Knowles (2016) and Honey et al. (2014) on integration: the success of integration relies on the teacher's ability to see interdisciplinary connections and manage project activities. The experience of Finland and Japan is particularly relevant for the Uzbek context: the former emphasizes the teacher's research position, the latter the culture of collaborative lesson analysis. These ideas can be implemented without requiring significant additional resources, for example, by organizing "lesson research" groups within existing pedagogical practice. The experience of South Korea demonstrates the possibility of implementing integration based on a centralized state policy, which can be suitable for the centralized management structure of Uzbekistan. At the same time, the direct transfer of the foreign model may be ineffective. When adapting, the following local factors must be taken into account: interregional differences in the material and technical base, the level of digital training of teachers, and national handicraft traditions. It is the latter factor that creates an important opportunity: traditional professions such as pottery, jewelry, wood carving, and atlas weaving can become project topics that naturally combine

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technology, art, chemistry, and economics. The limitation of the study is its theoretical-comparative nature: the effectiveness of the proposed model has not yet been proven through pedagogical experimentation. Therefore, at the next stage, the model should be tested in selected higher educational institutions, and the competence of the participants should be evaluated using previous and subsequent measurements.

Summary:

1. International experience shows that the effective implementation of an integrative approach relies on project-based activities, interconnection with practice, the teacher's experience of integration, and multifaceted assessment.
2. Uzbekistan's regulatory framework provides a sufficient foundation for implementing an integrative approach; however, interdisciplinary blocks are distinguished in teacher training curricula, and the practice and assessment system require updating.
3. The proposed model, consisting of content, technological, practical, and evaluative components, allows for the adaptation of international principles to local conditions, including national craftsmanship traditions.
4. Further research should focus on experimental testing of the model and evaluating its impact through quantitative indicators.

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