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# PEDAGOGICAL POTENTIAL OF INNOVATIVE TECHNOLOGIES IN THE DEVELOPMENT OF SUBJECT-METHODOLOGICAL COMPETENCE OF FUTURE TECHNOLOGY TEACHERS

*Abstract*

The article addresses the topical issue of developing the subject-methodological competence of future technology teachers within the context of the modernization of higher pedagogical education. The study substantiates the expediency of employing innovative educational technologies as an effective means of integrating the theoretical and practical components of professional teacher training. The essence of the subject-methodological competence of future technology teachers is clarified in accordance with the Professional Standard for Teachers of General Secondary Education Institutions, and its significance for ensuring the quality of the educational process is emphasized. Particular attention is paid to the pedagogical potential of information and communication technologies (ICT), digital technologies, project-based and interactive teaching methods, STEM and STEAM approaches, distance and blended learning formats, problem-based learning, the case study method, as well as technologies for modelling and visualizing educational content.

The purpose of the study is to provide a theoretical substantiation of the pedagogical potential of innovative educational technologies in the development of the subject-methodological competence of future technology teachers and to

identify effective approaches, forms, and methods for their implementation in the educational process of higher pedagogical education institutions.

Research methodology is based on theoretical methods, including analysis, synthesis, and generalization of scientific literature, educational policy and regulatory documents, as well as comparative analysis of pedagogical approaches to the professional training of future technology teachers.

Scientific novelty lies in the comprehensive analysis and identification of the methodological potential of innovative educational technologies as an integrated didactic toolkit for developing the subject-methodological competence of future technology teachers.

The findings indicate that innovative educational technologies create favourable conditions for developing the professional autonomy of future technology teachers, as well as their critical, technical, and creative thinking. Furthermore, they promote the ability to make pedagogically sound decisions and enhance readiness to implement contemporary methods of technology education in general secondary education institutions.

*Keywords:* subject-methodological competence, future technology teachers, innovative educational technologies, professional teacher training, higher pedagogical education.

*Problem statement.* In the context of contemporary educational development, particular attention is paid to the preparation of highly qualified teachers who are capable of effectively organizing the educational process, integrating modern technologies into teaching, and adapting educational content to the individual needs of learners. One of the key components of the professional training of future technology teachers is the development of subject-methodological competence, which encompasses not only comprehensive theoretical knowledge of the

technological education domain but also the ability to apply effective teaching methods and innovative pedagogical approaches in professional practice.

According to the Professional Standard for Teachers of General Secondary Education Institutions [2], subject-methodological competence is defined as a complex, multidimensional construct integrating professional knowledge, skills, and abilities, communicative competence, as well as an appropriate level of professional responsibility and teacher autonomy. In the context of technology teacher education, subject-methodological competence implies thorough mastery of the content of the technological education field, knowledge of contemporary teaching methods and instructional technologies, and the ability to adapt them pedagogically to meet the diverse educational needs of learners in order to ensure the effectiveness and quality of the educational process.

This competence constitutes the theoretical and methodological foundation for achieving educational objectives, organizing and assessing students' learning outcomes, and creating conditions conducive to their academic development. In accordance with the Professional Standard, the structure of subject-methodological competence of future technology teachers includes the ability to design educational content in alignment with the mandatory learning outcomes established by national educational standards; to develop learners' key competencies and cross-curricular skills; to organize integrated learning by applying knowledge of the types and mechanisms of integration within the technological education domain and implementing interdisciplinary approaches in technology education; and to select and implement contemporary teaching, learning, and assessment methods aimed at fostering students' knowledge, skills, values, and personal development [2].

Despite the regulatory definition of subject-methodological competence and its pivotal role in teachers' professional practice, a number of contradictions remain between contemporary requirements for teacher education and the actual

organization of the educational process in higher pedagogical education institutions. In particular, the insufficient integration of innovative educational technologies into the process of developing the subject-methodological competence of future technology teachers continues to hinder the effective implementation of the competency-based approach in teacher education.

Another significant contradiction lies between the necessity of preparing future teachers to design, model, and implement contemporary technology education and the continued predominance of traditional instructional forms and teaching methods, which often fail to provide an adequate level of practical training or foster students' professional autonomy. Against the backdrop of the digital transformation of education, the expansion of distance and blended learning, and the increasing implementation of information and communication technologies (ICT), as well as STEM-oriented educational approaches, there is a growing need for the purposeful integration of innovative educational technologies into teacher education. Such technologies represent an effective means of developing the subject-methodological competence of future technology teachers and are consistent with the current demands of technology education as well as the requirements of the Professional Standard for Teachers of General Secondary Education Institutions.

*Analysis of recent research and publications*. The development of the subject-methodological competence of future teachers, including future technology teachers, has become an important focus of scholarly research conducted by Ukrainian educators, who examine this issue within the broader context of teacher professional training and the implementation of the competency-based approach in education. In our previous studies, we analyzed theoretical approaches to defining the content and structure of the subject-methodological competence of technology teachers, thereby establishing a

theoretical foundation for further investigation into the potential of innovative educational technologies as a means of developing this competence [4].

O. Kobernyk, S. Yashchuk, and M. Oleksiuk emphasize the significance of methodological and project-technological competencies in the professional preparation of future technology teachers. V. Steshenko and D. Kilderov identify a system of specialized professional competencies required for technology teachers, whereas V. Savchenko, L. Kutsak, Yu. Tsyna, O. Kitova, and S. Chernyshov consider professional and pedagogical competence as an integrative characteristic of students' readiness for effective professional practice. Subject-methodological competence has been investigated directly by V. Vorozhbit-Horbatiuk, A. Boiarska-Khomenko, and S. Dotsenko, while its structural components and dynamic nature have been substantiated in the studies of A. Voloshchuk, O. Piskunova, and N. Yatsynina. Furthermore, the research conducted by I. Tkachivska [3], H. Lokarieva, and V. Nikonenko [1] demonstrates the positive impact of innovative educational technologies—particularly information and communication technologies, project-based learning, and digital technologies—on the development of students' professional knowledge, skills, and competencies, which constitute essential components of subject-methodological competence.

Despite the substantial body of research devoted to this issue, the scientific and methodological literature still lacks a systematic approach to the purposeful use of contemporary innovative educational technologies as a means of developing the subject-methodological competence of future technology teachers. Most existing studies focus either on the theoretical foundations of professional competence or on the application of individual educational technologies without considering their integrated implementation within the system of professional teacher education. Consequently, there remains a clear theoretical and practical need for further research aimed at designing integrated pedagogical models, developing methodological guidelines, and establishing criteria for the effective

implementation of innovative educational technologies in the professional preparation of future technology teachers.

*Purpose of the article*. The purpose of this study is to provide a theoretical substantiation of the pedagogical potential of innovative educational technologies in the development of the subject-methodological competence of future technology teachers and to identify effective approaches, forms, and methods for their implementation in the educational process of higher pedagogical education institutions in order to enhance the quality of professional teacher education, foster students' creative and critical thinking, and develop their readiness to effectively implement contemporary approaches to technology education in general secondary education institutions.

*Presentation o f the main material o f the study*. Within the framework of this study, the subject-methodological competence of a future technology teacher is regarded as an integral component of professional teacher education, manifested in the ability to design, organize, and implement the educational process in accordance with the requirements of contemporary educational standards. It is based on the integration of comprehensive knowledge of the technological education domain, proficiency in modern teaching methods and instructional technologies, and practical experience in applying pedagogical strategies in authentic educational settings [5].

Contemporary innovative educational technologies play a pivotal role in developing the subject-methodological competence of future technology teachers. These include information and communication technologies (ICT), digital technologies, project-based and interactive learning technologies, STEM and STEAM approaches, distance and blended learning, problem-based learning, the case study method, modelling and visualization technologies for educational content, as well as the use of online educational platforms and digital resources. Together, these technologies facilitate the integration of theoretical instruction

with practical training, promote professional autonomy and creativity, and enhance future teachers' capacity to design and implement contemporary technology education. The following sections examine their pedagogical potential and specific features of application within the professional preparation of future technology teachers.

Distance learning and digital educational platforms provide prospective teachers with continuous access to instructional and methodological resources regardless of time and location, thereby expanding opportunities for individualized learning and the development of personalized educational trajectories. Lecture materials, practical assignments, methodological guidelines, video tutorials, examples of educational projects, and teaching resources hosted on digital learning platforms such as Google Classroom, Moodle, and Microsoft Teams create a comprehensive digital learning environment that supports the systematic acquisition of professional knowledge and skills. The integration of these platforms into the educational process ensures a close connection between theoretical preparation and practical training. Students are able to engage with interactive learning materials, complete practical and creative assignments at their own pace, analyze their performance, and refine their work based on formative feedback provided by instructors.

Furthermore, the distance learning environment promotes students' independent cognitive activity by developing their ability to plan their own learning, monitor academic progress, and evaluate learning outcomes. These competencies are of particular professional significance for future technology teachers, whose future responsibilities extend beyond mastering contemporary instructional technologies to include organizing project-based technological activities, facilitating both individual and collaborative student learning, and monitoring learners' academic achievement. In addition, the systematic use of distance learning technologies contributes to the development of students' digital

competence, preparing them to effectively employ digital resources, online tools, and educational platforms in their future professional practice within general secondary education institutions.

Interactive teaching methods are designed not only to facilitate the acquisition of theoretical knowledge but also to promote learners' active engagement in the educational process through experiential learning. These methods encompass the use of virtual laboratories, simulation software, digital assessment systems, and online consultations.

The integration of virtual laboratories into the study of technology-related disciplines, such as General Physics, Electrical Engineering, Engineering Mechanics, Machine Science, and Fundamentals of Manufacturing, enables students to simulate authentic industrial, technical, and technological processes without risks to health and without the need for sophisticated or costly equipment. Consequently, future technology teachers are provided with opportunities to repeatedly perform experimental procedures, modify process parameters, and evaluate the outcomes of their decisions. Such learning experiences contribute to a deeper understanding of cause-and-effect relationships and foster the development of engineering thinking.

Simulation software represents an effective instructional tool for developing students' analytical and critical thinking, as it involves solving problem-based tasks that closely reflect the professional activities of technology teachers. Simulating classroom instruction, students' project-based activities, manufacturing processes, and technical systems encourages prospective teachers to predict outcomes, evaluate alternative solutions, and independently identify the most appropriate strategies for achieving educational objectives.

The use of digital assessment systems ensures systematic monitoring of students' academic achievement while fostering self-assessment and reflective learning skills. Computer-based testing incorporating immediate feedback enables

learners to identify knowledge gaps, analyze common errors, and adjust their learning strategies accordingly. For future technology teachers, such experience is particularly valuable, as it equips them with the ability to design and apply digital assessment tools for evaluating students' learning outcomes in their future professional practice.

Online consultations facilitate effective communication between instructors and students, promote individualized learning, and provide continuous pedagogical support throughout the educational process. During these consultations, future technology teachers are able to discuss complex theoretical issues, receive guidance on practical and project-based assignments, and refine their individual learning trajectories.

Project-based learning provides opportunities for students to engage actively in purposeful, independent, and creative educational activities. Throughout the implementation of educational projects, students not only acquire theoretical knowledge but also gain practical experience in applying it within authentic or professionally simulated educational contexts.

Within the system of professional preparation of future technology teachers, project-based methods facilitate the integration of technical, technological, artistic-design, psychological, and pedagogical disciplines, thereby contributing to the development of a holistic professional worldview. The implementation of educational projects enables students to model both typical and complex situations encountered in the professional practice of technology teachers, including lesson planning and organization, extracurricular activities, the development of instructional and methodological materials, the selection of appropriate teaching methods and instructional resources, and the assessment of students' learning outcomes.

A distinctive feature of project-based learning is its alignment with the activity-based and competency-based approaches, which position students as

active participants in the educational process. Within project activities, prospective teachers learn to formulate project goals and objectives, plan implementation stages, select appropriate resources, search for, analyze, and synthesize information, as well as present and justify the results of their work. This approach promotes the development of independence, responsibility, critical and creative thinking, reflective skills, and the ability to evaluate one's own professional performance.

Multimedia technologies and digital educational resources create favourable conditions for the visual, accessible, and well-structured presentation of educational content, which is particularly important in the study of technical and technological disciplines, engineering design, and art and design education. Their integration into the educational process enhances students' cognitive engagement, facilitates the comprehension of complex technological concepts and processes, and contributes to the development of digital literacy alongside subject-specific and methodological competencies.

The use of digital educational resources enables the integration of various types of information, including textual, graphical, audio, and video materials, as well as dynamic models, animations, and interactive simulations. This facilitates a deeper understanding of complex technological processes, the operating principles of machines and mechanisms, the stages of product design and manufacturing, and contributes to the development of future technology teachers' spatial, technical, and design thinking. In this context, multimedia technologies function not only as a means of visualizing educational content but also as a powerful tool for knowledge construction and students' creative self-expression.

Mastering contemporary tools for presenting and demonstrating educational content, such as multimedia presentations, video lectures, interactive posters, digital instructional materials, three-dimensional (3D) models, and electronic textbooks, enables future teachers to develop the methodological skills required

for the pedagogically appropriate selection and application of digital technologies in the educational process. Furthermore, the development of students' own multimedia products provides valuable experience in project-based technological activities and pedagogical creativity, both of which constitute essential components of the subject-methodological competence of future technology teachers.

Problem-based learning is aimed at enhancing higher education students' cognitive activity, developing critical and technical thinking, and fostering their ability to independently analyze and solve educational and professional problems. Its implementation facilitates the transition from the reproductive acquisition of knowledge to its meaningful application in novel, dynamic, and professionally relevant contexts.

Within the professional preparation of future technology teachers, problem-based learning is implemented through the creation of problem situations that simulate authentic or professionally relevant teaching contexts. Such situations may arise during the analysis of technological processes, product design and modelling, the selection of materials and manufacturing technologies, the development of engineering solutions, the organization of educational projects, or the planning of technology lessons. Confronting students with pedagogical and technological problems encourages them to explore alternative solutions, formulate hypotheses, justify their decisions, and select the most appropriate technological and instructional strategies.

Problem-based learning is particularly significant for the development of the methodological competence of future technology teachers. Through the analysis of pedagogical problem situations, students acquire the ability to select appropriate teaching methods and instructional strategies, predict learning outcomes, engage in reflective practice, and adjust their pedagogical decisions accordingly. Consequently, future teachers become better prepared to implement problem-

oriented tasks in technology education, organize project-based learning, and facilitate students' research and creative activities.

STEM and STEAM approaches are implemented through the interdisciplinary integration of technical, technological, scientific, and information-oriented educational components. Future technology teachers learn to integrate knowledge from physics, electrical engineering, mechanics, engineering and computer graphics, computer science, and the fundamentals of programming to solve complex practical tasks related to product design and manufacturing, technological process analysis, and the organization of students' learning activities. Such an interdisciplinary approach develops the ability to perceive technological objects and processes as complex systems governed by scientific principles and engineering solutions. It ensures the integrity of professional teacher education while promoting systems thinking, engineering thinking, creativity, and innovation, all of which correspond to the contemporary requirements of technology teachers' professional practice within the framework of the New Ukrainian School reform.

By incorporating the Arts component into STEM education, the STEAM approach further expands the opportunities for the professional preparation of future technology teachers through the development of creativity, aesthetic awareness, and design competence. The integration of decorative and applied arts, design and product modelling, computer graphics, and design education enables students to develop the ability to create functionally appropriate, technologically sound, and aesthetically appealing products. Moreover, the implementation of STEM and STEAM approaches possesses substantial methodological potential, as it equips future technology teachers with the competencies required to design contemporary technology lessons, integrated curricula, elective courses, and extracurricular activities based on interdisciplinary connections and practice-oriented learning tasks.

The case study method is focused on the analysis of authentic or simulated professional and pedagogical situations and facilitates the development of students' ability to apply theoretical knowledge in practical contexts. Its implementation brings the educational process closer to the real conditions of general secondary education institutions, stimulates students' cognitive engagement, and creates favourable conditions for the development of the professional thinking of future technology teachers.

Within the professional preparation of future technology teachers, the case study method is implemented through the analysis of educational and professional situations related to the design and delivery of technology lessons, the organization of students' project-based technological activities, the selection of educational content, teaching methods and instructional resources, as well as the solution of pedagogical, methodological, and technological problems. The analysis of cases based on the content of technology-, engineering-, and information-oriented educational components promotes the integration of knowledge acquired in the theory and methodology of technology education, computer science, machine science, electrical engineering, engineering graphics, computer-aided design, and the fundamentals of product design and modelling.

The case study method possesses considerable methodological potential in the professional preparation of future technology teachers, as it enables students to develop the competence required to design their own educational cases for implementation in general secondary education. Prospective teachers acquire practical experience in developing educational scenarios that reflect authentic technological processes, engineering and design tasks, issues related to workplace organization and occupational safety, as well as interdisciplinary connections within technology education.

Educational content modelling and visualization technologies provide effective visual representation of complex technical and technological processes,

engineering solutions, and manufacturing operations that are often difficult to comprehend through traditional explanatory and illustrative teaching approaches. Their implementation enhances the quality of students' learning, promotes the development of spatial and technical thinking, and fosters competencies essential for engineering design and project-based activities.

In the professional education of future technology teachers, modelling and visualization technologies are implemented through the use of computer-aided design (CAD), engineering graphics, three-dimensional (3D) modelling, digital prototypes, animations, and virtual models integrated into technology- and engineering-related educational components. These digital tools enable students to reproduce product design processes step by step, analyze structural characteristics of technical objects, investigate the operating principles of mechanisms and systems, and simulate technological processes while taking into account functional, aesthetic, and safety requirements.

An important advantage of modelling and visualization technologies lies in their substantial methodological potential for the professional preparation of future technology teachers. The use of these technologies enables prospective teachers to create digital product models, technical drawings, diagrams, technological process charts, and visual instructional materials that can subsequently be employed as didactic resources in general secondary education institutions. Consequently, these technologies enhance students' methodological readiness to organize project-based learning activities, promote learners' cognitive engagement, increase learning motivation, and support the development of creativity and problem-solving abilities.

*Conclusions.* The development of the subject-methodological competence of future technology teachers is a complex, multidimensional, and purpose-driven process that requires the systematic integration of traditional pedagogical approaches with contemporary innovative educational technologies. The

effectiveness of this process largely depends on scientifically grounded instructional design, the gradual progression of learning tasks, the organization of independent, project-based, and research-oriented learning activities, as well as the use of digital tools for modelling pedagogical situations and ensuring objective assessment of learning outcomes.

The integration of information and communication technologies (ICT), digital technologies, interactive and project-based learning methods, STEM and STEAM approaches, distance and blended learning formats, problem-based learning, the case study method, and technologies for modelling and visualizing educational content significantly expands the opportunities for developing the subject-methodological competence of future technology teachers. These innovative educational technologies create favourable conditions for enhancing students' cognitive engagement, fostering their critical, technical, and creative thinking, and developing their ability to make pedagogically sound decisions in diverse educational contexts.

Therefore, the integration of innovative educational technologies into the professional preparation of future technology teachers represents a key factor in improving the quality of teacher education. It ensures the development of subject-methodological competence in accordance with contemporary scientific and methodological standards and contributes to the preparation of competitive, highly qualified teachers capable of effectively implementing modern educational strategies, instructional methodologies, and innovative pedagogical practices in the context of the rapidly evolving educational environment.

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