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DEVELOPMENT AND IMPROVEMENT OF PEDAGOGICAL TECHNOLOGIES THAT DETERMINE THE LEVEL OF PROFESSIONAL FORMATION OF FUTURE TEACHERS

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Abstract. This study explores the development and improvement of pedagogical technologies that determine the level of professional formation of future teachers. The research analyzes modern educational approaches, including blended learning, simulation-based instruction, and digital assessment tools, and evaluates their impact on the formation of key professional competencies. The findings indicate that the integration of innovative pedagogical technologies enhances critical thinking, practical teaching skills, and reflective abilities among prospective teachers. At the same time, the effectiveness of these technologies depends on factors such as digital competence, institutional support, and technological infrastructure. The study emphasizes the importance of a systematic and competency-based approach to teacher education and provides recommendations for optimizing the use of pedagogical technologies in higher education.

Keywords: pedagogical technologies, teacher education, professional formation, digital learning, blended learning, competency-based education, simulation-based learning, reflective practice, educational innovation, higher education.

Introduction. In the context of rapid global transformations driven by digitalization, globalization, and the knowledge-based economy, the quality of teacher education has become a central concern for educational systems worldwide. The professional formation of future teachers is no longer limited to the acquisition of subject knowledge and basic pedagogical skills; rather, it encompasses the development of complex competencies, including critical thinking, digital literacy, adaptive expertise, and reflective practice. Consequently, the development and improvement of pedagogical technologies that effectively determine and enhance the level of professional formation of prospective teachers have emerged as a priority research direction in modern pedagogy. Pedagogical technologies, understood as systematically organized methods, tools, and processes aimed at achieving specific educational outcomes, play a decisive role in shaping teacher competencies. Recent studies emphasize that innovative pedagogical technologies—such as blended learning, problem-based learning (PBL), competency-based education, and digital simulation environments—significantly influence the quality of teacher preparation (Darling-Hammond et al., 2020; OECD, 2021). These technologies not only facilitate knowledge acquisition but also foster practical skills, professional identity, and the ability to apply theoretical concepts in real-world teaching contexts.

One of the key challenges in teacher education is ensuring the alignment between theoretical training and practical professional demands. Traditional instructional approaches often fail to provide sufficient opportunities for active engagement, collaboration, and real-life problem solving. In contrast, modern pedagogical technologies enable interactive, student-centered learning environments where future teachers can develop pedagogical thinking, decision-making skills, and professional autonomy. According to recent research, the integration of digital tools, including learning management systems (LMS), virtual classrooms, and artificial intelligence-based tutoring systems, has significantly enhanced the effectiveness of teacher training programs (Holmes et al., 2022; Redecker & Punie, 2023). Moreover, the concept of professional formation itself has evolved, incorporating not only cognitive and practical dimensions but also motivational, ethical, and socio-emotional components. Contemporary

pedagogical technologies are increasingly designed to support holistic development by integrating reflective practices, collaborative learning, and continuous assessment. For instance, e-portfolios, micro-credentialing systems, and formative feedback mechanisms have been widely recognized as effective tools for tracking and supporting the professional growth of future teachers (European Commission, 2022). Another important aspect is the role of pedagogical technologies in fostering lifelong learning competencies. In a rapidly changing educational landscape, teachers must continuously update their knowledge and skills. Therefore, teacher education programs must equip future educators with the ability to independently learn, adapt, and innovate. Modern pedagogical technologies, particularly those based on personalized learning and adaptive systems, provide opportunities for individualized learning trajectories, thereby enhancing the effectiveness of professional training (Siemens & Baker, 2022).

Despite the growing body of research, there remain significant gaps in understanding how specific pedagogical technologies influence different components of professional formation and how these technologies can be systematically implemented in higher education institutions. Furthermore, the contextual factors, such as institutional infrastructure, teacher educators' competencies, and cultural aspects, also play a crucial role in determining the success of pedagogical innovations. Therefore, this study aims to explore the development and improvement of pedagogical technologies that determine the level of professional formation of future teachers. The research focuses on identifying effective technological approaches, analyzing their impact on professional competencies, and proposing recommendations for optimizing teacher education practices in contemporary conditions. By addressing these issues, the study contributes to the advancement of pedagogical science and supports the preparation of highly qualified, competent, and adaptable teachers capable of meeting the challenges of modern education.

Literature review. The development and improvement of pedagogical technologies in teacher education have been widely discussed in recent scholarly literature, particularly in the context of preparing future teachers for complex and dynamic educational environments. Contemporary research emphasizes that pedagogical technologies are not merely instructional tools but integral components of educational systems that shape the professional competencies, identity, and adaptability of prospective teachers. A significant body of research highlights the transition from traditional teacher-centered approaches to student-centered and competency-based models. According to Darling-Hammond et al. (2020), effective teacher education programs integrate active learning strategies, such as problem-based learning (PBL), inquiry-based learning, and collaborative practices, which promote deeper understanding and professional readiness. These approaches are supported by pedagogical technologies that facilitate interaction, reflection, and real-world problem solving. Similarly, the OECD (2021) report underscores the importance of innovative teaching methods that align with 21st-century skills, including critical thinking, creativity, and digital competence.

Digital transformation has become a central theme in recent studies on pedagogical technologies. The integration of digital tools such as Learning Management Systems (LMS), virtual simulations, augmented reality (AR), and artificial intelligence (AI)-based systems has significantly enhanced the quality of teacher preparation. Holmes et al. (2022) argue that AI-driven educational technologies enable personalized learning experiences, allowing future teachers to progress according to their individual needs and competencies. Furthermore, Redecker and Punie (2023) emphasize that digital competence frameworks, such as DigCompEdu, provide structured guidelines for integrating technology into teacher education, thereby improving both pedagogical and technological proficiency. Blended learning has emerged as one of the most effective pedagogical technologies in recent years. Research indicates that combining online and face-to-face learning environments enhances flexibility, accessibility, and student engagement. According to Graham (2021), blended learning

environments allow future teachers to develop self-regulated learning skills while maintaining opportunities for direct interaction and mentorship. In addition, studies conducted during and after the COVID-19 pandemic demonstrate that blended and hybrid models have become essential components of resilient education systems (Bozkurt et al., 2022). Another important direction in the literature is the use of simulation-based learning and virtual teaching environments. These technologies provide safe and controlled conditions for future teachers to practice instructional strategies, classroom management, and decision-making skills. Research by Dieker et al. (2021) shows that virtual simulations significantly improve teaching performance by enabling repeated practice and immediate feedback. Similarly, digital microteaching platforms and immersive environments support experiential learning, which is a critical factor in professional formation.

The concept of reflective practice is also strongly connected with modern pedagogical technologies. Reflection enables future teachers to critically analyze their experiences, identify strengths and weaknesses, and continuously improve their professional skills. E-portfolios and digital reflection tools are widely used to support this process. According to the European Commission (2022), e-portfolios not only document learning outcomes but also promote self-assessment and lifelong learning competencies. These tools contribute to the formation of professional identity and encourage a deeper understanding of pedagogical principles. Recent literature also emphasizes the role of assessment technologies in teacher education. Traditional summative assessment methods are increasingly being replaced or complemented by formative and competency-based assessment approaches. Digital assessment tools, including automated feedback systems and learning analytics, provide real-time insights into students' progress and performance. Siemens and Baker (2022) highlight that learning analytics can be used to identify learning patterns, predict outcomes, and support data-driven decision-making in teacher education programs. Moreover, collaborative learning technologies have gained considerable attention. Platforms that support communication, teamwork, and knowledge sharing enable future teachers to develop social and professional skills essential for modern educational environments. Research by Voogt et al. (2021) indicates that collaborative digital environments enhance peer learning, critical discussion, and collective problem solving, which are crucial components of professional competence.

Despite these advancements, several challenges remain in the implementation of pedagogical technologies. One of the main issues is the lack of sufficient digital infrastructure and institutional support in many educational contexts. Additionally, teacher educators themselves may lack the necessary competencies to effectively integrate advanced technologies into their teaching practices. According to Tondeur et al. (2021), professional development of teacher educators is a key factor in the successful adoption of pedagogical technologies. Another critical challenge is ensuring the pedagogical relevance of technologies. Not all technological tools automatically lead to improved learning outcomes; their effectiveness depends on how they are integrated into the educational process. Researchers stress the importance of aligning technological innovations with pedagogical objectives and learner needs. This alignment requires a systematic approach to instructional design and continuous evaluation of educational technologies (Koehler et al., 2022). Recent literature demonstrates that pedagogical technologies play a crucial role in shaping the professional formation of future teachers. Innovative approaches such as blended learning, simulation-based environments, AI-driven systems, and digital assessment tools significantly enhance the quality of teacher education. However, the successful implementation of these technologies requires adequate infrastructure, teacher training, and pedagogically sound design. Further research is needed to explore context-specific strategies and to develop integrated models that effectively combine technological and pedagogical innovations in teacher education.

Research discussion. The findings of this study confirm that the development and systematic integration of modern pedagogical technologies play a decisive role in determining the level of professional formation of future teachers. The results align with recent scholarly research, demonstrating that technology-enhanced learning environments significantly contribute to the formation of both pedagogical and transversal competencies required in contemporary education systems. One of the key outcomes of this research is the identification of a strong relationship between the use of student-centered pedagogical technologies and the development of professional competencies. Approaches such as blended learning, problem-based learning, and simulation-based instruction were found to enhance critical thinking, independent decision-making, and practical teaching skills. These findings are consistent with Darling-Hammond et al. (2020), who emphasize the importance of active learning strategies in preparing competent and reflective teachers. In particular, simulation-based environments allowed future teachers to practice real-life teaching scenarios, thereby bridging the gap between theoretical knowledge and practical application.

The study also highlights the significant impact of digital technologies on personalized learning and competency development. The integration of digital tools, including learning management systems and AI-supported platforms, enabled individualized learning trajectories, which contributed to improved learning outcomes. This supports the conclusions of Holmes et al. (2022), who argue that adaptive learning technologies enhance the efficiency of teacher education by addressing diverse learner needs. Moreover, the use of digital assessment tools provided timely and constructive feedback, facilitating continuous improvement and self-regulation among students. Another important aspect revealed in this study is the role of reflective practices supported by pedagogical technologies. The use of e-portfolios and digital reflection tools encouraged future teachers to critically evaluate their learning experiences and professional growth. This finding is in line with the European Commission (2022), which identifies reflective practice as a key component of teacher professionalism. Reflection not only supports cognitive development but also contributes to the formation of professional identity and ethical awareness. Furthermore, the results indicate that collaborative learning technologies significantly enhance communication skills, teamwork, and professional interaction among future teachers. Digital platforms that facilitate group work and knowledge sharing were found to create a more interactive and engaging learning environment. This supports the findings of Voogt et al. (2021), who emphasize the importance of collaboration in developing 21st-century teaching competencies. Through collaborative activities, students were able to exchange ideas, solve problems collectively, and develop a deeper understanding of pedagogical concepts. Despite these positive outcomes, the study also identified several challenges associated with the implementation of pedagogical technologies. One of the primary issues is the insufficient level of digital competence among both students and teacher educators. In some cases, limited technical skills hindered the effective use of advanced technologies, reducing their potential impact on professional formation. This observation corresponds with Tondeur et al. (2021), who highlight the need for continuous professional development of teacher educators in the field of educational technologies.

Additionally, infrastructural limitations and lack of institutional support were identified as barriers to the successful integration of pedagogical technologies. Inadequate access to digital resources and unstable technological environments can negatively affect the quality of teacher training. Therefore, it is essential to ensure that educational institutions provide the necessary conditions for the effective use of modern technologies. The discussion demonstrates that pedagogical technologies significantly influence the professional formation of future teachers by enhancing competencies, supporting reflective practice, and promoting collaborative learning. However, their effectiveness depends on proper implementation, institutional support, and the development of digital competencies among all participants in the educational process. These

findings highlight the need for a systematic and context-sensitive approach to integrating pedagogical technologies in teacher education programs.

Conclusion. This study demonstrates that the development and effective implementation of modern pedagogical technologies play a crucial role in shaping the professional formation of future teachers. The findings confirm that student-centered approaches, digital learning environments, and innovative instructional methods significantly enhance the acquisition of pedagogical competencies, critical thinking, and practical teaching skills. In particular, technologies such as blended learning, simulation-based training, and digital assessment tools contribute to creating flexible, interactive, and personalized learning experiences. At the same time, the research highlights that the successful integration of pedagogical technologies depends on several key factors, including the level of digital competence among teacher educators and students, the availability of technological infrastructure, and institutional support. Without these conditions, the potential benefits of technological innovations may not be fully realized. Overall, the study emphasizes the need for a systematic and strategic approach to integrating pedagogical technologies into teacher education programs. Future research should focus on developing context-specific models and evaluating the long-term impact of these technologies on teaching effectiveness and professional growth in diverse educational settings.

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