

DEVELOPING TEACHERS' DIGITAL COMPETENCE IN INNOVATIVE EDUCATIONAL ENVIRONMENTS

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Abstract. This article examines the development of teachers' digital competence in innovative educational environments that integrate artificial intelligence, hybrid learning platforms, and immersive technologies. Through a systematic literature review and analysis of key frameworks such as DigCompEdu, it identifies effective strategies, persistent challenges, and practical pathways for professional growth. The study highlights the need for continuous, context-specific training to enhance pedagogical integration of digital tools, ultimately improving teaching quality and preparing students for a digital future.

Keywords: digital competence, teachers, innovative educational environments, DigCompEdu, AI integration, professional development

Annotatsiya. Ushbu maqola sun'iy intellekt, gibrid o'quv platformalari va immersiv texnologiyalarni integratsiya qilgan innovatsion ta'lim muhitlarida o'qituvchilarning raqamli kompetentsiyasini rivojlantirishni o'rganadi. DigCompEdu kabi asosiy ramkalarni tizimli adabiyotlar sharhi va tahlili orqali samarali strategiyalar, doimiy muammolar va kasbiy o'sish uchun amaliy yo'llarni aniqlaydi. Tadqiqot raqamli vositalarni pedagogik jihatdan integratsiya qilish uchun doimiy va kontekstga mos treninglar zarurligini ta'kidlaydi, bu esa ta'lim sifatini oshirish va o'quvchilarni raqamli kelajakka tayyorlashga yordam beradi.

Kalit so'zlar: raqamli kompetentsiya, o'qituvchilar, innovatsion ta'lim muhitlari, DigCompEdu, sun'iy intellekt integratsiyasi, kasbiy rivojlanish

Аннотация. Данная статья исследует развитие цифровой компетентности учителей в инновационных образовательных средах, интегрирующих искусственный интеллект, гибридные платформы обучения и иммерсивные технологии. С помощью систематического обзора литературы и анализа ключевых рамок, таких как DigCompEdu, она выявляет эффективные стратегии, сохраняющиеся вызовы и практические пути профессионального роста. Исследование подчеркивает необходимость непрерывной, контекстно-ориентированной подготовки для усиления педагогической интеграции цифровых инструментов, что в конечном итоге повышает качество преподавания и готовит учащихся к цифровому будущему.

Ключевые слова: цифровая компетентность, учителя, инновационные образовательные среды, DigCompEdu, интеграция ИИ, профессиональное развитие

Introduction. In the contemporary educational landscape, innovative environments powered by artificial intelligence (AI), hybrid learning models, and immersive technologies are transforming traditional teaching practices. These settings demand that educators possess advanced digital competence—not merely technical

proficiency, but the ability to integrate digital tools meaningfully into pedagogy to foster engaging, personalized, and equitable learning experiences.

The urgency of developing teachers' digital competence arises from rapid technological advancements and lessons learned during the global shift to remote and hybrid learning. Many educators still report intermediate or low levels of digital skills, particularly in areas such as AI-supported assessment, data-driven instruction, and ethical technology use [2]. This article aims to analyze the current state of teachers' digital competence development in innovative contexts. Its objectives include reviewing relevant literature and frameworks, outlining methodological approaches, discussing key findings, presenting results, and offering conclusions with practical recommendations.

Literature Review and Methodology. The literature on teachers' digital competence consistently points to the European Framework for the Digital Competence of Educators (DigCompEdu) as a foundational reference [1]. DigCompEdu organizes 22 competences into six areas: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence. It emphasizes pedagogical rather than purely technical skills and provides proficiency levels from newcomer to pioneer.

Recent systematic reviews reveal that while awareness of digital competence has grown, many in-service teachers demonstrate only moderate proficiency, especially in innovative applications such as AI personalization and hybrid classroom management. Studies highlight the effectiveness of targeted professional development programs that combine theoretical understanding with hands-on practice, mentoring, and reflective activities [3]. Barriers frequently cited include limited infrastructure, time constraints, varying prior experience, and insufficient institutional support [4].

Methodology

This article employs a qualitative approach based on a systematic review of peer-reviewed literature published primarily between 2022 and 2025. Sources were drawn from reputable databases including Scopus, Web of Science, and open-access educational journals. Inclusion criteria focused on studies addressing teacher digital competence in innovative or technology-rich environments, with emphasis on frameworks, training strategies, and empirical outcomes. Thematic analysis was used to identify recurring patterns in strategies, challenges, and results. The review process followed principles similar to PRISMA guidelines for transparency and rigor.

Discussion. Developing digital competence in innovative educational environments requires more than one-off workshops; it demands sustained, multi-layered efforts that address both technical and pedagogical dimensions. DigCompEdu provides a robust structure, but successful implementation depends on adapting it to local contexts, such as resource availability and cultural factors in diverse educational systems.

Key discussion points include the integration of AI tools, which introduces new demands for competencies in prompt engineering, bias detection, ethical decision-making, and human-AI collaboration. Teachers must learn not only to use these tools but also to model responsible practices for students. Hybrid environments further complicate matters by requiring seamless transitions between face-to-face and online modalities while maintaining student engagement and equity.

Effective strategies emerging from the literature involve blended professional development models—micro-credentials, communities of practice, peer mentoring, and simulation-based training.

Pre-service programs that embed digital competence throughout the curriculum show promising long-term results. However, challenges persist: resistance to change among some educators, digital divides affecting access, and the rapid evolution of technologies that outpace traditional training models. Addressing these requires strong leadership, adequate funding, and policies that incentivize continuous learning.

Results. The analysis yields several clear outcomes regarding teachers' digital competence development:

- Most studies report intermediate self-assessed competence levels among teachers, with higher proficiency in basic resource management and lower performance in advanced areas such as AI integration and learner empowerment through technology.
- Training programs grounded in DigCompEdu and combining practical application with reflection significantly improve competence, confidence, and innovative teaching practices.
- Institutional support factors—including infrastructure, leadership commitment, and collaborative cultures—are critical predictors of successful development.
- Common barriers include workload pressures, unequal access to devices and high-speed internet, and gaps between theoretical training and classroom realities.
- Positive results are observed when development initiatives are ongoing, context-specific, and linked directly to measurable improvements in student engagement and outcomes.

These findings underscore that systematic, supportive approaches can effectively bridge existing gaps in innovative educational settings.

Conclusion. In conclusion, building teachers' digital competence is essential for unlocking the potential of innovative educational environments. Frameworks like DigCompEdu offer valuable guidance, while evidence-based strategies emphasize continuous, practice-oriented professional development. By addressing identified challenges through targeted investments and adaptive policies, educational systems can empower teachers to deliver high-quality, future-ready instruction.

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