

between 45% and 85% of its water-holding capacity (field moisture capacity), or approximately 12% to 30% by weight [5].

Bioremediation is a promising and effective approach to environmental remediation that promotes the regeneration of natural habitats without excessive human intervention. Using natural mechanisms, this method is one of the safest for the environment and most cost-effective options for combating pollution. In the future, bioremediation may become the leading methodology in combating environmental pollution. Scientists are actively engaged in the creation of microorganisms with a modified genome that would have an enhanced ability to destroy toxic compounds. At the same time, experiments are continuing on the integration of nanotechnological developments in tandem with biological purification techniques [7].

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FORMATION OF STUDENT AUTONOMY IN AI-ENHANCED LEARNING ENVIRONMENTS IN HIGHER EDUCATION

У роботі досліджено проблему формування автономії студентів у середовищі навчання, збагаченому технологіями штучного інтелекту, у закладах вищої освіти з акцентом на викладання англійської мови. Проаналізовано дидактичні можливості AI-інструментів щодо забезпечення індивідуалізації навчання, формування навичок самостійної навчальної діяльності та розвитку метакогнітивних стратегій. Розкрито трансформацію ролі викладача та зміну характеру навчальної взаємодії в умовах використання ШІ. Окреслено ризики, пов'язані з академічною недоброчесністю та надмірною залежністю від цифрових інструментів. Обґрунтовано, що ефективне формування автономії можливе за умови методично виваженого впровадження ШІ, спрямованого на розвиток критичного мислення та відповідального використання технологій.

Ключові слова: автономія студентів, штучний інтелект, викладання англійської мови, заклади вищої освіти, персоналізоване навчання, самостійна навчальна діяльність, цифрова педагогіка.

The paper examines the formation of student autonomy in the context of artificial intelligence-enhanced learning environments in higher education, with particular reference to

English language teaching. It analyzes the pedagogical potential of AI-driven tools for fostering self-directed learning, adaptive learning trajectories, and personalized feedback. The study explores the transformation of the teacher's role, the reconfiguration of learner agency, and the challenges associated with academic integrity and over-reliance on AI systems. It is argued that the effective integration of artificial intelligence into language education requires a methodologically grounded approach aimed at developing metacognitive skills, critical thinking, and responsible use of digital technologies. The findings indicate that AI-supported environments can significantly enhance learner autonomy when aligned with appropriate instructional design and assessment strategies.

Keywords: *learner autonomy, artificial intelligence, English language teaching, higher education, personalized learning, digital pedagogy, self-directed learning.*

The rapid development of artificial intelligence technologies has significantly transformed the landscape of higher education, particularly in the field of English language teaching. AI-enhanced learning environments introduce new opportunities for individualization, continuous feedback, and flexible access to educational resources. Within this context, the concept of learner autonomy acquires renewed relevance, as students are increasingly required to take responsibility for their own learning trajectories, make informed decisions, and regulate their cognitive and metacognitive processes.

Learner autonomy is traditionally understood as the capacity to take control of one's own learning, including goal setting, strategy selection, monitoring, and self-assessment. In AI-supported environments, this concept is extended through the availability of adaptive systems capable of responding to individual learner needs in real time. Such systems provide personalized recommendations, generate learning content, and offer immediate feedback, thereby creating conditions for more efficient and self-directed learning. However, the presence of these technological affordances does not automatically lead to the development of autonomy. On the contrary, without appropriate pedagogical mediation, students may become dependent on AI-generated outputs, which can hinder the development of independent thinking and problem-solving skills.

The integration of artificial intelligence into English language teaching necessitates a reconfiguration of the teacher's role. Rather than acting as the primary source of knowledge, the teacher assumes the function of a facilitator, guide, and designer of learning experiences. This involves structuring tasks in a way that encourages active engagement with AI tools, critical evaluation of generated content, and reflection on the learning process. In this regard, the formation of learner autonomy is closely linked to the development of metacognitive awareness, which enables students to understand how they learn, evaluate the effectiveness of different strategies, and adjust their behaviour accordingly.

AI technologies offer substantial potential for supporting the development of such competencies. For instance, automated feedback systems can help learners identify patterns in their errors, while adaptive learning platforms can adjust the level of difficulty based on performance data. At the same time, generative AI tools can be used to simulate communicative situations, provide writing prompts, and model language use in various contexts. When integrated into a coherent instructional design, these tools can promote active learning and increase learner engagement.

Nevertheless, the implementation of AI in higher education raises several challenges. One of the most significant concerns relates to academic integrity, as students may rely on AI systems to complete assignments without engaging in genuine learning. This issue necessitates the development of new assessment approaches that emphasize process over product, as well as the incorporation of tasks that require critical analysis, personalization, and reflection. Another challenge is the uneven level of digital competence among both students and teachers, which may limit the effective use of AI technologies. Addressing this issue requires targeted training and the development of methodological guidelines for integrating AI into the learning process.

In addition, there is a need to consider the ethical implications of AI use in education, including data privacy, algorithmic bias, and the potential impact on learner agency. These factors underscore the importance of a balanced approach that combines technological innovation with pedagogical responsibility. The goal is not to replace human interaction with automated systems, but to enhance the learning experience by leveraging the strengths of both.

Empirical observations suggest that AI-enhanced learning environments can contribute to increased motivation, improved learning outcomes, and greater flexibility in managing the learning process. Students who actively engage with AI tools tend to demonstrate higher levels of self-regulation and a more strategic approach to learning. However, these outcomes are contingent upon the presence of a well-structured pedagogical framework that supports the gradual development of autonomy.

Therefore, the formation of student autonomy in AI-enhanced learning environments represents a key direction for the modernization of modern higher education. The integration of artificial intelligence into English language teaching creates favourable conditions for personalized, flexible, and learner-centred education. At the same time, it requires a reconsideration of traditional pedagogical approaches and the development of new methodological frameworks.

The findings indicate that the effective development of learner autonomy depends on the alignment of technological tools with pedagogical objectives, the promotion of metacognitive skills, and the establishment of clear guidelines for the responsible use of AI. Future research should focus on the empirical validation of specific models of AI-supported autonomy development, as well as on the long-term impact of these approaches on learner performance and professional competence.

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