

# *AI Integration into Secondary Education: Teaching Transformation, Digital Skills Challenges, and the Azerbaijan Case*

**Abstract:** Artificial Intelligence (AI) has emerged as one of the most transformative technologies reshaping educational systems worldwide. This review paper examines the application of AI in secondary school teaching processes with a particular focus on Azerbaijan. Unlike technologically advanced countries that actively develop AI technologies, Azerbaijan currently remains predominantly an importer rather than an exporter of AI solutions, creating challenges related to technological dependence, digital infrastructure, and human capital preparedness. Existing evidence suggests that AI technologies can improve educational efficiency through personalized learning systems, automated assessment tools, intelligent tutoring systems, learning analytics, and administrative support mechanisms. Such technologies may reduce teachers' routine workload and optimize classroom time allocation. However, successful integration requires digital competencies among teachers and students, curriculum adaptation, and institutional readiness. By reviewing international experiences and emerging developments in Azerbaijan, this study highlights opportunities and constraints associated with AI implementation in secondary education and discusses pathways for integrating AI into teaching models and pedagogical processes in developing educational contexts.

**Keywords:** Artificial Intelligence (AI); Secondary Education; AI in Teaching; Personalized Learning; Educational Digitalization; Azerbaijan.

**Összefoglalás:** A mesterséges intelligencia (MI) napjaink egyik legjelentősebb technológiai újítása, amely alapvetően alakítja át az oktatási rendszereket világszerte. Jelen áttekintő tanulmány az MI alkalmazását vizsgálja a középiskolai oktatási folyamatokban, különös tekintettel Azerbajdzsánra. A technológiailag fejlett országokkal ellentétben Azerbajdzsán jelenleg elsősorban MI-technológiák importőrnek tekinthető, nem pedig exportőrnek, ami technológiai függőséget, digitális infrastruktúrával kapcsolatos kihívásokat

\* Lecturer/Researcher Sumgayit State Technical College, Sumgayit State University  
Email: seriyyesevdimaliyeva@gmail.com  
ORCID: 0009-0000-9649-0371

[1] Chen, L.–Chen, P.–Lin, Z. (2020): *Artificial intelligence in education: A review*. IEEE Access.

[2] Zawacki-Richter, O.–Marín, V.–Bond, M.–Gouverneur, F. (2019): *Systematic review of AI applications in education*.

[3] Holmes, W.–Poyarska-Pomsta, K., et al. (2023): *Ethics of AI in education: Towards a community-wide framework*.

[4] Luckin, R.–Holmes, W.–Griffiths, M.–Forcier, L. B. (2016): *Intelligence unleashed: An argument for AI in education*. London: Pearson.

[5] UNESCO (2023): *Guidance for generative AI in education and research*.

és humán erőforrásbeli hiányosságokat eredményezhet. A szakirodalom szerint az MI hozzájárulhat a tanulás személyre szabásához, az intelligens oktatórendszerek alkalmazásához, az automatikus értékelési folyamatokhoz és az adminisztratív feladatok csökkentéséhez. Ezek a megoldások mérsékelhetik a tanárok munkaterheit és növelhetik az oktatás hatékonyságát. Az MI sikeres integrációjához azonban megfelelő digitális készségek, tantervi reformok és intézményi felkészültség szükséges. A tanulmány nemzetközi tapasztalatok és az azerbajdzsáni eset alapján értékeli az MI oktatási lehetőségeit és kihívásait.

**Kulcsszavak:** Mesterséges Intelligencia (MI); középfokú oktatás; MI az oktatásban; személyre szabott tanulás; oktatási digitalizáció; azerbajdzsán.

## Introduction

Artificial Intelligence (AI) increasingly influences educational systems and is transforming traditional approaches to teaching and learning processes worldwide. AI-powered educational technologies, including intelligent tutoring systems, adaptive learning platforms, automated assessment tools, predictive analytics, and generative AI applications, are changing how knowledge is delivered and managed within educational institutions [1, 2]. Educational researchers increasingly recognize AI as a transformative instrument capable of improving teaching effectiveness and learning personalization [3].

The application of AI in secondary education has become especially important due to increasing demands for individualized learning experiences and more efficient educational management systems [4]. Traditional teaching approaches frequently require teachers to dedicate substantial time to repetitive administrative tasks, grading procedures, lesson preparation, and classroom monitoring. AI-supported systems may reduce such time-consuming activities and enable educators to focus more on critical pedagogical functions such as mentoring, creativity development, and student engagement [3]. Studies indicate that teachers spend a considerable amount of time on repetitive administrative work that can potentially be automated through AI-supported technologies [5].

**Table 1. Previous scholarly findings on the AI application in Education**

Scholar/Organization	Study/Source	Context	Key Findings Relevant to This Paper
Luckin, Holmes, Griffiths, & Forcier (2016)	<i>Intelligence Unleashed: An Argument for AI in Education</i>	Global/conceptual	AI can support more personalized, flexible, inclusive, and engaging learning. It can help teachers create more sophisticated learning environments rather than replace them.
Zawacki-Richter, Marin, Bond, & Gouverneur (2019)	<i>Systematic review of AI applications in higher education</i>	Higher education/international	Reviewed AI applications in education and showed that the pedagogical use of AI remains underdeveloped, even though AI has been studied in education for decades.
Holmes, Bialik, & Fadel (2019)	<i>Artificial Intelligence in Education: Promises and Implications for Teaching and Learning</i>	School education/global	Discussed how AI may reshape teaching and learning, especially through smart systems, personalized support, and new ethical challenges.
Chen, Chen, & Lin (2020)	<i>Artificial Intelligence in Education: A Review</i>	Education/international	Found that AI is applied in administration, curriculum development, teaching, assessment, grading, feedback, and student learning processes.
European Commission (2022)	<i>Ethical Guidelines on the Use of AI and Data in Teaching and Learning for Educators</i>	Primary and secondary education/Europe	Provides guidance for teachers on using AI and data ethically, including risk awareness, responsible use, and educational benefits.
Kasneci et al. (2023)	<i>ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education</i>	Generative AI /education	Shows that large language models can support students and teachers, but also create challenges related to reliability, overdependence, academic integrity, and assessment.
UNESCO / Miao & Holmes (2023)	<i>Guidance for Generative AI in Education and Research</i>	Global policy guidance	Recommends human-centered GenAI use, regulation, data privacy, capacity building, and policy planning for education systems.
OECD / Borgonovi (2025)	<i>AI Adoption in the Education System</i>	Schools/ OECD countries	Reviews how AI can support education systems and proposes policy principles for AI adoption, including AI literacy and curriculum reform.

Source: Author's compilation based on previous literature on Artificial Intelligence in education and educational digitalization. Major sources include Chen et al. [1], Luckin et al. [4], Zawacki-Richter et al. [2], UNESCO [5], and OECD [6].

[1] Chen, L.–Chen, P.–Lin, Z. (2020): *Artificial intelligence in education: A review*. IEEE Access.

[2] Zawacki-Richter, O.–Marin, V.–Bond, M.–Gouverneur, F. (2019): *Systematic review of AI applications in education*.

[4] Luckin, R.–Holmes, W.–Griffiths, M.–Forcier, L. B. (2016): *Intelligence unleashed: An argument for AI in education*. London: Pearson.

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[6] World Bank (2025): *Digital Development and Skills in Azerbaijan*.

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Previous international studies have investigated AI implementation in educational environments across diverse contexts. Chen et al. [1] reviewed AI applications in education and emphasized intelligent tutoring systems, adaptive learning environments, and machine-learning-based educational tools. Similarly, Holmes et al. [3] highlighted ethical considerations associated with AI adoption in schools, including privacy concerns, equity issues, algorithmic transparency, and bias. Research in European educational contexts further suggests that AI technologies can support personalized educational experiences and improve learning outcomes when integrated effectively [2]. Within Azerbaijan, the discussion surrounding AI in education remains relatively recent. Although digital transformation initiatives and national AI-related strategies have gained increasing attention, Azerbaijan currently functions primarily as an importer rather than an exporter of AI technologies. Domestic AI ecosystems remain in developmental stages, while educational institutions rely predominantly on externally developed technological platforms and software systems [6]. Recent digital initiatives and educational reforms indicate increasing national interest in technological transformation and AI capacity-building efforts.

An additional challenge concerns digital competencies and skill gaps among educators and learners. Existing evidence suggests that Azerbaijan continues to face limitations in digital literacy and formal technology-related educational pathways. The development of technological skills frequently occurs through informal learning channels rather than structured educational systems [6].

In secondary schools, AI may be integrated into teaching models through adaptive learning systems, AI-assisted lesson planning, virtual assistants, personalized feedback mechanisms, predictive student performance analytics, and intelligent classroom management tools [4]. Such integration may improve efficiency, reduce time waste, and facilitate student-centered learning approaches. Nevertheless, successful implementation requires technological readiness, teacher training programs, curriculum reforms, and ethical governance frameworks [3].

## Global Experiences and AI Integration Models in Education

The global education sector has experienced substantial changes due to the integration of Artificial Intelligence (AI) technologies into teaching and learning environments. International organizations increasingly recognize AI as a transformative educational technology capable of improving learning outcomes, increasing institutional efficiency, and supporting personalized learning experiences [1, 5]. Recent estimates suggest that AI-powered educational systems may significantly reduce teachers' administrative burden while improving learning customization and educational accessibility [6]. Additionally, AI-supported learning platforms have demonstrated positive impacts on student engagement and learning analytics capabilities [3].

One of the most notable examples of systematic AI integration in education is Estonia. Estonia has long been recognized as a global leader in digital governance and educational digitalization. Building on earlier initiatives such as the Tiger Leap program, Estonia launched national AI-focused educational reforms to support AI integration into schools and educational institutions. Current initiatives are expected to provide AI-enabled educational opportunities to approximately 20,000 students and 3,000 teachers during initial implementation phases, with future expansion planned.

The Estonian case is particularly important because it demonstrates that small states can become technological leaders through coordinated educational reforms. Instead of limiting technology use, Estonia adopted an integration-oriented strategy emphasizing AI literacy, digital ethics, and teacher preparedness. Educational policies focus not only on technological implementation but also on pedagogical transformation and critical thinking skills.

[1] Chen, L.–Chen, P.–Lin, Z. (2020): *Artificial intelligence in education: A review*. IEEE Access.

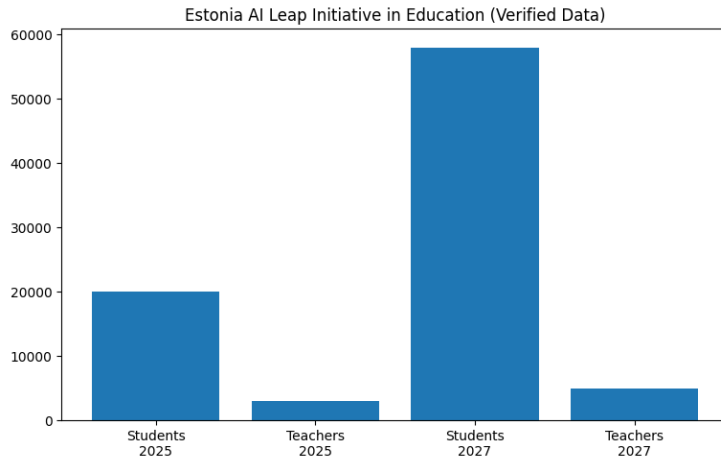
[3] Holmes, W.–Poyarska-Pomsta, K., et al. (2023): *Ethics of AI in education: Towards a community-wide framework*.

[5] UNESCO (2023): *Guidance for generative AI in education and research*.

[6] World Bank (2025): *Digital Development and Skills in Azerbaijan*.

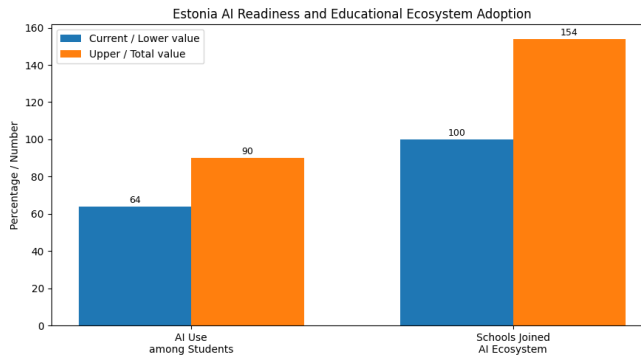
[7] University of Tartu. (2024). *Responsible AI Use Guidelines*.

**Fig 1. Estonia AI Leap Initiative in Education**



Source: Education Estonia, 2025; e-Estonia, 2025.

As illustrated in *Figure 1*, Estonia has adopted one of the most comprehensive AI integration initiatives in school education globally. The first phase targets 20,000 secondary school students and 3,000 teachers, while the expanded implementation aims to reach 58,000 students and 5,000 teachers by 2027. The initiative also emphasizes teacher training, AI literacy, and responsible use of AI technologies within classroom environments. This case demonstrates that educational AI transformation requires ecosystem-level reforms rather than isolated technological interventions [7].

**Fig 2. Estonia AI readiness and educational ecosystem adoption**

Source: Education Estonia, 2025; e-Estonia, 2025

As shown in *Figure 2*, Estonia demonstrated substantial educational preparedness prior to nationwide AI implementation. Student AI usage rates ranged between 64% and 90%, while more than 100 of 154 upper-secondary schools had already joined AI-related educational initiatives. Such evidence indicates that successful AI integration depends not only on policy interventions but also on technological culture, institutional engagement, and digital literacy readiness.

At the university level, the University of Tartu has emerged as one of the leading examples of institutional AI integration. The university introduced formal recommendations encouraging professors and students to responsibly integrate AI tools into teaching, learning, research, and thesis preparation processes. Rather than prohibiting AI applications, the institution promotes transparent and ethical use principles [7]. AI-assisted educational practices, intelligent support systems, and adaptive digital teaching environments are increasingly integrated into educational activities. Similarly, Tallinn University of Technology increasingly emphasizes AI-supported educational environments and digital learning ecosystems as part of Estonia's broader digital transformation agenda [8]. Such experiences demonstrate that educational institutions benefit when AI implementation extends beyond technological infrastructure and becomes embedded within teaching culture and institutional practice.

[7] University of Tartu. (2024). *Responsible AI Use Guidelines*.

[8] Transylvania University of Braşov (2025): *ELITE-AI Project Documentation*.

[2] Zawacki-Richter, O.–Marín, V.–Bond, M.–Gouverneur, F. (2019): *Systematic review of AI applications in education*.

[3] Holmes, W.–Porayska-Pomsta, K., et al. (2023): *Ethics of AI in education: Towards a community-wide framework*.

[6] World Bank (2025): *Digital Development and Skills in Azerbaijan*.

[8] Transylvania University of Braşov (2025): *ELITE-AI Project Documentation*.

[9] Government of Azerbaijan. (2025). *Artificial Intelligence Strategy of the Republic of Azerbaijan for 2025–2028*.

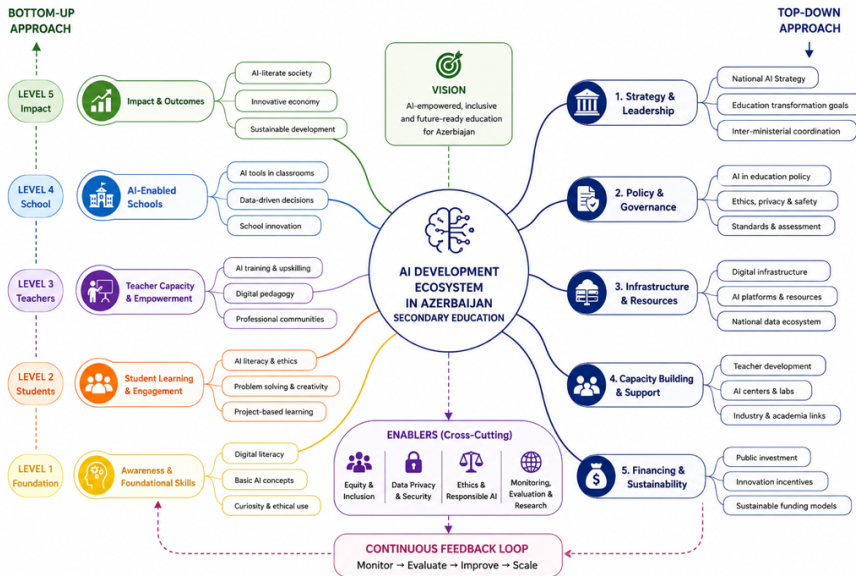
Another relevant international initiative involves the Erasmus+ funded ELITE-AI project coordinated by Transylvania University of Braşov. The ELITE-AI project aims to modernize educational approaches through AI-supported language learning methodologies, digital teaching competencies, and AI-enhanced pedagogical innovation [8]. The project particularly emphasizes preparing educators and students for future educational and labor-market transformations.

Research increasingly suggests that AI integration should not be understood merely as technological adoption but rather as educational ecosystem transformation. Universities globally are gradually moving toward AI-assisted assessment systems, skills-based evaluations, and intelligent learning environments [2]. Studies indicate that educational institutions increasingly support AI-assisted teaching practices instead of restrictive approaches [3].

### Azerbaijan Case: Emerging AI Adoption and Educational Transformation

Compared to advanced digital economies, Azerbaijan currently remains at an earlier stage of AI integration in education. Although digital transformation and technological modernization receive increasing attention, Azerbaijan still functions largely as an importer rather than a producer or exporter of AI technologies [6]. Consequently, educational institutions remain dependent on externally developed AI software systems and technological ecosystems. A significant institutional milestone occurred through the Presidential approval of the “Artificial Intelligence Strategy of the Republic of Azerbaijan for 2025–2028” by President Ilham Aliyev. The strategy aims to accelerate AI development, strengthen national technological capabilities, enhance digital infrastructure, and support AI-related human capital development [9].

Picture 1. AI development ecosystem in Azerbaijan surrounding secondary education



Source: Author's compilation based on Chen et al. [1]; Luckin et al. [4]; UNESCO [5]; Holmes et al. [3]; World Bank [6]; Estonia AI Leap initiative; University of Tartu AI implementation guidelines; and the Artificial Intelligence Strategy of the Republic of Azerbaijan for 2025–2028.

The strategy also emphasizes educational modernization, digital transformation, and institutional AI capacity building. National discussions increasingly support the establishment of AI laboratories and AI centers within higher education institutions to strengthen domestic competencies and facilitate AI ecosystem development [9]. The Azerbaijan State University of Economics (UNEC) increasingly demonstrates institutional digitalization efforts. Through online educational systems, learning management platforms, electronic educational services, and digital assessment mechanisms, UNEC continues modernizing educational processes (UNEC, 2025). Particularly in English language teaching, AI technologies may support adaptive language learning environments, personalized feedback systems, speech recognition tools, automated writing evaluation, and intelligent tutoring mechanisms.

[1] Chen, L.–Chen, P.–Lin, Z. (2020): *Artificial intelligence in education: A review*. IEEE Access.

[3] Holmes, W.–Porayska-Pomsta, K., et al. (2023): *Ethics of AI in education: Towards a community-wide framework*.

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[5] UNESCO (2023): *Guidance for generative AI in education and research*.

[6] World Bank (2025): *Digital Development and Skills in Azerbaijan*.

[9] Government of Azerbaijan. (2025). *Artificial Intelligence Strategy of the Republic of Azerbaijan for 2025–2028*.

[4] Luckin, R.–Holmes, W.–Griffiths, M.–Forcier, L. B. (2016): *Intelligence unleashed: An argument for AI in education*. London: Pearson.

Additionally, AI applications can improve examination procedures through automated assessment systems, plagiarism detection tools, intelligent online proctoring mechanisms, and learning analytics systems. Such technologies may reduce administrative workload and optimize educational efficiency [4]. Future opportunities for UNEC may include developing AI-assisted learning laboratories, interdisciplinary AI centers, predictive educational analytics systems, and curriculum modernization initiatives integrating AI competencies across educational programs. In the long term, the establishment of AI centers within Azerbaijani higher education institutions may contribute to strengthening local technological ecosystems and reducing dependence on imported AI technologies.

## Conclusion

Artificial Intelligence is increasingly transforming educational systems and creating new opportunities for improving teaching and learning processes. This review paper examined AI applications in secondary education through international experiences and the case of Azerbaijan. Existing evidence suggests that AI tools can support personalized learning, improve classroom efficiency, reduce administrative workload, and enhance student engagement through adaptive and intelligent educational systems. International experiences, particularly from Estonia and AI initiatives implemented at universities such as the University of Tartu and Tallinn University of Technology, demonstrate that successful AI integration depends not only on technological infrastructure but also on teacher preparedness, digital literacy, and supportive educational policies. Projects such as the Erasmus+ ELITE-AI initiative further highlight the importance of institutional cooperation and AI-supported pedagogical innovation. For Azerbaijan, AI integration presents both opportunities and challenges. Although the country remains primarily an importer of AI technologies, recent developments including the Artificial Intelligence Strategy of the Republic of Azerbaijan for 2025–2028 demonstrate growing attention toward educational digitalization and technological development. Strengthening teacher competencies, developing AI centers within educational institutions, and improving digital infrastructure may contribute to long-term educational transformation. Overall, effective AI integration requires a balanced ecosystem approach combining policy support, institutional readiness, digital skills, and educational innovation. Such efforts may help Azerbaijan build a more adaptive and future-oriented educational system.