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PAPER

Using Artificial Intelligence in Mobile Learning for Students of Technical Specialties

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ABSTRACT

Mobile learning has emerged as a pivotal method of education in Ukraine and Eastern Europe, especially in the conditions of war and displacement of students, which allows continuing education of technical students despite the lack of infrastructure and logistics. The research examined the effectiveness of artificial intelligence (AI)-enhanced mobile learning among students at three higher education institutions (HEIs): Sofia University St. Kliment Ohridski (Bulgaria), Metinvest Polytechnic Technical University (Ukraine), and National University Zaporizhzhia Polytechnic (Ukraine). The participants in a quasi-experimental study were 183 students, most of whom were in computer science, engineering, mathematics, and applied mechanics. Half were assigned to the experimental group using AI-built mobile learning, and the other half to the control group using standard mobile platforms. The AI-driven platform included adaptive testing, AI-based chatbot tutoring, solution explanation, a recommendation system, and learning analytics. Findings showed that AI had more positive effects (learning gains of 18%, $p < 0.05$) on learning outcomes, engagement, and time-on-task, and was perceived as more usable and associated with higher self-efficacy among students. The most useful features were adaptive testing and recommendation systems, which facilitated personal and self-managed learning. The results provide insight into the practical importance of AI tools in technical education, showing that they offer scalable solutions for enhancing academic performance, engagement, and resilience in both stable and crisis-affected learning settings.

KEYWORDS

artificial intelligence (AI), mobile learning, technical education, adaptive learning, learning analytics, eastern European universities

1 INTRODUCTION

1.1 Mobile learning amid wartime disruptions in Ukraine

The Russian-Ukrainian conflict has resulted in one of the most demanding educational crises in Eastern Europe and has dramatically disrupted the continuation

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of higher education and rapidly switched the move towards mobile learning as an emergency response system [1] and [2]. Campuses in technical universities have been closed, access to laboratories limited, infrastructure has been destroyed, and academic schedules disrupted, meaning thousands of Ukrainian students have to entirely depend on their mobile devices to continue their education. Mobile learning has not only become an additional resource but also a lifeline to academic survival, given that the learners, especially those in shelters or conflict zones or in foreign places, are displaced [3], [4], [5]. Wartime conditions have critically exposed the urgent need for robust mobile learning platforms capable of supporting technical, scientific, and mathematical disciplines, where high levels of critical thinking, procedural precision, and applied skills are required. Subsequently, the applicability of mobile learning in Ukraine has been increasing exponentially, which is the reason why it is necessary to study how advanced digital technologies, specifically artificial intelligence (AI), can enhance continuity, stability, and academic performance in the conditions of a prolonged crisis [6].

1.2 Impact of student displacement on technical education

The displacement of students has come with extensive academic and psychological effects, particularly to the students undertaking engineering, computer science, mathematics and applied mechanics courses [7], [8], [9]. Technical education requires a high level of interactive explanations, problem-solving in a cycle, and prompt feedback from instructors, but displaced learners usually study under unpredictable conditions with low connectivity, uneven access to devices, and increased emotional strain. Mobile learning tools that are customary in delivering static information and generalized tests are not effective in fulfilling the cognitive needs of technical, scientific and mathematical courses. This leads to increased learning gaps, decreased engagement, and decreased persistence in problem-solving activities by the displaced students. These conditions explain why mobile learning systems that can be customized to each user, give on-demand instructions, and recreate aspects of instructor-based instruction, which are important affordances that AI-enhanced mobile learning systems can offer [10], [11].

1.3 Need for interactive and adaptive tools in complex subjects

Technical, scientific and mathematical disciplines involve a level of complexity that demands learning tools that extend way beyond passive content delivery. Students will have to work with simulations, solve multi-step numerical tasks, and work with algorithmic thinking and be corrected to correct wrong beliefs. These interactive, analytics-driven or feedback-rich features are particularly unavailable on conventional mobile learning platforms and are not suitable for the requirements of contemporary technical education [12], [13], [14]. With the disruption of the Ukrainian universities to a greater degree, depending on mobile learning rather than traditional methods because of the war, the weaknesses of the static systems become even more evident. In the absence of adaptive challenge, explanatory robots, and smart feedback mechanisms, mobile education cannot assist sufficiently in the creation of profound conceptual knowledge. As such, the interactive digital programs, which can react dynamically to student performance, are as necessary as never before to the technical programs working under crisis conditions [15], [16].

1.4 Limitations of conventional mobile learning systems

Conventional mobile learning systems, especially in STEM programs, face significant limitations, including lack of personalization, adaptive feedback, real-time guidance, and diagnostic analytics [17], [18], [19]. These constraints are worsened in Ukrainian technical universities, where war-related disruptions and instructor shortages leave students in largely self-directed learning environments [22], [23], [24]. Traditional platforms cannot adjust content levels, detect learning gaps, or guide multi-step problem-solving [20], [21], limiting effectiveness and equity. AI-powered mobile learning can address these challenges by providing adaptive instruction, personalized feedback, and algorithmic learning paths [25], [26], [27], and supporting academic performance even in crisis conditions.

Artificial intelligence has a transformative potential that can directly cover the shortcomings of the traditional mobile learning systems, especially when it comes to technical domains [28]. Platforms based on AI are capable of automation and custom feedback or suggesting the right practice activities and detecting gaps in learning in real time. Chatbots are intelligent messages that can mimic a conversation with a tutor, and adaptive learning engines are engines that can adjust task difficulty to the performance of students. In wartime Ukraine, where many of the learners do not always have access to instructors, AI serves as a reliable and predictable source of academic support [29]. Furthermore, AI tools also increase the engagement rate, more profound thinking, and self-regulated learning strategies, which is why they are particularly appropriate in technical classes, where the knowledge of concepts depends on a consistent practice and the reinforcement of procedures [30], [31], [32].

1.5 Artificial intelligence for automation, adaptation, and self-regulated learning

Mobile learning that is enhanced with AI reinforces self-regulated learning through constant feedback, automatic monitoring of progress, and individual learning paths. Automation also saves on reliance on instructors, and adaptive mechanisms will make sure that the learning materials are adjusted according to the level of proficiency of a particular student [33], [34]. The latter features are especially essential to Ukrainian students who have to study on their own in a large part because of the wartime interruptions. The metacognitive awareness is also encouraged in the AI-based analytics dashboards because they allow students to monitor their progress, discover their weaknesses, and make appropriate changes to the study strategies [35], [36]. The existence of such support mechanisms produces a systematic individualized learning one that is resistant to external crisis, which makes AI an irreplaceable part of mobile learning in Ukraine's technical education [37].

1.6 International context: Bulgaria as an EU leader in artificial intelligence education

With its initiatives of digital transformation supported by the EU and rich ICT infrastructure, as well as its active involvement of AI tools in learning processes, Bulgaria takes up a significant role in the global AI-based education market. Bulgaria, being an EU member state, is enjoying superior funding systems, research systems, and policy frameworks that encourage innovation in higher education [38], [39]. Sofia University "St. Kliment Ohridski," the place of which is characterized by a progressive introduction of AI-powered digital learning tools, can be used to provide a didactic example to Ukrainian schools that encountered disruptions due to the war. Besides placing the study within the larger trends of digitalization in the global context, this international context also contributes to assessing the performance of the AI-based mobile learning solution in a stable European environment compared to the Ukrainian one affected by the conflict [40].

1.7 Cross-university collaboration for comparative analysis

The partnership between a single Bulgarian university and three Ukrainian universities allows making the first multi-institutional comparative analysis of AI-based mobile learning in Eastern Europe [41], [42], [43]. The use of the same AI-based mobile learning system in institutions with varying technological levels, academic frameworks, and geopolitical environments will provide solid information on scalability, adaptability, and cross-system functionality. This collaborative design strengthens the methodological rigor of the results, as it will be possible to compare the results in stable and crisis-prone settings. It is also capable of building research capacity in the region and empirically supports cross-border policy in digital transformation in technical education [44], [45], [46].

1.8 Identified research gaps and the need for empirical evidence

Artificial intelligence in education global rise, there is an empirical research study deficiency on AI-based mobile learning in all Eastern Europe, particularly in technical, scientific and mathematical disciplines. Key gaps comprise on comparative research studies crossways many universities, use of standardized AI systems, and as well as evidence from war-affected Ukrainian institutions. This study addresses these gaps by applying a unified AI-supported mobile learning interference in given data three universities to evaluate its impact on learner appointment, and digital pedagogy in diverse regional backgrounds.

1.9 Purpose of the study

Present research study aims to assess AI-based tools impacts on mobile learning in technical, science and mathematics disciplines crossways given data three universities in Ukraine and as well as Bulgaria. Further, it examines how AI can enhance adaptive instruction, personalized response, and as well as self-regulated learning while seeing contextual differences in infrastructure, institutional readiness, and pedagogical culture. The study seeks to provide indication for refining learner appointments, educational recital and future AI-supported learning.

Research Questions

1. Does AI improve educational performance of learners?
2. Is there any impact of AI in mobile learning?
3. What are best AI applications for STEM arenas?
4. Is there any differences in the results of Ukrainian and Bulgarian universities?

2 METHODOLOGY

2.1 Design and participant of study

In this study, a quasi-experimental design was used to assess the impact of AI tools on mobile learning among students studying STEM disciplines across three Eastern European universities. Furthermore, 183 learners conducted sample of study from three universities in Bulgaria and Ukraine. These were admitted in different types of programs including math, applied mechanics and computer sciences and learners were divided into groups.

2.2 Platform of mobile learning and artificial intelligence-enhanced

The study used Tech Learn-AI and as well as an AI-enhanced platform of mobile learning designed for Android and other types of different iOS, to sustenance learner in Bulgaria and Ukraine. It contained adaptive types of assessments and personalized recommendations. Regarding to procedure of interventions three participating universities over a duration of 4–8 weeks, which represents variances in semester's schedules but is reliable in rapports of methodology. Learners in every category of institution were grouped and categorized in either experimental group.

2.3 Design of control group and experimental group

Present study one of group type experimental group used Tech Learn-AI platform, appealing with adaptive type of testing and tutoring of AI, modified references, and learning analytics to receive real-time response and provision, particularly for learners affected by crisis of Ukraine and similarly control group used a standard mobile learning platform with the same content but without features of AI and as well as adaptive response.

2.4 Data collection instruments

To measure the effects of AI-based enhancements on mobile learning among students enrolled in STEM disciplines, multiple data collection tools were used to capture both quantitative and qualitative data. The selection of instruments was carefully aligned with learning outcomes, engagement, and learner perceptions, ensuring a comprehensive assessment of the intervention.

2.5 Data collection and evaluation methods

In this study participants accomplished standardized types of both pre- and post-tests in methodological subjects to extent knowledge gains, while Tech Learn-AI platform mechanically followed arrangement metrics like completion of task, usage of AI function and communication period. Furthermore, learners provided responses through different surveys and system usability scale (SUS) and open-ended questions.

3 RESULTS

3.1 Descriptive statistics

The study involved 183 undergraduate students from three universities in Ukraine and Bulgaria, enrolled in technical, science and mathematics disciplines, with wartime constraints reducing Zaporizhzhia Polytechnic's sample to 20 first-year students. The mean age was 20.8 years, with 61% male and 39% female, and students showed moderate baseline digital competency with mobile learning platforms.

Table 1. Sample structure and student characteristics across HEIs, including Zaporizhzhia Polytechnic

Universities	Mean Age	Gender (M/F)	Digital Competency
Sofia University (Bulgaria)	21.0	50/33	4.1 ± 0.5
Metinvest Polytechnic (Ukraine)	20.5	50/30	3.5 ± 0.6
Zaporizhzhia Polytechnic (Ukraine)	18.0	12/8	3.4 ± 0.8

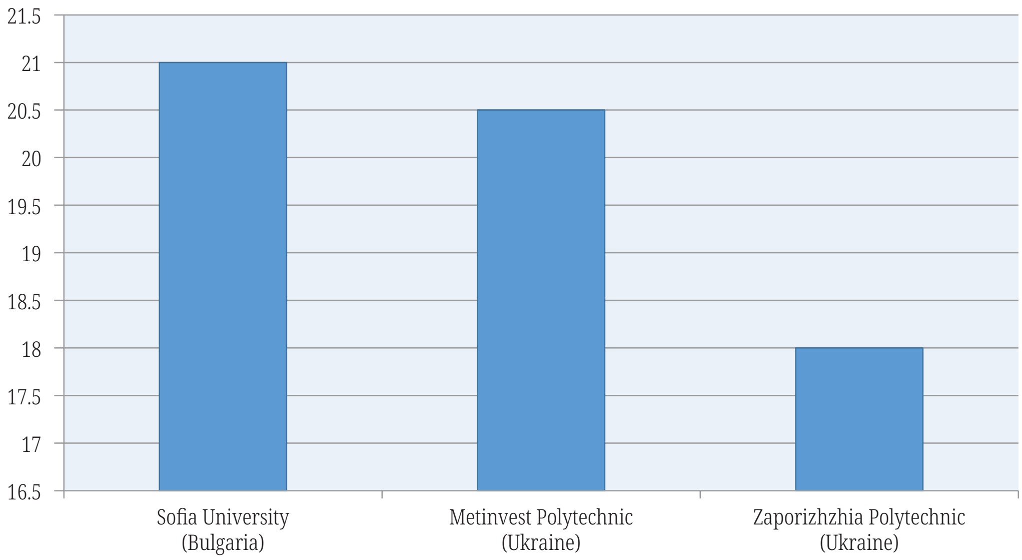

Fig. 1. HEIs characteristics

Interpretation: The sample included 183 students studying STEM disciplines across three universities, with a comparable sample structure and student characteristics across all three higher education institutions. Although the study initially planned for 50 students, only about 20 first-year mathematics students could participate at Zaporizhzhia Polytechnic due to the university's proximity (15 km) to the frontline, which imposed significant attendance limitations. The average age of the sample was 20.8 years, which is typical of undergraduate generations in all universities, and there were slight differences between universities in Bulgaria and Ukraine. There was a fairly equally distributed gender representation of 112 males and 71 females, and this offered sufficient gender diversity in order to generalize the results between the two genders in technical, science and mathematics disciplines, Remarkably, the digital competency level among students at Sofia University

(Bulgaria) was found to be slightly more advanced (M = 4.1 ± 0.5) than among Ukrainian students (M = 3.4 ± 3.6), which is understandable through the presence of a stronger digital infrastructure, a higher rate of AI-based educational resources integration, and a more comprehensive level of familiarity with adaptive learning environments in the EU. Even though the score in digital competency was slightly lower, Ukrainian students still had enough mastery of technology to use AI-enhanced mobile learning. In general, the sample design implies a balanced and representative sample of age, gender and digital readiness, which is a good starting point for studying how AI tools may affect learning outcomes, engagement and usability in various institutional and regional settings.

3.2 Learning outcomes

Pre or post-test results. The experimental group (AI-enhanced mobile learning) exhibited great academic performance improvement in comparison with the control group (standard mobile learning).

Table 2A. Pre- or post-test scores across groups

Group	Pre-test (M ± SD)	Post-test (M ± SD)	Mean Gain
Experimental (AI)	70.5 ± 6.2	84.3 ± 5.9	+13.8
Control (Standard)	70.1 ± 6.0	76.1 ± 6.8	+6.0

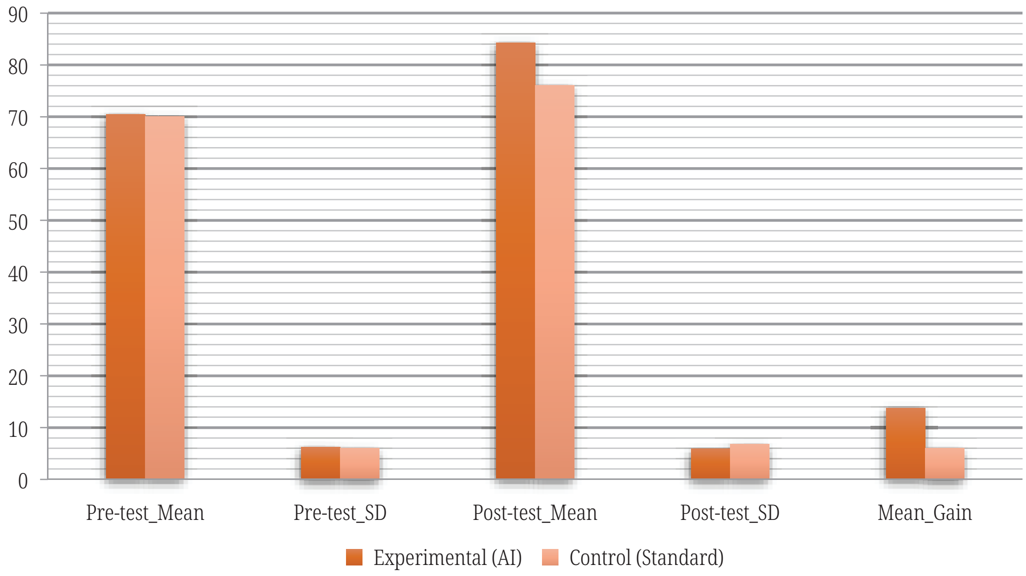

Fig. 2. Pre- or post-test scores across groups

Table 2B. Statistical results for group comparisons

Group	t	df	p	Cohen's d
Experimental (AI)	18.12	99	< .001	1.5
Control (Standard)	9.32	99	< .001	0.86

Differences between Universities. One-way ANOVA revealed that there were significant differences in the post-test scores between the three universities, $F(3,183) = 7.45$, $p < .001$, & eta-square = 0.10. Bulgarian students scored the highest in the post-test ($M = 87.2$, $SD = 5.4$), followed by Ukrainian universities, which were impacted by the wartime disruption, recording slightly lower scores ($M = 80.9–82.3$). Tukey post hoc tests were used to establish the significance of differences between Sofia University and Ukrainian HEIs, and Figures 1 and 2 depict that there are pre- and post-test changes in groups and universities, and that learning gains may be identified as a result of AI-driven mobile learning.

3.3 Engagement patterns

The students of the experimental group actively applied various AI features, such as adaptive testing, AI chatbot tutoring, solution explanations, and recommendation systems. It used an average of 6.2 hours per week with a standard deviation of 1.4, versus 3.8 hours per week with a standard deviation of 1.1 among the control group, with AI functions occupying 52% of all time spent interacting with apps.

Table 3. Artificial intelligence function engagement metrics

AI Function	Mean Weekly Usage (hrs)	Interaction Frequency (%)
Adaptive Testing	2.1 ± 0.5	85
AI Chatbot Tutor	1.5 ± 0.6	78
Solution Explanation	1.3 ± 0.4	72
Recommendation System	1.3 ± 0.5	64

Interpretation: The data on the engagement shows that the students in the experimental group took an active and regular use of various AI features, which proves the crucial role of the tools in facilitating learning. Experimental group students spent 6.2 hours per week using the mobile learning platform ($SD = 1.4$), which is much more than the 3.8 hours ($SD = 1.1$) of the control group participants, with the time spent on AI-related functions taking over half (52) of this time. Adaptive testing was the most common AI feature used (85% frequency of interaction, 2.1 hours per week), and the AI chatbot tutoring (78% frequency of interaction, 1.5 hours), solution explanations (72% frequency of interaction, 1.3 hours), and even the recommendation system (64% frequency of interaction, 1.3 hours) were quick on its heels. This tendency is also consistent with the realized learning gains, which earned a high positive correlation between the AI engagement and the post-test performance ($r = 0.62$, $p < .001$), which contributes to empirical evidence that effective use of AI tools directly results in a higher academic performance. Optional heat maps and dashboards also depicted interaction dynamics, the main periods of activity and the favorite AI functionality, which can be used to design future platforms and teaching methods. On balance, the results suggest that AI functions not only improve interaction but also produce a personalized learning process that is in self-regulation, which promotes not only increased performance but also long-term interaction during technical education.

Comparison between Ukraine and Bulgaria. Bulgarian students also, according to their report, received higher satisfaction and usability scores compared to

Ukrainian students, and this is attributed to the positive digital infrastructure base. However, the two groups rated AI integration positively, and Ukrainian students were keen on adaptive support and real-time feedback in the disruption of learning during wartime.

Interpretation: Survey data analysis shows that AI-enhanced mobile learning had a significant positive impact on student perceptions in several aspects and dimensions, such as satisfaction with such learning, self-efficacy, and usability. The students of the experimental group expressed more satisfaction (M = 4.36, SD = 0.52) and perceived self-efficacy (M = 4.18, SD = 0.55), which meant that AI tools have had a definite positive effect on the confidence, motivation, and engagement of students. Moreover, SUS usability scores were significantly greater when it was the AI-enhanced platform (M = 82.1, SD = 6.3) compared to the normal mobile learning (M = 69.4, SD = 7.1), indicating that the AI integration not only assists academic performance but also the overall user experience and the quality of interaction, too.

The comparison between Ukrainian and Bulgarian students showed that there is a bit more satisfaction and usability rates in Bulgarian students, probably because of a more stable digital infrastructure, greater familiarity of these students with AI-based platforms, and less trouble with infrastructure. However, Ukrainian students were highly appreciative of AI-based features, especially adaptive assistance and feedback in real-time, which alleviated the impact of the wartime displacement on the educational process, lack of access to campus laboratories, and connectivity problems. These findings imply that AI-enhanced mobile learning is an important source of critical scaffolding in crisis-prone situations, which enables students to continue learning and remain motivated and self-regulated in difficult conditions. On the whole, these findings may indicate the practical importance of the integration of adaptive, interactive, and personalized features in the curricula of technical higher education in addressing the background of crisis-affected situations. The overall positive results of all three universities are an indication that AI-dominated mobile learning can be successful and scaled, which can be used as a potential model for enhancing the quality of education in both stable and crisis-stricken settings.

4 DISCUSSION

Present research study inspected AI-enhanced effects mobile learning on technical learners crossways three universities in Ukraine and as well as Bulgaria emphasizing alterations in digital infrastructure and war-related distractions. Tools of AI meaningfully improved educational performance and apparent usability, with experimental group learners outdoing those in normal learning circumstances. Adaptive testing, tutoring of AI and personalized recommendations were chiefly effective in promoting problem-solving and as well as self-regulated type of learning. Learners of Bulgarian displayed higher post-test scores and their satisfaction due to better digital substructure, while Ukrainian learners still benefited despite displacement and also issues of connectivity. Recommendation systems and adaptive testing were most influential features of AI, though chatbots were writhed with multifaceted tasks, signifying room for improvement in development of AI. Limitations comprise small figures of universities, small intervention period and self-reported measures of arrangement. Upcoming research studies should discover longitudinal consequences; enlarging to additional organizations and as well as technical fields. General these findings prove that AI-enhanced mobile learning can support hardy, adaptive education and also provide practical theoretical visions for Eastern Europe and elsewhere.

5 CONCLUSION

This study proves that AI-enhanced mobile learning meaningfully rallies educational performance, arrangement and self-regulated learning among technical learners in Ukraine and Bulgaria. Experimental group learners using AI-integrated platforms outperformed control group learners in post-tests, particularly in complex subjects such as computer science, mathematics, engineering and applied mechanics. Personalized recommendation systems adaptive testing were most real features, while AI chatbots and solution explanations if valuable but task-limited provision. The conclusions highpoint that tools of AI foster personalized learning, and digital resilience, even under war-related disturbances in Ukrainian universities. Bulgarian learners displayed somewhat higher level of satisfaction due to steady infrastructure and prior contact to learning of AI. The research study endorses incorporating tools, tutoring of AI and modules of solution, alongside faculty provision to enhance consequences of learning. This study demonstrates that AI-enhanced mobile learning significantly improves academic performance, engagement, and self-regulated learning among students in technical, scientific and mathematical fields.

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7 REFERENCES

[1] N. Malysh, V. Shevchenko, and O. Tkachuk-Miroshnychenko, "Learning in Ukraine in wartime," *Open Learning: The Journal of Open, Distance and e-Learning*, vol. 40, no. 4, pp. 350–366, 2024. https://doi.org/10.1080/02680513.2024.2399847

[2] A. Gugushvili, "Russian public perceptions of the war in Ukraine: A paradox of optimism amid crisis," *Journal of Contemporary European Studies*, vol. 33, no. 3, pp. 950–974, 2025. https://doi.org/10.1080/14782804.2025.2472635

[3] S. Alon and C. Schechter, "Wartime leadership: Leading schools in a war crisis," *Journal of Educational Administration and History*, pp. 1–21, 2025. https://doi.org/10.1080/00220620.2025.2540399

[4] O. Bezrukova, O. Vilkova, and A. Petrenko-Lysak, "Social perception of war: A study of Ukrainian society under Russia's full-scale invasion," *Innovation: The European Journal of Social Science Research*, vol. 38, no. 1, pp. 70–91, 2025. https://doi.org/10.1080/13511610.2025.2467217

[5] O. Matveieva, "Social mobilization in wartime Ukraine: The connection between gender identity, national unity, and societal transformation," *Journal of Gender Studies*, vol. 35, no. 4, pp. 791–820, 2025. https://doi.org/10.1080/09589236.2025.2505558

[6] J. N. Clark, "Exploring the environmental impacts of war through sound and listening: A study of the Russia-Ukraine war," *Environmental Sociology*, pp. 1–15, 2025. https://doi.org/10.1080/23251042.2025.2510416
[7] E. A. Cech, "Culture of disengagement in engineering education?" *Science, Technology, & Human Values*, vol. 39, no. 1, pp. 42–72, 2013. https://doi.org/10.1177/0162243913504305
[8] J. Trevelyan, "Transitioning to engineering practice," *European Journal of Engineering Education*, vol. 44, no. 6, pp. 821–837, 2019. https://doi.org/10.1080/03043797.2019.1681631
[9] Z. Revesai, "Generative AI dependency: The emerging academic crisis and its impact on student performance," *Cogent Education*, vol. 12, no. 1, pp. 126–138, 2025. https://doi.org/10.1080/2331186X.2025.2549787
[10] B. Williamson, S. Bayne, and S. Shay, "The datafication of teaching in higher education: Critical issues and perspectives," *Teaching in Higher Education*, vol. 25, no. 4, pp. 351–365, 2020. https://doi.org/10.1080/13562517.2020.1748811
[11] M. Nedaei, F. Radmehr, and M. Drake, "Exploring undergraduate engineering students' mathematical problem-posing," *Mathematical Thinking and Learning*, vol. 24, no. 2, pp. 149–175, 2021. https://doi.org/10.1080/10986065.2020.1858516
[12] N. Garg, A. Kaur, F. Ahmad, and R. Dutta, "Augmenting education: The transformative power of AR, AI, and emerging technologies," *Human Behavior and Emerging Technologies*, vol. 2025, no. 1, pp. 221–236, 2025. https://doi.org/10.1155/hbe2/5681184
[13] C. Antonietti *et al.*, "Examining technology integration in upper secondary schools: A comparative analysis across school programs and subjects," *Tech. Know. Learn.*, pp. 12–37, 2025. https://doi.org/10.1007/s10758-025-09889-9
[14] A. Mimoudi and K. Mokhtari, "'AIA-PCEK': A new framework for teaching with AI," *Cogent Education*, vol. 12, no. 1, pp. 769–981, 2025. https://doi.org/10.1080/2331186X.2025.2563171
[15] M. de la Puente, J. Torres, and H. Guzman, "Coding finance: Impact of open-source financial software," *Interactive Learning Environments*, pp. 1–25, 2025. https://doi.org/10.1080/10494820.2025.2570488
[16] M. Kyambade, R. Kisseka, and A. Namatovu, "Blended learning models in Ugandan higher business education," *Cogent Education*, vol. 12, no. 1, pp. 116–129, 2025. https://doi.org/10.1080/2331186X.2025.2545329
[17] H. Bai, "Pedagogical practices of mobile learning in K-12 and higher education settings," *TechTrends*, vol. 63, pp. 611–620, 2019. https://doi.org/10.1007/s11528-019-00419-w
[18] F. Gao, L. Li, and Y. Sun, "A systematic review of mobile game-based learning in STEM education," *Educational Technology Research and Development*, vol. 68, pp. 1791–1827, 2020. https://doi.org/10.1007/s 11423-020-09787-0
[19] D. Mutambara and A. Bayaga, "Determinants of mobile learning acceptance for STEM education in rural areas," *Computers & Education*, vol. 160, pp. 166–181, 2021. https://doi.org/10.1016/j.compedu.2020.104010
[20] S. López-Pernas, E. Oliveira, Y. Song, and M. Saqr, "AI, explainable AI and evaluative AI," in *Advanced Learning Analytics Methods*, M. Saqr and S. Lopez-Pernas, Eds., Springer, Charm, 2026, pp. 31–45. https://doi.org/10.1007/978-3-031-95365-1_2
[21] Z. Varpina and K. Fredheim, "'Well it seems I'm caught up in a trap': Adoption of AI in university writing," in *Research and Innovation Forum 2024*, A. Visvizi, O. Troisi, V. Corvello, and M. Grimaldi, Eds., Springer, Charm, 2025, pp. 26–39. https://doi.org/10.1007/978-3-031-78623-5_13
[22] A. Krymska, O. Sopotsko, and I. Zrybnieva, "The role of digital technologies in Ukrainian enterprises," *Futurity of Social Sciences*, vol. 3, no. 3, pp. 76–98, 2025. https://doi.org/10.57125/FS.2025.09.20.04

[23] S. Luchyk *et al.*, "Education as a driver of innovative recovery and economic development of Ukraine," in *Data-Centric Business and Applications*, A. Semenov, I. Yepifanova, and J. Kajanova, Eds., Springer, Charm, 2025, pp. 165–182. https://doi.org/10.1007/978-3-031-81557-7_9

[24] T. Gorokhova, "Digitalisation: Catalysing the transition to a circular economy," in *Building Resilience Through Digital Transformation*, I. Bartuseviciene, B. Antanas, A. Karasavvoglou, and P. Polychronidu, Eds., 2025, pp. 129–143. https://doi.org/10.1007/978-3-031-90054-9_9

[25] L. Voitenko *et al.*, "Toward the development of the Ukrainian Water Quality Index (UWQI)," in *Science, Engineering Management and Information Technology (SEMIT 2025)*, in *Communications in Computer and Information Science*, A. Mirzazadeh, Z. Molamohamadi, B. Erdebilli, E. Babaee Tirkolaee, and G. W. Weber, Eds., vol. 2651. Springer, Cham, 2025, pp. 28–41. https://doi.org/10.1007/978-3-032-04225-5_2

[26] F. M. Alexander *et al.*, "Geopolitical and technical futures of the internet protocol," in *Geopolitics at the Internet's Core*, Palgrave, Cham, 2025, pp. 195–224. https://doi.org/10.1007/978-3-031-89478-7_9

[27] M. Alsabah *et al.*, "Key technologies toward smart healthcare systems based on IoT," *Artificial Intelligence Review*, vol. 58, p. 343, 2025. https://doi.org/10.1007/s10462-025-11342-3

[28] I. N. Albukhari, "The role of artificial intelligence in architectural design: A systematic review of emerging technologies and applications," *J. Umm Al-Qura University Engineering and Architecture*, vol. 16, pp. 1457–1476, 2025. https://doi.org/10.1007/s43995-025-00186-1

[29] P. Balasubramanian *et al.*, "Generative AI for cyber threat intelligence," *Artificial Intelligence Review*, vol. 58, p. 336, 2025. https://doi.org/10.1007/s10462-025-11338-z

[30] T. Khater *et al.*, "Generative AI models optimization toward molecule design," *Journal of Cheminformatics*, vol. 17, p. 116, 2025. https://doi.org/10.1186/s13321-025-01059-4

[31] H. Shafiee Rad, "Reinforcing L2 reading comprehension through artificial intelligence intervention," *Smart Learning Environments*, vol. 12, p. 23, 2025. https://doi.org/10.1186/s40561-025-00377-2

[32] M. Khalil, J. Wong, B. Wasson, and F. Paas, "Adaptive support for self-regulated learning," *British Journal of Educational Technology*, vol. 55, no. 4, pp. 1281–1289, 2024. https://doi.org/10.1111/bjet.13479

[33] S. H. Jin *et al.*, "Supporting students' self-regulated learning using artificial intelligence," *International Journal of Educational Technology in Higher Education*, vol. 20, p. 37, 2023. https://doi.org/10.1186/s41239-023-00406-5

[34] I. Han *et al.*, "Mobile based AI chatbot for self-regulated learning in a hybrid flipped classroom," *Journal of Computing in Higher Education*, vol. 38, pp. 285–309, 2025. https://doi.org/10.1007/s12528-025-09434-8

[35] H. Shafiee Rad, "Reinforcing L2 reading comprehension through artificial intelligence intervention: Refining engagement to foster self-regulated learning," *Smart Learning Environments*, vol. 12, p. 23, 2025. https://doi.org/10.1186/s40561-025-00377-2

[36] Hariyanto *et al.*, "Artificial intelligence in adaptive education," *Discover Education*, vol. 4, p. 458, 2025. https://doi.org/10.1007/s44217-025-00908-6

[37] S. Chavdarova-Kostova, "Report on smart education in the republic of Bulgaria," in *Smart Education in China and CEE Countries*, R. Zhuang et al., Eds., Springer, 2023, pp. 81–108. https://doi.org/10.1007/978-981-19-7319-2_4

[38] N. T. Nikolinakos, "Launching a European initiative on AI" in *EU Policy and Legal Framework for AI*, Springer, Cham, vol. 53, 2023, pp. 23–29. https://doi.org/10.1007/978-3-031-27953-9_2

[39] F. Serodes, "Equipping educators and students for the twin transition," in *Teachers Time Management*, Springer, Cham, 2025, pp. 57–97. https://doi.org/10.1007/978-3-031-97864-7_3
[40] L. Fuchs, C. Cuevas-Garcia, and G. Bombaerts, "The societal role of universities," *Tertiary Education and Management*, vol. 29, pp. 263–277, 2023. https://doi.org/10.1007/s11233-023-09126-x
[41] C. Wolff *et al.*, "Cross-border projects in digital education ecosystems," in *Mobility for Smart Cities*, M. E. Auer, H. Hortsch, O. Michler, and T. Köhler, Eds., Springer, 2022, pp. 382–294. https://doi.org/10.1007/978-3-030-93904-5_39
[42] M. Ebner *et al.*, "Implementing multilingual MOOCs with AI," in *Digital Education: EMOOCS 2025*, E. Hamonic and R. Sharrock, Eds., Springer, 2026, pp. 86–119. https://doi.org/10.1007/978-3-032-00056-9_15
[43] J. N. Rolf, "Educational cooperation," in *Central Asia in a Multipolar World*, J. Lempp and S. Mayer, Eds., Springer, 2024, pp. 481–491. https://doi.org/10.1007/978-3-031-63727-8_28
[44] L. Ripoll González *et al.*, "Managing stakeholder involvement in place branding: The need for network management," *Place Branding and Public Diplomacy*, vol. 21, pp. 143–156, 2025. https://doi.org/10.1057/s41254-024-00384-z
[45] J. Traxler and P. Jandrić, "Decolonising educational technology," in *Geopolitics of Postdigital Educational Development*, M. A. Peters, B. J. Green, O. Kamenarac, P. Jandrić, and T. Besley, Eds., Springer, 2025, pp. 163–196. https://doi.org/10.1007/978-3-031-99378-7_9
[46] C. Papakostas, C. Troussas, and C. Sgouropoulou, "AI-enhanced augmented reality in education," in *Special Topics in AI and AR*, Springer, Charm, 2024, pp. 13–50. https://doi.org/10.1007/978-3-031-52005-1_2
[47] M. A. S. Khasawneh *et al.*, "Portfolio assessment in AI-enhanced learning environments," *Language Testing in Asia*, vol. 15, 2025. https://doi.org/10.1186/s40468-025-00345-0
[48] M. M. Daher and F. Ziade, "Technology, workforce, and sustainable work," in *Navigating Business, Sustainability and Technology*, H. El-Chaarani, I. El Dandachi, S. El Nemar, and Z. El Abiad, Eds., Springer, 2023, pp. 119–136. https://doi.org/10.1007/978-981-99-8572-2_6
[49] R. A. Rahimi and G. S. Oh, "Rethinking the role of educators in the 21st century," *Journal of Marketing Analytics*, vol. 12, pp. 182–197, 2024. https://doi.org/10.1057/s41270-024-00303-4
[50] O. A. Ajani, B. T. Gamede, and R. Bansal, "Challenges and opportunities of integrating Industry 5.0 and emerging technologies in higher education for enhancing employability skills," in *Industry 5.0 and Emerging Technologies.* in *Studies in Systems, Decision and Control*, A. Chakir, R. Bansal, and M. Azzouazi, Eds., vol. 565, Springer, 2024, pp. 36–56. https://doi.org/10.1007/978-3-031-70996-8_11

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