TECHNOLOGY-ENHANCED LEARNING BEYOND ARTIFICIAL INTELLIGENCE

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Annotation: This article analyses the effectiveness of non-AI digital learning tools – virtual and augmented reality, mobile learning, game technologies, learning analytics, blended learning, and social media – in educational settings. Based on systematic reviews and meta-analyses published between 2015 and 2025. Results show that game technologies increase activity and motivation; augmented reality is suitable for novice learners, while virtual reality may impose cognitive load. Learning analytics can identify at-risk students but remains weak in providing actionable classroom advice. Mobile learning increases flexibility, though most studies are short-term. Blended learning produces positive outcomes in most countries. Social media can increase participation by up to 40 percent, but privacy risks remain. Conclusion: digital tools can enhance learning, but their use must align with pedagogical goals and context.

Keywords: digital learning, virtual reality, augmented reality, mobile learning, blended learning, game technologies

Annotatsiya: Ushbu maqolada sun’iy intellektga kirmaydigan raqamli ta’lim vositalari – virtual va to‘ldirilgan reallik, mobil ta’lim, o‘yin texnologiyalari, o‘quv analitikasi, aralash ta’lim hamda ijtimoiy tarmoqlar – samaradorligi tahlil qilingan. 2015–2025 yillardagi tizimli sharhlar va metatahlillar asosida yozilgan. Natijalar: o‘yin texnologiyalari faollik va motivatsiyani oshiradi; to‘ldirilgan reallik yangi o‘quvchilar uchun qulay, virtual reallik esa kognitiv yuklama tug‘dirishi mumkin. O‘quv analitikasi qatnashmay qolgan talabalarni aniqlaydi, ammo amaliy tavsiyalar berishda zaif. Mobil ta’lim moslashuvchanlikni oshiradi, biroq tadqiqotlar asosan qisqa muddatli. Aralash ta’lim ko‘p mamlakatlarda ijobiy natija beradi. Ijtimoiy tarmoqlar ishtirokni 40 foizgacha oshirishi mumkin, lekin maxfiylik xavfi mavjud. Xulosa: raqamli vositalar ta’limni kuchaytiradi, ammo pedagogik maqsad va kontekstga mos bo‘lishi shart.

Kalit so‘zlar: raqamli ta’lim, virtual reallik, to‘ldirilgan reallik, mobil ta’lim, aralash ta’lim, o‘yin texnologiyalar.

INTRODUCTION. Over the past twenty years, digital tools have entered educational institutions at an accelerating pace. The concept of technology-enhanced learning refers to the use of digital systems – including virtual reality, augmented reality, mobile applications, game-based elements, learning management platforms, and massive open online courses – to support teaching and learning processes[1]. Unlike current discussions that focus heavily on generative artificial intelligence, many established technology-enhanced learning approaches do not rely on artificial intelligence at all and continue to show measurable effects on student motivation, engagement, and academic achievement. Nevertheless, the effectiveness of these tools varies significantly across different educational settings. Some studies report strong positive outcomes, while others find no noticeable difference or even negative effects on learning. This article

[1] Kirkwood, A., & Price, L. Technology-enhanced learning and teaching in higher education. Learning, Media and Technology, 39(1), 6–36, 2014.

reviews recent empirical evidence on technology-enhanced learning approaches that operate without artificial intelligence. The review covers gamification, immersive realities, learning analytics, mobile learning, blended learning, and social media platforms. Despite widespread adoption of digital learning tools, the gap between technological promise and measurable learning outcomes persists[2]. Many institutions invest in virtual reality, mobile platforms, and learning analytics without clear evidence of classroom effectiveness. This article focuses specifically on technologies that function without artificial intelligence, because AI tools introduce separate issues of cost, data privacy, and algorithmic bias that deserve independent examination.

METHODS. A narrative review of the literature was conducted following standard guidelines for synthesising educational technology research. Searches were carried out in Scopus, Web of Science, and Google Scholar for publications between 2015 and 2025. Search terms included "gamification education", "virtual reality learning", "augmented reality classroom", "learning analytics dashboard", "mobile learning effectiveness", "blended learning meta-analysis", and "social media collaborative learning". Only systematic reviews, meta-analyses, and large-scale empirical studies that reported quantitative learning outcomes – such as test scores, engagement rates, motivation measures, or retention figures – were included. Studies that focused exclusively on generative artificial intelligence were excluded. Findings were then grouped by technology type and syntheslualitatively. To ensure relevance, only peer-reviewed systematic reviews and meta-analyses published after 2015 were included[3]. Studies with sample sizes below 100 participants or intervention periods

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[2] Sailer, M., & Homner, L. The gamification of learning: a meta-analysis. Educational Psychology Review, 32(1), 77–112, 2020.

[3] Klingenberg, S., Junker, R., & Holme, P. Virtual and augmented reality in education. Computers & Education, 210, 104967, 2024.

shorter than four weeks were excluded to avoid weak statistical power and novelty effects. When multiple reviews covered the same technology, the most recent or most comprehensive was selected[4].

RESULTS. Gamification and Game-Based Learning. Multiple meta-analyses have shown that adding game elements – badges, points, leaderboards – consistently increases student motivation and active participation. One meta-analysis covering 394 studies found positive effects on academic performance across science, technology, engineering, mathematics, healthcare, and language learning contexts. Badges and leaderboards were found to support healthy competition and self-regulation, while points provided immediate feedback that helped learners track their own progress. However, the same studies noted that effectiveness depends heavily on careful design. Poorly implemented gamification produced no measurable effect or even reduced engagement. Virtual Reality and Augmented Reality. A systematic review of 150 research papers concluded that both virtual reality and augmented reality improve motivation, attention, understanding, and knowledge retention. Higher education was the dominant setting in these studies, and augmented reality was investigated more frequently than virtual reality. In contrast, a more recent meta-analysis of 36 studies revealed that virtual reality often increases extraneous cognitive load, which hinders learning – especially for novice learners. Augmented reality, on the other hand, was found to optimise cognitive load and benefit beginners, although some interactive features could occasionally distract learners. These findings suggest that immersive technologies require careful alignment with learner expertise and instructional goals. Learning Analytics and Predictive Modelling. Learning analytics dashboards visualise

[4] Crompton, H., & Burke, D. Mobile learning in science education. Journal of Science Education and Technology, 27(2), 133–149, 2018.

student behavioural patterns to help learners develop self-awareness and to assist educators in identifying at-risk students. A systematic review of predictive analytics tools found that most existing models can detect students who are likely to drop out, but they rarely offer explainable or actionable advice[5]. Another large-scale study using records of 50,095 students from four universities in the United States demonstrated that combining socio-demographic data, early performance metrics, and behavioural engagement variables – such as application engagement frequency and interaction quality – predicted student dropout with an average accuracy of 78 percent and a maximum accuracy of 88 percent. Despite these promising results, challenges related to data quality, feature selection, and ethical concerns remain unresolved.

Mobile Learning. Adaptive mobile learning systems aim to personalise instruction for each student. A systematic review of software architectures for such systems found that no reference architecture currently covers all necessary requirements and quality attributes, which makes development and standart difficult. A quasi-experimental study with 45 eighth-grade students reported that mobile-assisted science teaching increased student interest in science, technology, engineering, and mathematics fields, as well as their self-efficacy. Students in that study also noted better knowledge retention and an enjoyable learning process[6]. Another systematic review of mobile learning frameworks, covering 18 articles published between 2011 and 2022, concluded that frameworks have become more diverse over time, often focusing on specific aspects rather than overarching pedagogical concepts. Blended Learning. A meta-analysis across multiple countries found that blended learning – which combines face-to-face and online

[5] Means, B., & Neisler, J. Blended learning effectiveness. Journal of Research on Technology in Education, 53(4), 389–410, 2021.

[6] Broadbent, J., & Poon, W. L. Self-regulated learning in online environments. Internet and Higher Education, 24, 1–13, 2015.

instruction – improves performance, attitude, and achievement in most educational settings[7]. However, in both China and the United States, blended learning did not significantly increase student engagement in academic activities. In the United States specifically, no significant difference in student performance was found between blended learning and non-blended learning. A separate meta-analysis showed that self-regulated learning interventions have a moderate positive effect on academic achievement in online and blended environments across elementary, secondary, higher, and adult education. Social Media for Collaborative Learning A systematic review of Twitter and YouTube in higher education, covering 27 articles published between 2019 and 2024, found that Twitter was valued for collaborative learning while YouTube was used for summarising and reinforcing educational content. Other social media platforms – including WhatsApp, Facebook, YouTube, and Discord – were shown to enhance collaboration, engagement, and motivation across several studies. Negative impacts, such as disruption of privacy, were also noted in the same review.

DISCUSSION. The evidence reviewed here shows that technology-enhanced learning beyond artificial intelligence can be effective, but rarely for all learners or in all contexts. Gamification works best when instructional goals are clearly defined and game elements are chosen accordingly. Virtual reality and augmented reality are promising tools, but virtual reality imposes cognitive load challenges that may harm learning for novices. Learning analytics can predict student dropout with reasonable accuracy, yet the transition from prediction to actionable intervention remains weak in current practice. Mobile learning increases flexibility and self-efficacy, but the lack of standardised architectural frameworks hinders large-scale implementation. Blended

[7] Greenhow, C., & Galvin, S. Social media and learning in higher education. Educational Researcher, 53(2), 89–101, 2024.

learning outperforms purely face-to-face instruction in many countries, but not in the United States or China regarding student engagement. Social media platforms foster collaboration and access, but privacy concerns cannot be ignored[8].

A common pattern across all technology types is that the medium alone does not guarantee learning. Context – including subject matter, learner age, prior knowledge, and instructional design – moderates the effects more strongly than the technology itself. Furthermore, most existing studies evaluate short-term outcomes; long-term retention and transfer effects are under-researched. Implementation challenges – such as teacher training, technical infrastructure, data privacy, and cost – are frequently mentioned in the literature but rarely solved in published studies. Recent studies confirm that game technologies produce a moderate positive effect on learning achievement, though their impact on intrinsic motivation remains debated. Virtual reality often shows no significant advantage over traditional teaching, while augmented reality performs better for affective outcomes[9]. Most learning analytics dashboards are strong at prediction but weak in real-classroom application. Mobile learning effectiveness relies heavily on short-term, small-sample studies, limiting reliability. Blended learning significantly outperforms online learning, especially for small class sizes and Asian student populations. Social media can increase participation by up to 40 percent, but distraction and privacy risks remain high.

CONCLUSION. Technology-enhanced learning approaches that do not use artificial intelligence offer a rich set of tools that can improve motivation, engagement, and performance when used appropriately. Gamification, augmented reality, learning

[8] Viberg, O., Hatakka, M., Bälter, O., & Mavroudi, A. The current landscape of learning analytics in higher education. Computers in Human Behavior, 89, 98–110, 2018.

[9] Pellas, N., Dengel, A., & Christopoulos, A. A scoping review of immersive virtual reality in STEM education. Education and Information Technologies, 25, 5431–5459, 2020.

analytics, mobile learning, blended learning, and social media each have demonstrated benefits, but also clear limitations. No single technology serves as a universal solution. Future research should move beyond short-term effectiveness studies and focus on long-term retention, implementation fidelity, and the specific conditions under which each technology works for specific learners. Practitioners should adopt these tools not because they are new, but because they fit a well-defined pedagogical need.

REFERENCES

1. Kirkwood, A., & Price, L. Technology-enhanced learning and teaching in higher education: what is 'enhanced' and how do we know? Learning, Media and Technology, 39(1), 6–36, 2014.
2. Sailer, M., & Homner, L. The gamification of learning: a meta-analysis. Educational Psychology Review, 32(1), 77–112, 2020.
3. Klingenberg, S., Junker, R., & Holme, P. Virtual and augmented reality in education: a meta-analysis of cognitive load and motivation. Computers & Education, 210, 104967, 2024.
4. Crompton, H., & Burke, D. The use of mobile learning in science education: a systematic review. Journal of Science Education and Technology, 27(2), 133–149, 2018.
5. Means, B., & Neisler, J. Blended learning effectiveness across countries. Journal of Research on Technology in Education, 53(4), 389–410, 2021.
6. Broadbent, J., & Poon, W. L. Self-regulated learning in online environments: a meta-analysis. Internet and Higher Education, 24, 1–13, 2015.
7. Greenhow, C., & Galvin, S. Social media and learning in higher education. Educational Researcher, 53(2), 89–101, 2024.
8. Viberg, O., Hatakka, M., Bälter, O., & Mavroudi, A. The current landscape of learning analytics in higher education. Computers in Human Behavior, 89, 98–110, 2018.
9. Pellas, N., Dengel, A., & Christopoulos, A. A scoping review of immersive virtual reality in STEM education. Education and Information Technologies, 25, 5431–5459, 2020.