

AI-Powered Game-Based Learning for Project Management Education

Matthew Daniels

Kemmy Business School, University of Limerick, Ireland

matthew.daniels@ul.ie

Abstract: Bridging the gap between theory and practice remains a core challenge in project management education, as students often struggle to transfer classroom knowledge into complex, uncertain, and ethically charged environments. As serious games increasingly integrate artificial intelligence (AI), new opportunities arise for scalable, adaptive, and ethically informed learning. This paper introduces and evaluates an AI-enhanced Game-Based Learning (AI-GBL) framework that positions AI as a pedagogical co-orchestrator—modulating narrative and challenge—rather than a content add-on. It embeds serious game mechanics through two interactive modalities: AI-driven stakeholder interviews and collaborative crisis scenarios requiring students to make decisions, weigh trade-offs, and reflect on consequences. Structured debriefs and ethically ambiguous dilemmas reinforced reflection, judgment, and leadership identity. Within this framework, the lecturer served as a game master, shaping the environment, guiding discussion, and ensuring ethical engagement, while AI dynamically adapted gameplay. Grounded in Kolb's experiential learning cycle and scaffolded by the 5E model, the design also drew on Self-Determination Theory and Flow to support autonomy, competence, and engagement. A mixed-methods, quasi-experimental pretest–posttest design was applied in live classrooms. Undergraduates ($n = 113$) were grouped by tutorial exposure (experimental: ≥ 3 , $n = 66$; control: ≤ 2 , $n = 47$), while a postgraduate cohort ($n = 47$) contributed qualitative reflections. Students in the AI-GBL group achieved significantly higher posttest scores (means: 66.64 vs. 48.00). ANCOVA controlling for pretest confirmed a large effect (partial $\eta^2 = .799$), though this should be interpreted cautiously due to the non-randomised design. Qualitative reflections revealed growth in ethical reasoning, collaborative identity, and adaptive decision-making, alongside signs of over-reliance on AI—highlighting the need for scaffolding in ethical AI literacy. Findings suggest that AI-GBL can enhance domain-specific performance and the metacognitive and affective dimensions of adaptive expertise—ethical sensitivity, reflective judgment, and leadership identity. Three design principles emerge: (1) AI should function as a co-orchestrator, modulating challenge and feedback in real time; (2) open-ended, ethically complex scenarios deepen reflection beyond procedural accuracy; and (3) critical scaffolding is essential to prevent passive reliance on AI-generated outputs. This study builds on prior conceptual work published in *Project Leadership and Society* by providing empirical evidence of AI-GBL's effectiveness, advancing design principles for AI-integrated serious games, and identifying directions for future research, including longitudinal tracking, replication, and cross-domain application.

Keywords: Generative AI, Game-Based learning, Experiential learning, Project management education, Serious games

1. Introduction

Bridging the gap between theoretical instruction and practical application remains a central challenge in project management education (Darrell et al., 2010; Egginton, 2012; Nicholson, 2015). While students often demonstrate proficiency with established tools and methodologies, many struggle to transfer this knowledge into real-world contexts marked by ambiguity, stakeholder complexity, and emergent crises. This persistent theory–practice divide reflects a broader misalignment between academic models and the adaptive, human-centred problem-solving required in contemporary project environments (Darrell et al., 2010; Huemann & Turner, 2024). This gap is further exacerbated by the "accidental project manager" phenomenon—individuals promoted into leadership roles based on technical or managerial expertise, rather than formal training in project management (Pelgrim et al., 2022; Ward et al., 2018). As demand for project-based competencies grows, conventional educational approaches are increasingly insufficient for preparing professionals to navigate modern projects' volatile, uncertain, and ethically complex terrain.

Traditional project management education prioritises routine expertise—using known methods to address well-defined problems efficiently. While this expertise is necessary, it is insufficient for tackling today's complex project landscapes. In contrast, adaptive expertise involves the ability to transfer knowledge flexibly, innovate under pressure, and make sound judgments in uncertain or novel situations (Pelgrim et al., 2022; Ward et al., 2018). As Huemann and Turner (2024) put it, "Complex projects are mysteries which require innovation. Conventional project management is not good at innovation." This observation highlights the core educational imperative: to equip learners not just to solve familiar problems, but to lead through ambiguity, engage in ethical reasoning, and adapt their decision-making to dynamic contexts.

This paper introduces an AI-enhanced Game-Based Learning (AI-GBL) framework that integrates generative AI simulations with experiential learning principles to address the limitations of static case studies and linear instruction. The AI-GBL model presents emotionally resonant, high-stakes scenarios that provide a safe

environment for learners to practise decision-making, navigate ethical dilemmas, and cultivate adaptive, reflexive leadership skills. Unlike simulations, which typically model fixed processes with predetermined outcomes, the AI-GBL design incorporated game mechanics—role-play, uncertainty, trade-offs, and narrative consequence—that required active decision-making and reflection. This distinction situates the intervention within serious games rather than passive simulation.

This study builds on prior conceptual work published in *Project Leadership and Society* (Daniels et al., 2025), which outlined six pedagogical themes—relevance, agility, identity, ethics, motivation, and adaptability—and proposed AI as a pedagogical co-orchestrator for leadership education. The present paper extends that work by subjecting the model to empirical testing in live classroom contexts, reporting quantitative outcomes alongside qualitative reflections.

2. Theoretical Framework

The design of the AI-GBL intervention is grounded in Kolb's Experiential Learning Theory, which conceptualises learning as a cyclical process in which knowledge is created through the transformation of experience (Kolb & Kolb, 2005, 2008, 2022). Kolb's experiential learning cycle—concrete experience, reflective observation, abstract conceptualisation, and active experimentation—fosters the metacognitive and strategic capacities central to adaptive leadership.

AI_GBL operationalises this model by immersing learners in complex, simulated challenges, reinforcing learning through iterative action and reflection. To operationalise this cycle within a digital environment, the intervention adopted the 5E Instructional Model: Engage, Explore, Explain, Elaborate, and Evaluate (Daniels et al., 2025; Owens & Sadler, 2024). This constructivist framework scaffolded learner interaction with AI simulations by structuring engagement through the 5E model. Simulated crises-initiated inquiry (Engage), followed by stakeholder exploration (Explore) and guided debriefings that connected gameplay to theoretical concepts (Explain). This sequence rendered experiential learning systematic and pedagogically purposeful, deepening conceptual understanding and applied competence.

Sustaining motivation in complex learning environments remains a challenge in higher education. This intervention addressed it by integrating Self-Determination Theory (SDT) and Flow Theory (Beard, 2015; Csikszentmihalyi & Csikszentmihalyi, 1990; Nash, 2025; Ryan & Deci, 2000). SDT posits that intrinsic motivation arises when learners experience autonomy, competence, and relatedness, while Flow Theory describes deep task immersion achieved through an optimal balance of challenge and skill. The AI-GBL design reinforced both: adaptive task difficulty supported competence, branching narratives fostered autonomy, and collaborative crises promoted relatedness. Together, these elements sustained self-directed engagement in emotionally and cognitively demanding scenarios.

In this intervention, AI functioned as a pedagogical co-orchestrator—actively shaping the learning environment alongside the instructor (Kamalov et al., 2023). Reflecting a shift from AI as a content provider to an instructional partner, this model aligns with emerging research that emphasises augmentation over replacement of human expertise. Building on the concept of classroom orchestration (Dillenbourg et al., 2011), the AI dynamically moderated narrative flow, introduced adaptive challenges, and sustained decision complexity in real time. The system created unpredictable, high-fidelity learning conditions by generating context-sensitive disruptions—such as ethical dilemmas or stakeholder shifts. These just-in-time interventions enabled scalable, responsive engagement, supporting critical thinking and the development of adaptive judgment in complex project scenarios.

The AI-GBL was structured as a serious game, employing game mechanics to foster project leadership through immersive, high-stakes simulations that replicate professional challenges without real-world risk (Daniels et al., 2025; Michael & Chen, 2005). Gameplay was governed by explicit rules and resource constraints, requiring learners to manage time, budget, team capacity, and risk buffers. Decisions were locked before outcomes were revealed, compelling learners to commit and reflect on consequences. Each cycle followed a four-phase loop—planning, action, feedback, and reflection—through which learners analysed scenarios, enacted decisions, received AI-generated outcomes, and iteratively refined strategies across progressively complex rounds. This design promoted iterative learning, critical reflection, and adaptive decision-making.

The intervention employed two modalities to cultivate leadership and adaptive expertise: virtual stakeholder interviews and collaborative crisis management. In the former, learners engaged with AI-generated stakeholders to practise questioning, negotiation, and synthesis, strengthening communication and analysis skills. In the latter, teams responded to time-sensitive crises such as budget cuts or personnel losses, requiring rapid analysis,

coordinated decisions, and emotional resilience. Together, these modalities fostered strategic leadership and collaborative problem-solving under conditions of uncertainty.

A defining feature of the AI-GBL model is its integration of ethical ambiguity with structured feedback, designed to provoke reflection and sustain productive struggle. Feedback was delivered to preserve cognitive tension, encouraging persistence rather than premature closure, consistent with research highlighting its impact on performance and retention (DeFalco et al., 2018; Emerson et al., 2020; Goldberg, 2015). Using multimodal learning analytics, the AI adapted feedback to learners' cognitive, emotional, and behavioural states—for example, adjusting difficulty or offering scaffolds when frustration was detected. In this way, the AI functioned as a responsive learning partner, regulating cognitive load, supporting emotional resilience, and clarifying complex decision-making processes in real time.

Explicit win and fail conditions were embedded into the game structure to distinguish the intervention from an open-ended simulation. A win state is achieved when learners meet key project goals—such as completing deliverables on time and within budget—while maintaining positive stakeholder relationships and upholding ethical standards. Conversely, a failure state is triggered if a team accumulates too many strategic missteps, such as exceeding strike limits or depleting their risk buffer entirely. These outcomes create tangible consequences for decisions, reinforcing motivation and sustaining meaningful engagement throughout the learning experience.

The game content embeds ethical ambiguity and promotes productive failure—where learners grapple with complex problems before receiving direct instruction, leading to deeper conceptual understanding (Daniels et al., 2025). Scenarios are deliberately open-ended, requiring students to balance competing values and justify their decisions. For example, in "The Fast-Track Offer," a subcontractor proposes bypassing mandatory safety inspections to accelerate delivery, forcing a choice between meeting a tight deadline and safeguarding public welfare. In "No Right Answer," students face irreconcilable demands from multiple stakeholders, ensuring that any decision will inevitably disadvantage at least one party. Such morally and strategically complex challenges foster *phronēsis* (practical wisdom) and adaptive judgment. The mechanics and their pedagogical alignment are summarised in Table 1.

Table 1: Mapping of Serious Game Mechanics to Pedagogical Themes

Pedagogical Theme	Serious Game Mechanic	Learning Outcome
Relevance	Realistic, industry-aligned scenarios with complex stakeholder dynamics.	Bridges the theory-practice gap by applying concepts in authentic contexts.
Agility	AI-generated disruptions (e.g., budget cuts, regulatory changes).	Develops adaptive responsiveness and strategic decision-making under volatility.
Identity	Narrative-rich dilemmas require reflection on personal values.	Fosters the construction of a reflexive and ethically grounded leadership identity.
Ethics	Scenarios with conflicting moral values and biased AI advice.	Cultivates ethical AI literacy and the capacity for values-based judgment.
Motivation	Adaptive challenges, clear goals, and an immediate feedback loop.	Sustains intrinsic engagement by satisfying needs for competence and autonomy.
Adaptability	Open-ended problems with no single correct solution ("productive failure").	Encourages iterative learning and the development of adaptive expertise.

3. Methodology

This study employed a mixed-methods, quasi-experimental pretest–posttest design to evaluate the effectiveness of an AI-enhanced Game-Based Learning (AI-GBL) framework. Quasi-experimental approaches are suitable in authentic classroom contexts where random assignment is not feasible due to existing timetables and groupings (Creswell & Creswell, 2017). Baseline comparisons were conducted to reduce the risk of selection bias, and no significant differences between groups were confirmed. An Analysis of Covariance (ANCOVA) was then used with posttest performance as the dependent variable, group membership as the fixed factor, and pretest scores as the covariate. This analytic strategy adjusted for prior knowledge, yielding a more accurate intervention effect estimate.

The study sample comprised 113 undergraduates enrolled in project management modules at an Irish university. Group membership was determined by level of exposure to AI-GBL tutorials: students who attended three or

more sessions formed the experimental group (n = 66). In comparison, those attending two or fewer sessions formed the control group (n = 47) and received conventional case-based instruction. A separate postgraduate cohort (n = 47) was not part of the quasi-experiment but contributed qualitative data through reflective journals and project plans.

Although individual QCA (Quality Credit Average) scores were unavailable for the study participants, institutional records show that the average QCA for project management students has remained stable at approximately 3.00 (B2 classification) over the past three academic years. This benchmark corresponds to an upper second-class honours level and reflects the typical academic profile of students in the programme. Given the consistent entry requirements, module structure, and assessment practices, it is reasonable to assume academic comparability across the sampled groups. While this assumption does not eliminate the possibility of selection bias, it helps contextualise group equivalence and supports the plausibility of the observed intervention effects.

The intervention positioned AI as a pedagogical co-orchestrator rather than a content add-on, embedding serious game mechanics rather than passive simulation. Two interactive modalities were central. In the virtual stakeholder interviews, students engaged with AI-driven characters representing clients, sponsors, or team members, requiring negotiation, probing, and interpretation of incomplete or conflicting information. In the collaborative crisis management exercises, teams responded to AI-generated project disruptions such as budget reversals, shifting deadlines, or stakeholder disputes, which introduced volatility and demanded collective decision-making under pressure. Each activity was followed by a structured debrief in which the lecturer acted as a game master—shaping the flow of play, motivating learners, and framing ethically ambiguous dilemmas as opportunities for reflection. This pedagogical presence ensured that AI-driven dynamics remained embedded within a purposeful game-based learning environment. Scenarios were deliberately framed without a single "right answer," encouraging learners to confront trade-offs and strengthen reflective judgment, leadership identity, and ethical sensitivity.

To clarify the logic of the intervention, Table 2 Summarises how each activity mapped to targeted competencies and pedagogical features.

Table 2: Mapping of AI-GBL Modalities to Targeted Competencies

AI-GBL Modality	Description	Targeted Competencies	Pedagogical Features
Virtual Stakeholder Interviews	AI-driven role-play requiring negotiation and sense-making with incomplete information.	Communication, negotiation, critical thinking, uncertainty management	Adaptive AI dialogue, emotionally resonant interaction
Collaborative Crisis Management	Teams respond to AI-generated project disruptions.	Teamwork, strategic decision-making, adaptability, and leadership under stress	Collective problem-solving, dynamic escalation
Structured Debriefs	Facilitated reflection on decisions, trade-offs, and implications.	Reflective judgment, ethical reasoning, and leadership identity	Guided discussion, values clarification
Ethically Ambiguous Scenarios	Challenges framed without a single "right answer."	Ethical sensitivity, metacognitive awareness, adaptive expertise	Moral tension, exploration of consequences

Several pedagogical frameworks informed the design. Kolb's experiential learning cycle guided the structuring of activities into phases of experience, reflection, conceptualisation, and experimentation. Classroom delivery followed the 5E model (Engage, Explore, Explain, Elaborate, Evaluate), ensuring progressive consolidation of learning. Self-Determination Theory underpinned the motivational design, sustaining autonomy through choice, competence through graduated challenge, and relatedness through collaboration. Finally, flow theory informed the adaptive use of AI to balance challenge with skill, maintaining immersion and engagement.

Quantitative data were collected through scenario-based pretests and posttests administered to the undergraduate cohort. ANCOVA was applied to assess posttest outcomes while controlling for pretest scores. Qualitative data were drawn from postgraduate reflective journals and project plans. Thematic analysis identified patterns of adaptive thinking, ethical reasoning, and engagement with AI-generated content, with coding iteratively cross-checked to ensure reliability. These insights were used to contextualise and triangulate the quantitative results. The scenario-based pretest and posttest instruments were developed in alignment with module learning outcomes and the targeted competencies outlined in Table 2. While not standardised assessments, they were reviewed by teaching faculty for content validity and piloted in previous iterations of the module to ensure alignment with intended learning goals.

4. Results

Unadjusted posttest means indicated markedly higher performance among the experimental group ($M = 66.64$, $SD = 5.47$, $n = 66$) than the control group ($M = 48.00$, $SD = 2.89$, $n = 47$). Pretest means were broadly comparable (Control: $M = 19.04$, $SD = 7.49$; Experimental: $M = 21.36$, $SD = 7.26$). Gain scores likewise favoured the experimental group ($M = 45.27$, $SD = 8.47$) over the control group ($M = 28.96$, $SD = 7.82$).

Descriptive statistics were calculated for tutorial attendance to ensure transparency in intervention exposure. Control group students (≤ 2 tutorials, $n = 47$) attended on average 0.81 tutorials ($SD = 0.85$, range = 0–2). Experimental group students (≥ 3 tutorials, $n = 66$) attended on average 4.48 tutorials ($SD = 1.52$, range = 3–8). These figures confirm a clear differentiation in exposure to the AI-GBL intervention (Table 3).

Table 3: Tutorial Attendance by Group

Group	N	Min	Max	Mean	SD
Control	47	0	2	0.81	0.85
Experimental	66	3	8	4.48	1.52

After adjusting for pretest performance, a one-way ANCOVA showed a very large group effect on posttest scores, $F(1, 110) = 437.78$, $p < .001$, partial $\eta^2 = .799$. This means that group membership (AI-GBL vs. control) explained almost 80% of the difference in learning outcomes, independent of students' starting ability. The pretest covariate was insignificant, $F(1, 110) = 1.46$, $p = .230$, indicating that baseline knowledge did not drive the observed gains. The model explained 80.6% of the variance in posttest outcomes ($R^2 = .806$). Table 4 Presents the statistical components underlying these results. The Sum of Squares (SS) values show how much variation each factor explains, while df (degrees of freedom) and MS (mean square) standardise this variation for comparison. The resulting F and p values test whether each effect is significant, and partial η^2 estimates effect size. The group factor had a very large effect ($\eta^2 = .799$), while the pretest covariate contributed little ($\eta^2 = .013$).

Table 4: ANCOVA Results for Undergraduate Posttest Scores (Covariate: Pretest Score)

Source	SS	df	MS	F	p	Partial η^2
Pretest Score (Covariate)	101.9	1	101.9	1.46	.230	.013
Group (Exp vs Ctrl)	30,530.6	1	30,530.6	437.78	<.001	.799
Error	7,673.0	110	69.8	—	—	—

The ANCOVA controlled for students' initial knowledge (pretest scores) to isolate the effect of the intervention. The F and p values test whether between-group differences are statistically significant, while partial η^2 estimates the proportion of variance in posttest performance explained by group membership. In this study, pretest scores did not significantly predict posttest outcomes ($p = .230$). However, group membership (AI-GBL vs. control) had a very large effect (partial $\eta^2 = .799$), suggesting that approximately 80% of the variance in posttest performance—after adjusting for baseline knowledge—can be attributed to the intervention. While this represents a substantial effect within the institutional context, it should be interpreted cautiously given the quasi-experimental design and non-random group allocation.

Thematic analysis of postgraduate reflective journals and project plans revealed a broad spectrum of engagement with the AI-GBL environment. Most students demonstrated growth in ethical reasoning and strategic awareness. Approximately 22% of students demonstrated high levels of ethical engagement, employing frameworks such as virtue ethics and showing nuanced consideration of stakeholder trade-offs. These students frequently used collective language—e.g., "our decision" and "our ethical position"—indicating a shift toward collaborative identity and values-based leadership.

By contrast, approximately 24% of students relied heavily on AI-generated suggestions with limited critical evaluation, often accepting outputs at face value without reflecting on ethical or contextual implications. This tendency was more pronounced in the absence of tutor guidance, suggesting that high autonomy in AI-rich environments may lead to superficial engagement unless explicit scaffolding is provided.

Taken together, the quantitative and qualitative results present a consistent pattern. While AI-GBL enhanced applied performance and fostered ethical reflection for many learners, it also revealed a potential risk of over-reliance on AI tools when lacking pedagogical support. For example, the qualitative theme of "leading through uncertainty" identified in postgraduate reflections aligns directly with the intended outcomes of the crisis

management scenarios and reinforces the posttest improvements observed in strategic reasoning and adaptive thinking.

5. Discussion

The findings demonstrate that the AI-GBL framework significantly enhanced applied learning while reaffirming the vital role of the lecturer as game master. Far from a passive simulation, the intervention established a structured game-based environment aligned with recognised definitions of serious games (Gee, 2003; Kiili, 2005; Prensky, 2001). Game-based learning incorporates challenge, feedback, decision-making, and reflection. AI components provided adaptive challenges and narrative variation, while the lecturer coordinated motivation, guided debriefs, and transformed ethically ambiguous scenarios into opportunities for judgment and leadership development. Rather than replacing the teacher, AI amplified their role within a carefully designed game-based structure.

Quantitative results showed that students exposed to AI-GBL achieved significantly higher post-test scores than the control group, with ANCOVA indicating that group membership explained nearly 80% of the performance variance. These outcomes demonstrate the effectiveness of key mechanics: decision-making under uncertainty, dynamic AI-generated consequences, and reflective debriefs. Unlike static case studies, this approach created interactive, playable problems where learners could test strategies, adapt, and experience productive failure in a safe environment.

Qualitative reflections further highlighted the framework's affective and metacognitive impact. Many postgraduates demonstrated growth in ethical reasoning, collaborative identity, and adaptive decision-making—often neglected in traditional instruction. High performers used collective language ("our decision") and critically engaged with AI outputs, signalling identity-based leadership and critical AI literacy. In contrast, some students deferred uncritically to AI, reflecting a known risk in game-based contexts: without scaffolding, players may prioritise superficial success over deeper engagement (Kiili, 2005). Crucially, the lecturer ensured the activities retained their integrity as serious games—anchored in rules, uncertainty, and consequence—while framing them as spaces for ethical reasoning and leadership. Learning gains, therefore, resulted from AI's adaptive capabilities and the educator's active pedagogical presence.

Finally, this study extends the conceptual model introduced in Project Leadership and Society (Daniels et al., 2025). Whereas the earlier paper proposed six pedagogical themes—relevance, agility, identity, ethics, motivation, and adaptability—these findings demonstrate their real-world enactment. AI-generated crises supported relevance and agility; open-ended dilemmas cultivated identity and ethics; dynamic challenge sustained motivation; and reasoning through uncertainty fostered adaptability—core affordances of serious games (Gee, 2003; Prensky, 2001).

5.1 Limitations and Implications

The study's quasi-experimental design introduced the possibility of self-selection bias, as group allocation was based on tutorial attendance. While pretest scores were statistically equivalent and ANCOVA adjusted for baseline variance, the absence of random assignment limits causal inference. The large observed effect size (partial $\eta^2 = .799$) should also be interpreted with caution, as it may reflect novelty effects or contextual factors specific to the institutional setting. Although full academic records were not available for all participants, historical programme data indicate a consistent average QCA of approximately 3.00 (B2 classification) over the past three academic years. This benchmark supports the assumption that participants were broadly representative of the wider cohort, helping to contextualise the observed learning gains. Nevertheless, future studies should adopt more robust designs to address residual bias—such as randomised controlled trials (RCTs), propensity score matching (PSM), or hierarchical linear modelling (HLM) to account for nested data structures across classes or institutions. As the lead researcher also acted as the facilitator and game master during the intervention, some degree of instructor bias cannot be entirely ruled out. However, all learning outcomes were assessed through independently scored pre/post instruments, and future studies should consider using external facilitators or blinded raters to minimise this risk further.

The single-university setting and focus on project management also constrain generalisability. Future work should examine the AI-GBL framework in other disciplines, educational levels, and cultural contexts. Additionally, reflective accounts from postgraduate participants highlighted the potential risk of over-reliance on AI outputs, underscoring the importance of scaffolding to promote ethical AI literacy. Despite these limitations, the findings demonstrate that AI can operate as a pedagogical co-orchestrator when meaningfully embedded in serious games. For educators, the implication is clear: AI-GBL should not be seen merely as a

simulation or efficiency tool, but as a deliberate, systems-oriented design that invites learners to engage with complexity, navigate ambiguity, and develop leadership and ethical reasoning in uncertain environments.

6. Conclusion and Future Directions

Bridging the gap between theoretical instruction and practical application remains a persistent challenge in project management education. This study shows that an AI-enhanced game-based learning (AI-GBL) framework can meaningfully address this divide by embedding complexity, ethical tension, and identity formation into the learning process. Moving beyond static case studies and procedural training, the framework enabled learners to practise decision-making under uncertainty, reflect on consequences, and develop adaptive, ethically informed leadership.

The findings confirm three key contributions. First, the AI-GBL model produced substantial learning gains in applied decision-making and critical thinking among undergraduates. Second, it showed that AI can act as a pedagogical co-orchestrator, dynamically adjusting challenge and narrative to sustain engagement. Third, it highlighted that autonomy in AI-rich environments demands explicit scaffolding: without ethical and reflective framing, learners may fall into uncritical reliance on algorithmic tools.

At the same time, the lecturer remains indispensable. Acting as a game master, the teacher motivated learners, shaped the flow of activities, and ensured ethically ambiguous scenarios became opportunities for reflection rather than confusion. The intervention's success depended not only on AI's affordances but equally on the educator's pedagogical presence.

Beyond empirical findings, this study contributes to the evolution of serious games. Traditional designs often emphasise rules, scoring, or optimisation, while AI-GBL prioritises narrative consequence, ethical ambiguity, and adaptive feedback. This reorientation aligns game-based learning more closely with professional leadership's complex, value-driven nature. Future research should pursue randomised controlled trials, longitudinal designs, and cross-domain applications in engineering, healthcare, and business education. Ethical AI literacy also deserves greater emphasis, ensuring graduates emerge technically proficient and critically engaged with the tools shaping their practice.

This study builds on the conceptual model previously outlined in *Project Leadership and Society* by offering empirical validation. It demonstrates how AI-GBL can bridge the persistent theory–practice gap while amplifying—rather than replacing—the educator's role. In this way, AI-GBL provides both a blueprint for reimagining teaching practice in the age of AI and a pathway toward cultivating more reflective, resilient professionals equipped for the complexities of contemporary project environments.

Ethical Clearance Statement: This study involved standard classroom teaching and publicly available teaching materials as part of a routine educational programme and thus did not require formal ethical clearance according to University of Limerick policy. Nevertheless, all data were anonymised, and informed consent was obtained for student contributions.

AI declaration: No AI was used in this paper.

References

- Beard, K. S. (2015). Theoretically speaking: An interview with Mihaly Csikszentmihalyi on flow theory development and its usefulness in addressing contemporary challenges in education. *Educational Psychology Review*, 27(2), 353–364. <https://doi.org/10.1007/s10648-014-9291-1>
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper & Row.
- Daniels, M., Kelly, É., Flynn, S., & Kelly, J. (2025). Advancing project leadership education through AI-enhanced game-based learning. *Project Leadership and Society*, 6, 100189. <https://doi.org/10.1016/j.plas.2025.100189>
- Darrell, V., Baccarini, D., & Love, P. E. D. (2010). Demystifying the folklore of the accidental project manager in the public sector. *Project Management Journal*, 41(5), 56–63. <https://doi.org/10.1002/pmj.20164>
- DeFalco, J. A., Rowe, J. P., Paquette, L., Georgoulas-Sherry, V., Brawner, K., Mott, B. W., ... Lester, J. C. (2018). Detecting and addressing frustration in a serious game for military training. *International Journal of Artificial Intelligence in Education*, 28(2), 152–193. <https://doi.org/10.1007/s40593-017-0152-1>
- Dillenbourg, P., Prieto, L. P., & Olsen, J. K. (2018). Classroom orchestration. *International Handbook of the Learning Sciences*, 180–190. <https://doi.org/10.4324/9781315617572-18>
- Egginton, B. (2012). Realising the benefits of investment in project management training. *International Journal of Managing Projects in Business*, 5(3), 508–527. <https://doi.org/10.1108/17538371211235344>

- Emerson, A., Cloude, E. B., Azevedo, R., & Lester, J. (2020). Multimodal learning analytics for game-based learning. *British Journal of Educational Technology*, 51(5), 1505–1526. <https://doi.org/10.1111/bjet.12992>
- Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment*, 1(1), 20. <https://doi.org/10.1145/950566.950595>
- Goldberg, B. (2015). Feedback source modality effects in game-based training: A trade-off analysis. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 59(1), 1858–1862. <https://doi.org/10.1177/1541931215591401>
- Huemann, M., & Turner, R. (2024). *The handbook of project management* (6th ed.). Routledge. <https://doi.org/10.4324/9781003274179>
- Kamalov, F., Calonge, D. S., & Gurrib, I. (2023). New era of artificial intelligence in education: Towards a sustainable multifaceted revolution. *Sustainability*, 15(16), 12451. <https://doi.org/10.3390/su151612451>
- Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. *The Internet and Higher Education*, 8(1), 13–24. <https://doi.org/10.1016/j.iheduc.2004.12.001>
- Kolb, A. Y., & Kolb, D. A. (2005). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of Management Learning & Education*, 4(2), 193–212. <https://doi.org/10.5465/amle.2005.17268566>
- Kolb, A. Y., & Kolb, D. A. (2008). The learning way: Meta-cognitive aspects of experiential learning. *Simulation & Gaming*, 40(3), 297–327. <https://doi.org/10.1177/1046878108325713>
- Kolb, A. Y., & Kolb, D. A. (2022). Experiential Learning Theory as a Guide for Experiential Educators in Higher Education. *Experiential Learning and Teaching in Higher Education*, 1(1), 38. <https://doi.org/10.46787/elthe.v1i1.3362>
- Michael, D. R., & Chen, S. L. (2005). *Serious games: Games that educate, train, and inform*. Muska & Lipman/Premier-Trade.
- Nash, C. (2025). Self-Directed Learning and Psychological Flow Regarding the Differences Among Athletes, Musicians, and Researchers. *Psychology International*, 7(1), 20. <https://doi.org/10.3390/psychoint7010020>
- Nicholson, S. (2015). A RECIPE for meaningful gamification. In T. Reiners & L. C. Wood (Eds.), *Gamification in education and business* (pp. 1–20). Springer. https://doi.org/10.1007/978-3-319-10208-5_1
- Owens, D. C., & Sadler, T. D. (2024). Socio-scientific issues instruction for scientific literacy: 5E framing to enhance teaching practice. *School Science and Mathematics*, 124(3), 203–210. <https://doi.org/10.1111/ssm.12626>
- Pelgrim, E., Hissink, E., Bus, L., van der Schaaf, M., Nieuwenhuis, L., van Tartwijk, J., & Kuijer-Siebelink, W. (2022). Professionals' adaptive expertise and adaptive performance in educational and workplace settings: An overview of reviews. *Advances in Health Sciences Education*, 27(5), 1245–1263. <https://doi.org/10.1007/s10459-022-10190-y>
- Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the Horizon: The International Journal of Learning Futures*, 9(5), 1–6. <https://doi.org/10.1108/10748120110424816>
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Ward, P., Gore, J., Hutton, R., Conway, G. E., & Hoffman, R. R. (2018). Adaptive skill as the conditio sine qua non of expertise. *Journal of Applied Research in Memory and Cognition*, 7(1), 35–50. <https://doi.org/10.1016/j.jarmac.2018.01.009>