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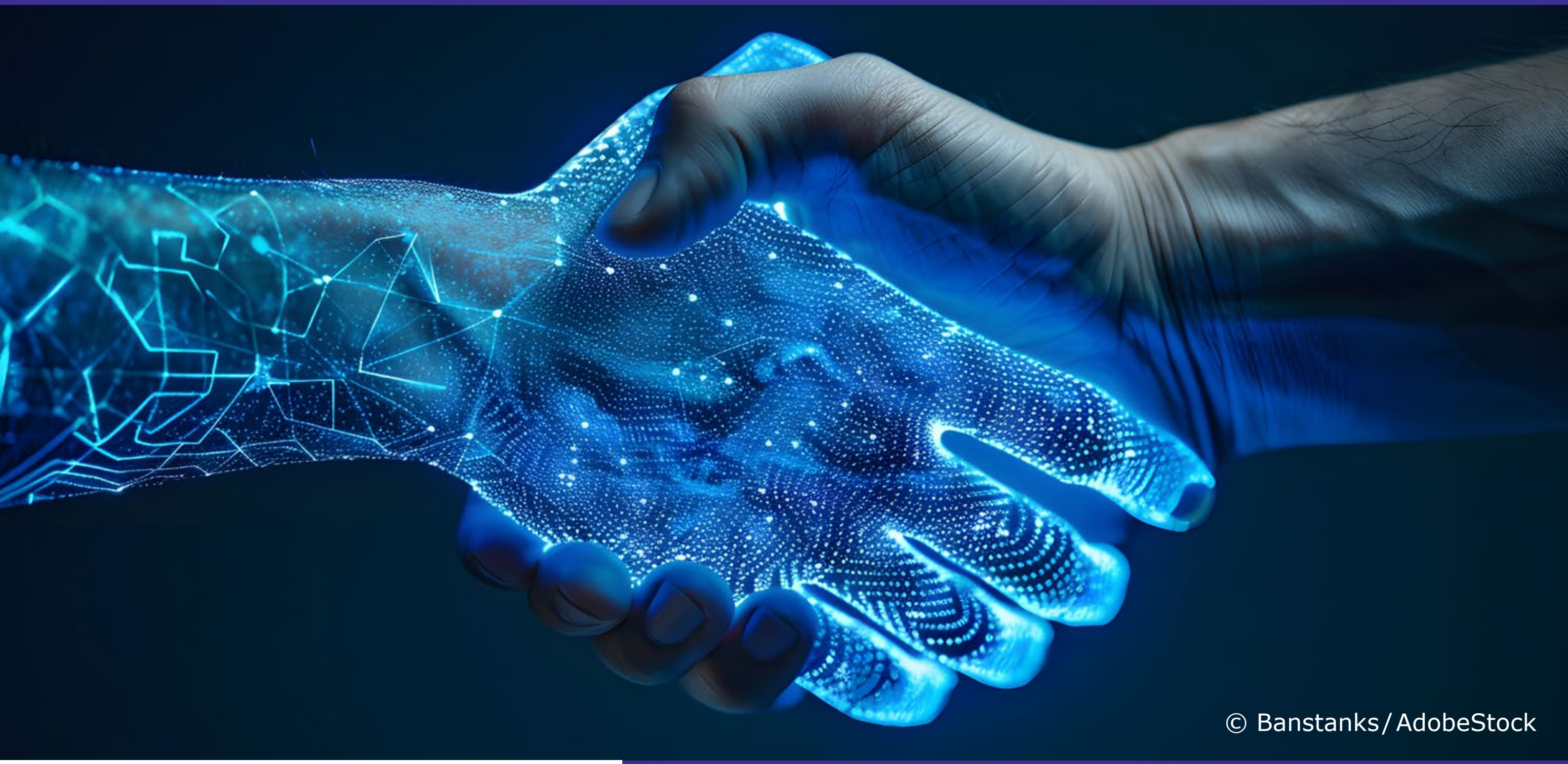

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Beyond performance: Pedagogy and assessment in AI-enhanced business simulation games

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Abstract

Business simulation games are widely used in management education to support experiential learning and strategic decision-making. Recent advances in artificial intelligence (AI), particularly large language models, are increasingly integrated into such simulations as adaptive competitors or decision agents. While these developments enhance realism, they also challenge traditional pedagogical and assessment approaches that rely primarily on performance-based outcomes. This paper argues that AI-enhanced business simulation games require a reconceptualization of pedagogy and assessment that prioritizes learning processes over competitive results. Building on experiential learning theory and serious game design research, we develop a conceptual framework that articulates how AI reshapes learning conditions and necessitates structured pedagogical scaffolding before, during, and after gameplay. Furthermore, we propose a multidimensional assessment approach aligned with cognitive, meta-cognitive, behavioral, and motivational learning outcomes. By repositioning AI as a catalyst for reflection and sense-making rather than an optimal decision benchmark, this paper contributes to the design of AI-enhanced simulations that support deeper experiential learning in management education.

Keywords: business simulation games, artificial intelligence in education, experiential learning, simulation-based assessment, management education

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Beyond performance: Pedagogy and assessment in AI-enhanced business simulation games

Introduction

Business simulation games have long been established as powerful pedagogical tools in management and business education. By placing students in dynamic, competitive environments that approximate real-world decision contexts, simulations aim to foster experiential learning, strategic thinking, and managerial judgment (Anderson & Lawton, 2009; Salas et al., 2009). Grounded in experiential learning theory, their educational value lies not merely in participation but in the structured integration of experience, reflection, conceptualization, and experimentation (Kolb, 1984). Consequently, prior research emphasizes that the effectiveness of simulation games depends critically on pedagogical design choices, including instructional scaffolding, feedback, and assessment alignment rather than on gameplay alone (Garris et al., 2002; de Freitas & Oliver, 2006).

Recent advances in artificial intelligence, particularly large language models (LLMs), are beginning to reshape business simulation environments. AI-driven agents can now act as adaptive competitors or decision-makers, introducing non-deterministic behaviors, strategic variability, and dynamic responses to student actions. While these developments enhance realism, they also fundamentally alter the learning conditions within simulations. AI integration reduces predictability, complicates causal attribution between decisions and outcomes, and challenges traditional assumptions about optimal strategies and performance-based success (Rahwan et al., 2019). As a result, students are increasingly required to engage in sense-making, judgment, and reflective reasoning rather than rule-based optimization.

Despite growing interest in AI-enhanced simulations, existing research has focused predominantly on the technical capabilities and strategic performance of AI agents. Comparatively little attention has been paid to how AI integration reshapes pedagogy and assessment, particularly from the perspective of student learning. This paper addresses this gap by conceptualizing how AI-enhanced business simulation games can be pedagogically designed and assessed to support meaningful learning outcomes. Specifically, we develop a pedagogical and assessment-oriented framework that emphasizes learning processes, reflection, and multidimensional outcomes over narrow performance metrics. In doing so, the paper contributes to the literature on simulation-based learning by repositioning AI not as a benchmark for optimal decision-making, but as a catalyst for deeper experiential learning.

Theoretical foundations

Serious games, experiential learning, and simulation pedagogy

Business simulation games are widely used in management education as experiential learning environments that allow students to engage with complex, dynamic decision contexts. Their pedagogical foundation is commonly grounded in Experiential Learning Theory (ELT), which conceptualizes learning as a cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). Within this framework, simulation games provide the concrete experience of managerial decision-making, while learning emerges through structured reflection and conceptual sense-making.

However, prior research cautions against assuming that learning occurs automatically through gameplay alone. While simulation games are engaging, engagement does not necessarily translate into meaningful learning outcomes (Garris et al., 2002). Empirical studies in management education have repeatedly emphasized that the pedagogical effectiveness of simulations depends on deliberate instructional design, including feedback mechanisms, reflection prompts, and debriefing activities (Salas et al., 2009; Anderson & Lawton, 2009). As argued in serious game design research, game mechanics must be explicitly aligned with intended learning objectives rather than treated as pedagogically neutral features (de Freitas & Oliver, 2006). Without such alignment, simulations risk reinforcing surface-level optimization behavior rather than deeper managerial understanding.

Learning outcome typologies for simulation games

Learning outcomes in simulation-based learning are inherently multidimensional. Beyond cognitive knowledge acquisition, simulations can foster meta-cognitive skills (e.g., reflection and self-regulation), motivational outcomes (e.g., engagement and self-efficacy), and behavioral capabilities (e.g., strategic consistency and decision discipline) (Connolly et al., 2012). Meta-analyses of serious games demonstrate that their educational value often lies in these broader outcome dimensions rather than in factual knowledge gains alone (Wouters et al., 2013).

This multidimensionality has direct implications for assessment. Constructive alignment theory emphasizes that learning outcomes, instructional activities, and assessment methods must be coherently aligned (Biggs & Tang, 2011). Consequently, different outcome types require different forms of evidence: cognitive learning may be assessed through analytical reports, meta-cognitive learning through reflective writing, and behavioral learning through observed decision patterns. Relying solely on performance metrics such as final profit therefore provides an incomplete and potentially misleading representation of student learning in simulation games.

AI and LLMs in business simulations

The integration of artificial intelligence and large language models (LLMs) into business simulations fundamentally alters their pedagogical character. LLM-driven agents act as adaptive and non-deterministic competitors, introducing variability that reduces predictability and complicates causal attribution between decisions and outcomes (Rahwan et al., 2019). Unlike traditional rule-based simulations, AI-enhanced environments shift the learning focus from rule mastery toward sense-making, judgment, and reflective reasoning (Rahwan et al., 2019). While this challenges traditional performance-based assessment, it simultaneously increases the pedagogical relevance of simulations as representations of real-world managerial uncertainty.

To illustrate these dynamics concretely, consider a strategy simulation in which an LLM-driven competitor adjusts its pricing and market entry decisions in response to student moves. In a traditional rule-based simulation, a student who consistently undercuts prices can expect a predictable market share gain. In an AI-enhanced version, the competitor may respond by repositioning into adjacent segments, launching product innovations, or accepting short-term losses to defend market position, behaviors that closely mirror real competitive dynamics. Students who rely on previously successful heuristics may find them undermined, prompting the kind of reflective recalibration that experiential learning theory identifies as central to genuine learning. Similarly, in a supply-chain simulation with an AI-driven demand forecasting agent, students may initially defer to AI-generated recommendations. Over successive rounds, those who critically challenge the agent's assumptions, questioning its demand model or stress-testing its forecasts against disruption scenarios, demonstrate qualitatively richer learning than those who simply follow its output. These contrasting trajectories highlight why assessment in AI-enhanced simulations must capture reasoning processes rather than outcomes alone.

AI-enhanced pedagogy in business simulation games

The integration of artificial intelligence into business simulation games fundamentally reshapes their pedagogical design requirements. In traditional simulations, learning environments are largely deterministic, allowing students to infer relatively stable cause–effect relationships between decisions and outcomes. By contrast, AI- and LLM-driven agents introduce adaptive, non-deterministic behaviors that dynamically respond to student actions. While this increases realism, it also necessitates a shift in pedagogical focus: from rule-based optimization toward sense-making, judgment, and reflective reasoning.

The pedagogical role of AI in simulation-based learning

From a pedagogical perspective, AI should not be framed as an oracle or benchmark of optimal decision-making. Instead, AI agents function most effectively as learning "provocateurs" that challenge student assumptions and disrupt simplistic strategic heuristics. By acting as adaptive competitors or market participants, AI agents expose students to ambiguity, strategic surprise, and imperfect information, conditions that closely resemble real managerial environments. This aligns with experiential learning theory, which emphasizes learning through cycles of action, feedback, and reflection rather than through prescriptive rule following.

Importantly, the presence of AI shifts learning objectives away from outperforming competitors toward developing coherent strategies and defensible decision rationales. Students are required to interpret AI behavior, evaluate its plausibility, and decide when to adapt or resist its implied logic. In this sense, AI enhances pedagogical value not by being consistently "better" than human players, but by creating opportunities for critical engagement and comparative reasoning.

Pedagogical scaffolding around AI-integrated gameplay

To realize these learning benefits, AI-enhanced simulations require deliberate pedagogical scaffolding before, during, and after gameplay. Prior to simulation start, instructors should explicitly frame the role and limitations of AI agents, clarifying that AI behavior is neither infallible nor normative. Establishing learning objectives that emphasize reasoning quality, reflection, and learning processes helps prevent outcome fixation and uncritical reliance on AI-driven patterns.

During gameplay, pedagogical interventions should encourage students to articulate the rationale behind their decisions. Structured decision logs, reflection prompts, or interim strategy statements can support meta-cognitive engagement by requiring students to explain how they interpret both market signals and AI behavior. Such scaffolding helps externalize student thinking and creates a basis for subsequent learning evaluation.

Post-simulation debriefing is particularly critical in AI-enhanced environments. Debriefing sessions should focus on comparing student strategies with observed AI behaviors, examining divergences between intended strategies and realized outcomes, and reflecting on how uncertainty influenced decision-making. Rather than evaluating whether students matched AI performance, instructors can use AI-generated behavior as a contrastive tool to stimulate discussion about strategic coherence, adaptability, and managerial judgment. Through these structured pedagogical interventions, AI-enhanced simulations become environments for reflective experiential learning rather than competitive optimization exercises.

Assessment in AI-enhanced business simulation games

Assessment plays a critical role in determining what students attend to and how they engage with simulation games. In AI-enhanced simulations, traditional performance-based assessment approaches, such as grading based solely on final profit or market share, become increasingly problematic. The adaptive and non-deterministic behavior of AI agents introduces outcome volatility that weakens the causal link between student decisions and observed results. Consequently, strong learning processes may coexist with poor performance outcomes, while superficial or opportunistic strategies may occasionally be rewarded. In such environments, outcome-focused grading risks misrepresenting student learning and incentivizing short-term optimization rather than reflective engagement.

Limitations of performance-based assessment

Performance metrics have historically been used as proxies for learning in simulation games. However, prior research has demonstrated that financial success alone is an insufficient indicator of cognitive or meta-cognitive development. This limitation is amplified in AI-integrated simulations, where students face unequal exposure to AI behaviors and stochastic market dynamics. AI agents may adapt in ways that obscure causal attribution, making it difficult for students to infer which actions led to which outcomes. Under these conditions, performance-based assessment can undermine pedagogical intent by rewarding luck, imitation, or unexamined reliance on AI-generated patterns rather than thoughtful strategic reasoning.

A multi-dimensional assessment framework

To address these challenges, assessment in AI-enhanced simulation games should be explicitly aligned with the multidimensional learning outcomes such environments are designed to support. Cognitive learning can be assessed through analytical reports or strategy documents that evaluate the coherence, consistency, and justification of student decisions. Meta-cognitive learning is well captured through reflective journals or post-simulation essays that require students to articulate what they learned, how their thinking evolved, and how they interpreted AI behavior. Behavioral learning may be assessed through analysis of decision trajectories over time, examining strategic consistency, responsiveness to feedback, and evidence of learning across rounds. Finally, motivational and engagement-related outcomes can be evaluated through structured self-assessments or reflective narratives.

Importantly, AI agents can serve as comparative reference points without being treated as normative benchmarks. Student learning is demonstrated not by matching AI performance, but by critically evaluating AI behavior, articulating points of agreement or disagreement, and justifying alternative strategic choices. By shifting assessment emphasis from outcomes to learning processes, instructors can ensure that AI-enhanced simulations reward reflective judgment, strategic reasoning, and experiential learning. Such assessment designs reinforce pedagogical goals and help position AI not as an answer-generating authority, but as a catalyst for deeper learning in complex decision environments.

Discussion and conclusion

Discussion

This paper argues that the integration of artificial intelligence into business simulation games fundamentally reshapes both pedagogy and assessment. While AI-enhanced simulations increase realism and strategic complexity, they also disrupt traditional assumptions about predictability, causal attribution, and performance-based success. As a result, instructional designs that rely primarily on competitive outcomes are no longer sufficient in pedagogical terms. Instead, AI integration necessitates a shift toward learning designs that foreground sense-making, judgment, and reflective reasoning.

At the same time, AI integration in educational settings introduces risks that warrant explicit attention. A central concern is automation bias: the well-documented tendency of decision-makers to over-weight algorithmically generated recommendations, even when those recommendations are suboptimal or contextually inappropriate (Parasuraman & Manzey, 2010). In simulation contexts, students who observe AI agents achieving strong results may defer to AI-implied strategies without critically evaluating their underlying assumptions, effectively learning to follow patterns rather than develop independent judgment. Closely related is the risk of overreliance, whereby students outsource strategic reasoning to AI outputs rather than exercising and strengthening their own analytical capabilities. Left unaddressed, these tendencies would undermine the very learning objectives that AI-enhanced simulations are intended to support. Pedagogical design must therefore actively counteract automation bias and overreliance through explicit framing of AI limitations, structured prompts for critical evaluation of AI behavior, and assessment designs that reward independent reasoning over imitation of AI-generated patterns.

For educators, these findings imply a reconceptualization of the instructor's role, from evaluator of outcomes to architect of learning processes. Effective use of AI-enhanced simulations requires explicit pedagogical framing, structured reflection, and assessment methods that reward coherent reasoning rather than short-term optimization. For simulation designers, the results highlight the importance of pedagogically configurable AI systems that support transparency, reflection, and comparison rather than merely maximizing strategic sophistication. From a research perspective, the paper contributes to simulation-based learning and serious games literature by extending established pedagogical frameworks to AI-driven environments, thereby opening avenues for empirical research on learning processes rather than AI performance. More broadly, the arguments developed here connect to a wider pedagogical transformation that generative AI is triggering across management education. As AI systems become capable of generating strategic analyses, synthesizing market intelligence, and producing decision recommendations at scale, the traditional emphasis on knowledge transmission, teaching students what to know and how to apply established frameworks, becomes increasingly insufficient as an educational objective. What AI cannot replicate is the capacity for situated judgment: the ability to critically assess AI-generated outputs, recognize the limits of algorithmic reasoning, and take responsibility for decisions under uncertainty. Business simulation games, when designed with these goals in mind, offer a particularly productive environment for cultivating exactly these capabilities. The pedagogical principles advanced in this paper, prioritizing reflection over optimization, assessing reasoning processes rather than outcomes, and treating AI as a catalyst for critical thinking rather than a source of answers, thus extend beyond simulations to inform the broader redesign of management education in the era of generative AI.

Conclusion

AI does not improve business simulation games simply by making them more intelligent. Its educational value lies in how it reshapes learning conditions and challenges students to engage with uncertainty, ambiguity, and judgment. This paper demonstrates that the pedagogical and assessment design of AI-enhanced simulations is central to realizing their learning potential. By shifting focus from performance outcomes to learning processes, educators can position AI as a catalyst for deeper experiential learning rather than as a shortcut to optimal decisions. Future research should empirically examine how different pedagogical and assessment designs influence student learning in AI-integrated simulation environments.

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