COMPARATIVE ANALYSIS OF LEARNING GAINS IN EDUCATIONAL ENVIRONMENTS MEDIATED BY GAMIFICATION VERSUS ARTIFICIAL INTELLIGENCE

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Abstract

Pedagogical innovation mediated by emerging technologies has assumed a central role in the contemporary transformation of the teaching–learning process, particularly in response to the demands of an increasingly digital, interconnected, and data-driven society. In this context, gamification and artificial intelligence stand out as promising strategies for reshaping educational practices by fostering greater engagement, personalization, and dynamism in learning experiences. This study presents a systematic literature review that critically analyzes the contributions of these two approaches to educational improvement, encompassing indexed publications from 2021 to 2026. The investigation was guided by a reformulated research question, with clearly defined descriptors, explicit inclusion and exclusion criteria, and a structured process of identification, screening, and selection of studies, organized through a methodological flowchart. The findings indicate that gamification, when grounded in consistent theoretical frameworks and aligned with well-defined pedagogical objectives, enhances student engagement, intrinsic motivation, and active participation. Simultaneously, artificial intelligence demonstrates significant potential in personalizing learning pathways, continuously monitoring performance, and providing adaptive real-time feedback, thereby supporting more precise and data-informed pedagogical interventions. The comparative synthesis suggests that integrating gamification with intelligent systems may further strengthen educational outcomes by combining motivational and analytical dimensions within hybrid instructional models. It is concluded that the effective implementation of these technologies requires structured pedagogical planning, ongoing teacher training, and robust ethical regulation to ensure effectiveness, equity, and sustainability in contemporary educational settings.

Keywords: Artificial intelligence, Educational technology, Gamification, Pedagogical innovation, Systematic review.

INTRODUCTION

The incorporation of digital technologies in higher education has promoted significant transformations in teaching and learning processes, especially through the adoption of active methodologies and advanced technological resources. In this context, gamification and artificial intelligence (AI) stand out as innovative strategies that seek to enhance student engagement, autonomy, and academic performance. Recent literature indicates that AI has been progressively integrated into educational environments, expanding possibilities for personalization, data analysis, and support for pedagogical decision-making (Akinwalere; Ivanov, 2022; Younas; El-Dakhs; Noor, 2025). In parallel, gamification has consolidated itself as a didactic approach capable of mobilizing intrinsic motivation and active participation, fostering meaningful knowledge construction (Buenadicha-Mateos et al., 2025; Vairavan, 2024).

Gamification, understood as the application of game elements and dynamics in non-playful contexts, has been explored from different theoretical and methodological perspectives. Studies indicate that its implementation goes beyond the mere assignment of points and rewards, involving creative, collaborative, and emancipatory processes (Carolei, 2022a; Carolei, 2022b). The notion of "gamicity," for example, broadens the traditional concept by integrating responsible and transformative practices within the educational context (Carolei, 2022c). Moreover, empirical investigations indicate that gamification can positively impact academic performance by promoting greater engagement and persistence in proposed activities (Buenadicha-Mateos et al., 2025; Souza; Ribeiro; Versuti, 2025). In Science and Biology teaching, this strategy has demonstrated potential for systematizing complex content and fostering active learning in the final years of elementary education (Queiroga; Pacheco, 2024; Moura; Henriques, 2024).

In turn, artificial intelligence has been consolidating as one of the main drivers of educational innovation. Tools based on language models, chatbots, and adaptive systems make it possible to provide immediate feedback, personalized learning pathways, and support for self-regulation (Hwang; Chang,

2021; Ge et al., 2025). The integration of AI with educational processes also favors the development of socioemotional skills and transversal competencies, especially when articulated with virtual learning environments (Marengo et al., 2025). However, the adoption of these technologies involves ethical, pedagogical, and structural challenges, requiring institutional preparedness and adequate teacher training (Akinwalere; Ivanov, 2022; Kassengkhan; Moldagulova; Serbin, 2025).

A comparative analysis between environments mediated by gamification and those structured with support from artificial intelligence becomes relevant in view of the need to understand not only levels of engagement, but also the effective learning gains provided by each approach. While gamification tends to strengthen motivational and collaborative aspects, AI stands out for its capacity for personalization and continuous monitoring of student progress (Kassengkhan; Moldagulova; Serbin, 2025; Marengo et al., 2025). Furthermore, recent studies suggest that combining both strategies can enhance self-regulation and critical thinking, expanding educational outcomes (Ge et al., 2025). Even so, a gap is observed in the literature regarding a systematic comparison of the impacts of these approaches on objective indicators of learning.

Within the scope of active methodologies, the integration between teaching, research, and outreach also reinforces the importance of strategies that place the student at the center of the educational process (Costa et al., 2026; Meroto et al., 2024). The systematic literature review constitutes an essential tool for mapping evidence, identifying trends, and grounding robust comparative analyses (Campos; Caetano; Laus-Gomes, 2023). Thus, the discussion of gamification and artificial intelligence must be supported by consistent empirical evidence, capable of guiding grounded pedagogical practices that are contextualized to contemporary demands.

In light of this scenario, it becomes imperative to investigate, critically and systematically, the effects of these two approaches on academic performance and the quality of the educational process. Although both are associated with pedagogical innovation, their mechanisms of action, levels of personalization, motivational impacts, and cognitive outcomes may differ significantly. Understanding

these differences is fundamental to support institutional decision-making and to improve teaching strategies in the context of digital education.

Accordingly, the present study aims to comparatively analyze learning gains in educational environments mediated by gamification versus artificial intelligence, in light of recent scientific evidence, identifying the potentialities, limitations, and pedagogical implications of each approach for promoting more effective, innovative, and student-centered teaching.

METHODOLOGY

This is a systematic literature review with a qualitative approach and a descriptive-analytical character, conducted with the objective of identifying, analyzing, and synthesizing scientific evidence regarding learning gains in educational environments mediated by gamification versus artificial intelligence, from 2021 to 2026. The systematic review was chosen because it enables methodological rigor in the search, selection, critical appraisal, and synthesis of studies, reducing biases and ensuring greater reliability of the results (Campos; Caetano; Laus-Gomes, 2023).

The methodological protocol was developed following previously defined steps: (1) formulation of the research question; (2) definition of the databases; (3) establishment of descriptors and Boolean operators; (4) application of inclusion and exclusion criteria; (5) selection and critical analysis of studies; and (6) synthesis of findings. The guiding question was structured based on the following problematization: To what extent do gamification and artificial intelligence influence students' academic performance?

Searches were carried out in the following electronic databases: Scopus, Web of Science, ERIC, PubMed, IEEE Xplore, and Google Scholar, as they include relevant productions in the areas of Education, Educational Technology, and Computer Science. Descriptors in Portuguese and English were used, combined through the Boolean operators AND and OR, namely: "Gamificação" OR "Gamification"; "Inteligência Artificial" OR "Artificial Intelligence"; "Aprendizagem" OR "Learning

Gain" OR "Academic Achievement"; "Educação Superior" OR "Higher Education"; "Ambientes Virtuais de Aprendizagem" OR "E-learning".

The search strategy was structured with combinations such as: ("Gamification" AND "Learning Gain") AND ("Artificial Intelligence" OR "AI in Education"); ("Gamificação" AND "Desempenho Acadêmico") AND ("Inteligência Artificial" AND "Educação"). Filters were applied related to publication period (2021 to 2026), language (Portuguese, English, and Spanish), and document type (scientific articles, experimental studies, quasi-experimental studies, systematic reviews, and meta-analyses).

Inclusion criteria comprised: (a) studies published between January 2021 and December 2026; (b) research that explicitly addressed the use of gamification or artificial intelligence in formal educational contexts; (c) investigations presenting indicators of learning gains, academic performance, content retention, or development of cognitive skills; (d) full-text availability; and (e) peer-reviewed studies.

Excluded were: (a) duplicate works; (b) studies addressing exclusively technical aspects of software development without pedagogical analysis; (c) publications dealing only with student perception or satisfaction without measurement of learning outcomes; (d) simple abstracts, editorials, letters to the editor, and chapters without empirical evaluation; and (e) research outside the established time scope.

The selection process occurred in three stages: reading of titles, reading of abstracts, and full-text reading of eligible texts. Screening was carried out independently by two reviewers, with subsequent consensus in cases of disagreement. After the final selection, data were extracted into a structured instrument containing: authors, year, country, methodological design, level of education, type of intervention (gamification or AI), learning indicators used, and main results.

Data analysis was conducted through thematic qualitative synthesis, allowing the identification of emergent categories related to motivational impact, personalization of learning, development of self-regulation, and academic performance. When available, quantitative data related to standardized tests,

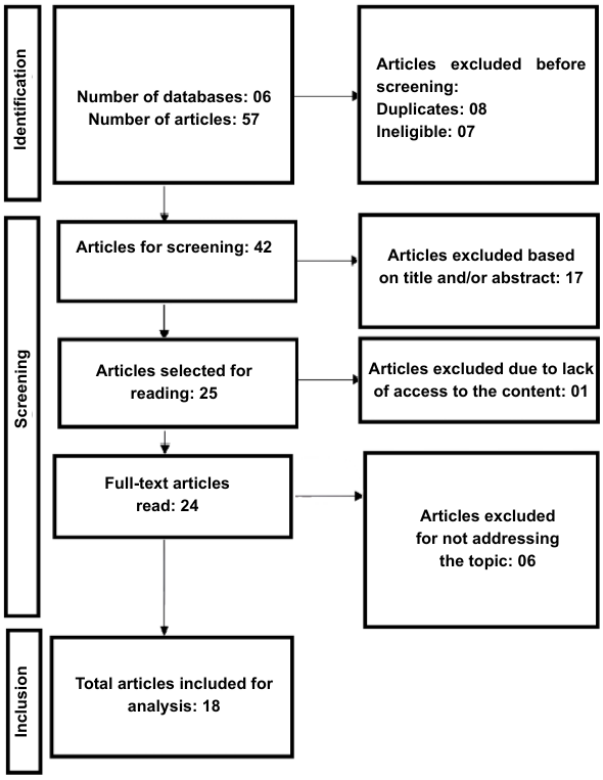
comparative means, and effect measures were considered in order to support the comparative discussion between approaches.

The methodological quality assessment of included studies was performed based on criteria of clarity of objectives, adequacy of design, description of the sample, validity of assessment instruments, and consistency of the reported results. This procedure contributed to strengthening the interpretive robustness of the review.

The flow of identification, screening, eligibility, and inclusion of studies will be presented, including the total number of records identified, excluded, and analyzed in the final sample.

Figure 1

Flowchart of the study selection process



Source: Authors (2026)

In this way, the adopted methodology ensures transparency, systematicity, and scientific rigor in the investigative process, enabling a consistent comparative analysis of learning gains in educational environments mediated by gamification versus artificial intelligence.

RESULTS AND DISCUSSION

The analysis of the studies included in this systematic review revealed a robust and multifaceted panorama of learning gains in educational environments mediated by gamification and by artificial intelligence from 2021 to 2026. In line with the methodological guidance of Campos, Caetano, and Laus-Gomes (2023), the results are presented in an integrated manner with critical discussion, enabling examination not only of identified effects but also of their pedagogical, methodological, and institutional implications. Overall, the findings indicate that both approaches promote positive impacts on academic performance, although they are grounded in distinct theoretical assumptions and operate through different mechanisms of learning mediation.

Within the set of studies focused on gamification, there was a predominance of empirical research with experimental and quasi-experimental designs, concentrated mainly in higher education. Buenadicha-Mateos, Sánchez-Hernández, González-López, and Tato-Jiménez (2025) demonstrate that the structured implementation of game elements—such as levels, progressive challenges, symbolic rewards, and continuous feedback—resulted in a significant increase in academic performance, measured by standardized assessments and pass rates. According to Buenadicha-Mateos et al. (2025), student engagement constitutes an essential mediating variable between the playful experience and cognitive gain, evidencing that intrinsic motivation plays a central role in knowledge consolidation.

Corroborating this perspective, Vairavan (2024) identified, in an experimental study in language teaching, that students exposed to gamified applications showed greater content retention and persistence in proposed activities. According to Vairavan (2024), the combination of clear goals, symbolic rewards, and structured progression favored not only immediate performance but also the maintenance of learning

over time. These results reinforce the understanding that gamification acts significantly on affective-motivational dimensions, with measurable cognitive repercussions.

In basic education contexts, Queiroga and Pacheco (2024) observed that the systematic application of gamification in Biology Science teaching contributed to greater conceptual organization and active student participation. According to Queiroga and Pacheco (2024), the use of collaborative challenges and structured narratives increased student involvement and favored the internalization of complex scientific concepts. Moura and Henriques (2024) add that, in Natural Sciences classes, the integration of gamification and artificial intelligence enhanced learning by associating playfulness and personalization, promoting greater autonomy and critical reflection.

From a theoretical standpoint, Carolei (2022a) proposes the concept of gamicity as a critical expansion of traditional gamification, advocating transformative and socially responsible practices. According to Carolei (2022a), play should be understood as a pedagogical device capable of articulating aesthetic experience, ethical reflection, and collective construction of knowledge. In another work, Carolei (2022b) argues that creative gamification requires intentional planning and consistent theoretical grounding, avoiding reductions based exclusively on extrinsic rewards. Amaral and Carolei (2022) reinforce this perspective by relating playful practices to the construction of territorial and cultural meanings, expanding the notion of learning gains to identity and social dimensions.

Table 1

Synthesis of studies on gamification and their impacts on learning gains

Author/Year	Gamified Foundations and Strategies	Learning Gain Indicators	Main Evidenced Contributions
Buenadicha-Mateos et al. (2025)	Structuring by levels, progressive challenges, symbolic reward system, and continuous formative feedback	Highlighted the cultural and experiential dimension as a component of formative gain	Demonstrated a statistically significant relationship between gamified engagement and improvement in academic performance
Vairavan (2024)	Gamified application with gradual goals, positive reinforcement, and performance-based progression	Content retention, persistence, and intrinsic motivation	Evidenced increased retention and greater persistence in learning activities
Queiroga; Pacheco (2024)	Collaborative challenges, contextualized narrative, and problem solving	Conceptual organization, active participation, and performance in formative assessments	Contributed to the systematization of scientific content and increased student involvement
Moura; Henriques (2024)	Integration between gamified dynamics and interactive digital resources	Autonomy, problem solving, and meaningful learning	Fostered student protagonism and the development of cognitive competencies
Souza; Ribeiro; Versuti (2025)	Analysis of gamified instructional design and its motivational mechanics	Academic performance and engagement levels	Indicated that the quality of gamified design directly influences educational outcomes
Carolei (2022a)	Concept of gamicity as a transformative, ethical, and socially situated practice	Critical, reflective, and emancipatory dimensions of learning	Expanded the concept of learning gains beyond quantitative metrics

Carolei (2022b)	Creative gamification grounded in pedagogical intentionality and emancipation	Reflective engagement and active participation	Evidenced the need for consistent theoretical grounding for pedagogical effectiveness
Amaral; Carolei (2022)	Territorial playful practices and sensory experiences	Identity construction and contextualized learning	Highlighted the cultural and experiential dimension as a component of formative gain

Source: Authors (2026)

Table 1 shows, in a synthetic manner, that studies on gamification converge regarding the positive impact on engagement, motivation, and academic performance levels, although they present variations in methodological designs and in the assessment instruments used. It is observed that research of an experimental nature tends to demonstrate quantitative gains in performance tests and retention rates, as indicated by Buenadicha-Mateos et al. (2025) and Vairavan (2024), while investigations of a qualitative and theoretical character, such as those by Carolei (2022a; 2022b), emphasize broader formative dimensions, including emancipation, criticality, and collective construction of knowledge. In addition, studies applied to basic education, such as Queiroga and Pacheco (2024), highlight contributions to conceptual organization and active participation, reinforcing that learning gains are not restricted to higher education. Thus, the table makes it possible to understand that the effectiveness of gamification is directly related to pedagogical planning, didactic intentionality, and the coherent integration of playful elements with educational objectives.

With regard to artificial intelligence, the analyzed studies highlight as the main differential the ability to personalize and adapt to students' individual needs. Akinwalere and Ivanov (2022) state that AI-based systems enable continuous monitoring of academic progress, identification of learning gaps, and provision of adaptive real-time interventions. According to Akinwalere and Ivanov (2022), such resources

expand opportunities for individualized learning in higher education, although they require institutional investments and specialized teacher training.

Hwang and Chang (2021) analyze the use of educational chatbots and emphasize that these tools provide immediate feedback, clarification of doubts, and metacognitive support. According to Hwang and Chang (2021), continuous interaction with intelligent systems contributes to the development of self-regulation, an element considered essential for sustainable learning gains. This metacognitive dimension is also emphasized by Ge et al. (2025), who demonstrate that the use of large language models, integrated with gamified elements, strengthens skills of planning, monitoring, and evaluating one's own learning.

The review conducted by Younas, El-Dakhs, and Noor (2025) shows that AI-based tools, including advanced conversational models, have driven academic innovation by providing more interactive and responsive experiences. According to Younas, El-Dakhs, and Noor (2025), AI fosters the development of higher-order cognitive competencies when aligned with clear pedagogical objectives and coherent assessment practices. This perspective is expanded by Marengo, Pagano, Lund, and Santamato (2025), who advocate the integration of artificial intelligence and gamification as a promising strategy for optimizing e-learning environments and assessing socioemotional competencies.

When systematically comparing the two approaches, Kassengkhan, Moldagulova, and Serbin (2025) argue that gamification and artificial intelligence share the goal of promoting critical thinking and problem solving, but differ in terms of mediation mechanisms. According to Kassengkhan, Moldagulova, and Serbin (2025), gamification acts predominantly on motivation and collaboration, while AI prioritizes personalization and predictive analysis of educational data. This distinction was corroborated in the present review, in which it was observed that studies on gamification emphasize indicators of engagement and satisfaction, whereas research on AI prioritizes metrics of individual progression and content adaptation.

Table 2

Comparison between environments mediated by gamification and by artificial intelligence

Analytical Dimension	Gamification-Mediated Environments	Artificial Intelligence–Mediated Environments
Pedagogical Foundation	Based on active methodologies, experiential learning, and the theory of intrinsic motivation	Grounded in adaptive learning, educational data analysis, and self-regulation theory
Central Mediation Mechanism	Playful engagement through challenges, symbolic rewards, and social interaction	Personalization of instruction through adaptive algorithms, automated feedback, and continuous monitoring
Predominant Focus	Motivation, collaboration, and active participation	Individualization of learning and metacognitive development
Assessment Indicators	Scores, test performance, content retention, participation levels	Individual progression, predictive performance analysis, self-regulation metrics
Cognitive Contributions	Content consolidation through immersive experiences and collaborative problem solving	Development of metacognitive competencies, individualized support, and adaptive interventions
Identified Limitations	Risk of superficiality when lacking structured pedagogical intentionality	Ethical challenges, technological dependence, need for infrastructure and specialized teacher training
Convergence Potential	Can be integrated with intelligent systems to broaden personalization	Increases effectiveness when associated with playful and motivational dynamics

Source: Authors (2025)

Table 2 enables a comparative visualization of the main distinctions and convergences between environments mediated by gamification and by artificial intelligence, showing that both approaches contribute to learning gains, but through distinct pedagogical mechanisms. It is observed that gamification places greater emphasis on engagement, intrinsic motivation, and collaboration, as discussed by Buenadicha-Mateos et al. (2025), while artificial intelligence stands out for personalized instruction, continuous monitoring, and development of self-regulation, as pointed out by Akinwalere and Ivanov

(2022) and Ge et al. (2025). The table also demonstrates that the indicators used to measure outcomes vary significantly, reinforcing the need for methodological standardization to enable more precise comparisons. Moreover, the comparative synthesis suggests that integrating the two strategies may represent a promising path to enhance both motivational and cognitive aspects of learning, in line with the analyses of Marengo et al. (2025) and Kassengkhan, Moldagulova, and Serbin (2025).

The methodological analysis of the studies revealed heterogeneity in the instruments used to measure learning gains. Buenadicha-Mateos et al. (2025) and Souza, Ribeiro, and Versuti (2025) employed comparative performance assessments before and after the gamified intervention, whereas Akinwalere and Ivanov (2022) analyzed adaptive learning data generated by intelligent systems. This methodological diversity, although it enriches the field, hinders direct comparisons and highlights the need for standardization of indicators.

At the institutional level, Costa et al. (2026) emphasize that the effectiveness of active methodologies and digital technologies depends on curricular integration and strategic alignment among teaching, research, and outreach. According to Costa et al. (2026), the adoption of technological resources must be associated with pedagogical intentionality and continuous teacher education. This analysis converges with Akinwalere and Ivanov's (2022) warning regarding ethical and structural challenges related to implementing artificial intelligence in higher education.

The discussion of results allows the inference that gamification presents more consolidated evidence with respect to increasing motivation, engagement, and persistence, especially in collaborative environments. On the other hand, artificial intelligence demonstrates greater potential for personalizing instruction and developing self-regulation, contributing to continuous monitoring and adaptive interventions. As highlighted by Kassengkhan, Moldagulova, and Serbin (2025), the choice between approaches should not be exclusive, but rather guided by specific pedagogical objectives and the educational context.

There is also a growing trend of research investigating the convergence between gamification and artificial intelligence. Marengo et al. (2025) argue that hybrid environments enhance learning gains by combining playful engagement with adaptive data analysis. Ge et al. (2025) corroborate this perspective by evidencing significant improvements in self-regulation when intelligent systems are associated with gamified dynamics. Nevertheless, the literature still lacks longitudinal studies that assess long-term impacts and examine potential side effects, such as technological dependence or conceptual superficiality.

In summary, the results of this systematic review indicate that both gamification and artificial intelligence contribute significantly to learning gains, albeit through distinct and complementary pathways. The consolidation of more standardized comparative evidence, together with in-depth ethical and pedagogical analyses, is essential to guide evidence-based educational decisions. As emphasized by Campos, Caetano, and Laus-Gomes (2023), the production of rigorous and systematized knowledge is an indispensable condition for the advancement of pedagogical innovation in technology-mediated educational contexts.

CONCLUSION

The present systematic review enabled an in-depth analysis of the contributions of gamification and artificial intelligence in the contemporary educational scenario, evidencing that these strategies constitute significant vectors of pedagogical innovation. The synthesis of studies published between 2021 and 2026 demonstrates that incorporating these technologies transcends the instrumental dimension, assuming a structuring role in the reorganization of teaching practices. A progressive transition is observed from models centered on the unidirectional transmission of knowledge to interactive, adaptive, and evidence-oriented approaches, in which the student occupies a leading position in the educational process.

In the domain of gamification, the findings indicate that the systematized use of game mechanics and dynamics—such as level-based progression, immediate feedback, gradual goals, and symbolic reward

systems—fosters students' cognitive and emotional engagement. When articulated with clearly defined pedagogical objectives, gamification enhances intrinsic motivation, stimulates active participation, and strengthens persistence in the face of academic challenges. However, the literature also warns of the need for consistent theoretical grounding in order to avoid a merely aesthetic or superficial application of playful elements, which could compromise pedagogical intentionality and the effectiveness of the intervention.

With regard to artificial intelligence, the analyzed studies show substantial advances in learning personalization, early identification of difficulties, and the provision of adaptive real-time feedback. Intelligent tutoring systems, predictive analytics algorithms, and platforms based on learning analytics demonstrate potential to support data-informed pedagogical decisions, increasing diagnostic precision and instructional individualization. Nevertheless, relevant ethical challenges emerge, especially concerning data protection, algorithmic transparency, and teacher training for the critical use of these technologies—indispensable aspects to ensure equity and responsibility in the educational context.

The comparative analysis of results reveals that the convergence between gamification and artificial intelligence represents a promising perspective for the development of hybrid educational ecosystems. While gamification strengthens motivational and experiential dimensions, artificial intelligence expands the analytical and adaptive capacity of the educational process. Integrating these approaches may foster more responsive, dynamic, and student-centered pedagogical practices, reconciling engagement, personalization, and continuous performance monitoring. Such articulation points to a paradigmatic reconfiguration of teaching, aligned with the demands of the digital society and 21st-century competencies.

Despite the identified advances, the review revealed important methodological limitations in the analyzed studies, such as heterogeneity of designs, the predominance of short-duration investigations, and the diversity of assessment instruments used. These variables hinder direct comparisons and the consolidation of robust evidence. Moreover, a scarcity of research conducted in public educational

contexts and in regions with restricted technological infrastructure was observed, highlighting inequalities in access to and implementation of technology-mediated pedagogical innovations.

In view of this panorama, the conduction of longitudinal research with mixed methodological approaches is recommended, investigating in an integrated manner the cognitive, motivational, and socioemotional impacts of pedagogical models that articulate gamification and artificial intelligence. It is also suggested that ethical protocols and institutional guidelines be developed to ensure the responsible use of educational data, promoting transparency, security, and algorithmic fairness. Future investigations encompassing different educational levels and distinct sociocultural contexts may contribute to strengthening scientific evidence and supporting data-informed educational policies, consolidating theoretical and practical foundations for sustainable and socially inclusive pedagogical innovation.

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