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Investigating the Impact of Game-Based Learning and Gamification Strategies in Physical Education: A Comprehensive Systematic Review

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ABSTRACT

This study deals with the integration of game-based learning strategies and gamification in education, focusing on physical education. The aim is to critically evaluate the evidence gathered over the last decade on the influence of game-based learning (GBL) and gamification on various research variables. The study encompasses an analysis of different educational levels, variables, game dynamics, and the variety of games used. It also seeks to uncover the potential benefits of deploying such game-centred methods in education. This systematic review is based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach, and includes a thorough search of five interdisciplinary databases. It includes a comprehensive screening process with specific inclusion and exclusion criteria, focusing on quantitative experimental research that investigates the application of gamification and GBL in the context of physical education. The findings highlight the substantial role of GBL and gamification as effective educational tools, particularly noting their positive effects on student engagement, academic achievements, and the enhancement of health and physical fitness levels. The study underscores the necessity for further exploration into the specific needs and challenges faced by students engaged in learning through these innovative educational approaches.

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1. Introduction

In the evolving landscape of education, it is crucial to explore innovative pedagogical methods that align with the needs of modern learners. With the emergence of the digital age, today's students, often referred to as 'digital natives' (Prensky, 2001), have grown up in an era dominated by digital and technological advancements. This shift has ushered in a new phase of digital socialization, offering expansive possibilities in educational methodologies as well as broader aspects of digital interaction. Traditional educational theories, largely rooted in cognitive principles, fall short in addressing the socialization and emotional aspects now possible through digital technologies (Illeris, 2003). Such an evolution in educational needs mandates that educators innovate their teaching strategies (Gorozidis & Papaioannou, 2014). Therefore, it is imperative to examine the current research on active learning strategies (Yildirim, 2017; Ho, 2019; Erickson & Sammons-Lohse, 2020) and conduct thorough literature reviews (Young et al., 2012; Manzano-León et al., 2021; Andreu, 2021).

Games have been recognized by various scholars as effective tools for integrative student engagement (Alcaraz-Muñoz et al., 2020; Taub et al., 2019). In the realm of formal education, especially

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in physical education, games not only facilitate meaningful learning but also foster cooperation and social skills (Milteer et al., 2012; Parlebas, 2001). Games serve as versatile tools, useful for teaching sport-specific skills in physical education, and extend beyond mere skill instruction. They offer a unique way to engage theoretical knowledge in an enjoyable, motivating manner (Nørgård et al., 2017), encouraging active participation both in practical and theoretical aspects of education. Studies have shown that games can enhance enjoyment (Engels & Freund, 2020), decision-making skills (Barba-Martín et al., 2020), and even be integrated with technology (Koekoek et al., 2018). Emphasizing student involvement in their learning processes, methodologies like game-based learning (GBL) and gamification have gained traction (Quintas et al., 2020; Figueroa-Flores, 2016). This study aims to investigate the motivational effects of gamification and game-based learning in various educational levels. These strategies are increasingly recognized for their potential to address educational system shortfalls, enhancing student motivation and learning (Plass et al., 2015). GBL, which involves the strategic incorporation of games or video games in education, serves as a tool for learning specific concepts (Fu et al., 2019; Maloney et al., 2012; Nyberg & Meckbach, 2015). Serious games, or exergames that involve physical activity, have shown positive impacts on learning, cognition, and skill development in general education (Breuer & Bente, 2010; Benzing & Schmidt, 2018) and have yielded encouraging results in physical education in terms of motivation, learning, and positive emotional responses (Lamb et al., 2018; Kosmas et al., 2018; Xu et al., 2019; Vukićević et al., 2019).

Gamification differs by integrating game elements in non-gaming contexts (Deterding et al., 2011). Its rising adoption in physical education is attributed to its effectiveness in boosting motivation and commitment to exercise (Arufe-Giráldez et al., 2022). These methodologies align with the constructivist approach to learning, providing students with experiential opportunities to construct knowledge through cognitive and emotional experiences (Boyle et al., 2011; Manzano-León et al., 2022). GBL approaches use games to engage students in learning content (Cornellà et al., 2020). They offer challenges related to the subject matter, with three crucial components: the player, the task, and the artifact (Kiili, 2005). An imbalance in these components can disrupt the 'flow,' a concept introduced by Mirvis and Csikszentmihalyi (1991), essential for a positive gaming experience. While some studies show no drawbacks to educational gaming (Garneli et al., 2016; Huizenga et al., 2009), the focus is not solely on achieving the flow state but on the contributing factors like control, concentration, and action scope (Manzano-León et al., 2022).

Gamification elements in education are categorized into dynamics (narrative, progress, relationships), mechanics (rules, challenges, cooperation, coordination), and components (badges, points, leaderboards, levels) (Werbach & Hunter, 2012). Empirical studies demonstrate that these elements can positively influence motivation and performance (Göksün & Gürsoy, 2019; Hassan et al., 2019), though some findings are contradictory (Ding, 2018; Kyewski & Krämer, 2018). From a design perspective, gamification and GBL differ in their intent: gamification aims to embed game elements into an existing dynamic, whereas GBL seeks to create a comprehensive game environment (Kapp, 2012). Effective gamification design: a multi-level approaches are these (Deterding et al., 2011):

Design Patterns in Game Interfaces: This segment includes a broad array of established standards and successful components for interaction design, addressing specific problems within certain contexts. Common examples include implementation of badges, leaderboards, and various levels.

- *Patterns and Mechanics in Game Design:* This level focuses on the recurrent elements of a game's gameplay, covering aspects such as managing time limits, resource constraints, and the organization of gameplay turns.
- *Principles and Heuristics in Game Design:* This involves critical assessment of design solutions or methods tailored to specific problems in game design. Important factors here include sustained engagement, clear objectives, and diverse game styles to captivate players.
- *Game Modeling:* At this juncture, the game's components or the gaming experience itself are conceptualized. Notable examples of game models are the Mechanics-Dynamics-Aesthetics

(MDA) framework, elements like challenge and fantasy, curiosity, the atomic structure of game design, and the Conceptual Framework for Educational Game Engagement (CEGE).

- *Methods in Game Design:* This pertains to specific practices and processes in game design, encompassing playtesting, player-focused design, and the creation of games with a conscious recognition of values. Studies have consistently demonstrated a strong connection between physical education methodologies and student motivation and performance, especially via game-based learning (GBL) (Yien, Hung, Hwang, & Lin, 2011) and gamification techniques (Sotos-Martínez, Ferriz-Valero, García-Martínez, & Tortosa-Martínez, 2022).

Gamification, in particular, has been recognized for its role in enhancing meaningful and motivational experiences in primary and secondary physical education (Fernandez-Rio, Heras, González, Trillo, & Palomares, 2020). Contrastingly, research has shown notable academic improvements without a corresponding rise in intrinsic motivation among university students (Ferriz-Valero, Østerlie, Martínez, & García-Jaén, 2020).

Systematic reviews of GBL and gamification in the educational sector suggest that gaming trends and external influences significantly impact student engagement and learning outcomes (Abdul Jabbar & Felicia, 2015). In primary education, GBL has shown to effectively boost motivation and academic success (Hainey, Connolly, Boyle, Wilson, & Razak, 2016), yet there is a call for more extensive, longitudinal studies in physical education to fully understand the long-term impacts of GBL.

Given the varied impacts and diverse implementation methods of gamification and GBL in education, ranging from kindergarten to university-level physical education, a thorough literature review was deemed necessary. This review aimed to evaluate the motivational influence of gamified systems and GBL across all educational levels. The primary research questions were:

- Which educational stage has the most empirical studies?
- What are the dominant game dynamics and mechanics used for educational purposes in the reviewed studies?
- Between digital and physical games, which is more prevalent in the studies?
- What are the potential impacts of gamification and GBL in the context of physical education?

2. Research Methodology

2.1. Research Model

The systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009), ensuring a comprehensive and transparent approach in collecting and synthesizing scientific evidence related to GBL and gamification in physical education. The review spanned January to December 2022, focusing on the latest and most pertinent findings.

The review concentrated on collating scientific evidence, adhering to specific inclusion criteria to effectively address the research questions. The search parameters covered databases like Scopus and PubMed with queries in English:

- *Database Selection Rationale:* We chose Scopus and PubMed for their extensive coverage of peer-reviewed scientific literature. Scopus is renowned for its broad indexing of multidisciplinary research, which is crucial for capturing diverse perspectives in game-based learning and gamification. PubMed, on the other hand, is a well-established database in the medical and health sciences, offering access to studies that might explore the physiological and psychological aspects of gamification in education.
- *Search Terms and Strategy:* The search strategy was carefully crafted to capture the most relevant studies. Keywords used included "gamification," "game-based learning," "educational games," "motivational effects," and "physical education." These terms were combined using Boolean operators like AND and OR to refine the search. For instance, a sample query could be

"gamification AND education," "game-based learning AND motivation," or "educational games IN physical education." The strategy involved an initial broad search followed by a narrowing down of results based on specific criteria.

- *Inclusion Criteria:* Studies were selected based on language (English), publication format (peer-reviewed articles), research focus (specifically on gamification and game-based learning in education), type of research (empirical studies, literature reviews, case studies), and specificity to game-based learning or gamification. Non-relevant or duplicative articles were excluded.
- *Exclusion Criteria:* Articles not in English, those not peer-reviewed (such as conference abstracts, opinion pieces, and editorials), and studies not directly addressing gamification or game-based learning in the context of education were excluded.
- *Review Process:* The selected articles underwent a detailed review. Initially, titles and abstracts were screened to assess relevance. Full texts of potentially relevant studies were then reviewed to determine their suitability based on the inclusion criteria. The final selection included 17 scientific papers, which were thoroughly analyzed and synthesized (Figure 1 illustrates the selection process).
- *Quality Assessment:* To ensure the validity and reliability of the findings, a quality assessment of the selected studies was conducted. This involved evaluating the methodological rigor, sample size, study design, and the relevance of results to the research questions.
- *Data Extraction and Synthesis:* Key information was extracted from each study, including study objectives, methodology, sample characteristics, findings, and conclusions. This data was then synthesized to identify common themes, patterns, and gaps in the literature.

By detailing each step of the systematic review process, the study establishes a clear, replicable research methodology, enhancing the credibility and reliability of its findings.

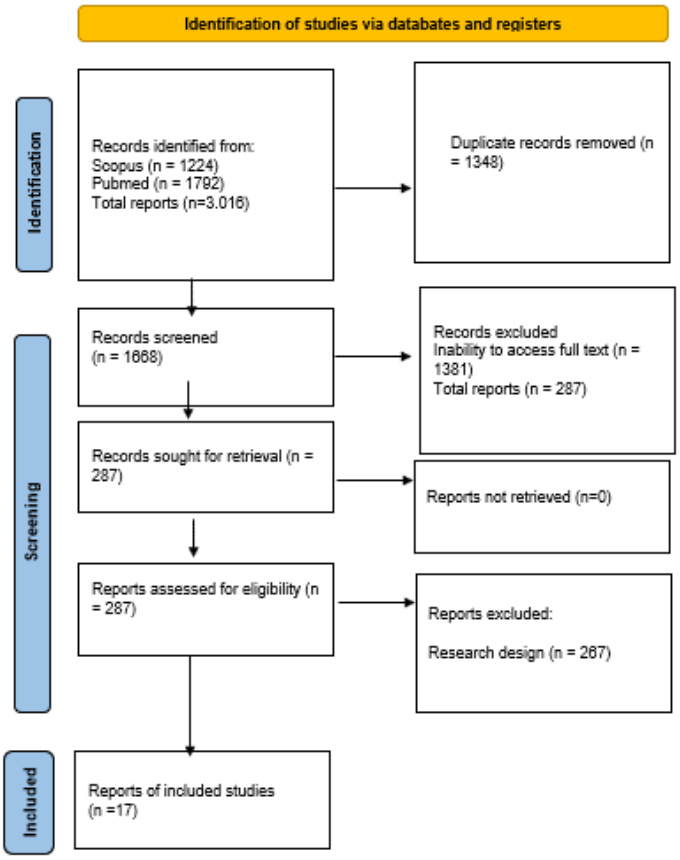

Figure 1. Search and selection PRISMA 2020 flow for source analysis

The systematic review's search and selection protocol, illustrated in Figure 1, delineates the multi-stage process utilized to identify and refine the sources for analysis. The protocol commenced with the identification of records across various databases, followed by a meticulous screening process. This sequential approach ensured that only the most relevant and robust studies were included in the final review.

3. Results

The final cohort of studies included in this review comprises 17 investigations that rigorously adhered to the pre-defined selection criteria. However, it is important to note that while our review spanned from January to December 2022, focusing on the latest and most pertinent findings, we also included significant studies from previous years to ensure a comprehensive understanding of the topic. This inclusion of earlier studies explains the presence of research from different years in Table 1.

Moreover, while 17 studies were initially selected based on our criteria, Table 1 systematically tabulates the synthesized characteristics of only 13 of these studies. This selection was made to focus on those studies that most directly address our core research questions and provide clear, cohesive data relevant to the critical details such as participant count, the number of game implementation sessions, research type, educational setting, game dynamics and mechanics, game types, electronic support tools used, and the consequent effects on student outcomes. The remaining four studies, though meeting our selection criteria, were not included in the table due to their distinct focus or methodology, which diverged from the primary variables presented in Table 1. These studies are still acknowledged in other sections of the review, contributing to the overall depth and breadth of our research findings.

Table 1. Summary of selected research in the systematic review

Authors	Sample Size	Educational Stage	Gamification Strategy	Game Type and Devices	Outcomes Measured
Robertson et al. (2018)	157	Primary	Collaborative challenges	Multi-device challenge game	Physical performance and health
Cenizo-Benjumea et al. (2022)	497	Primary	Individual challenges without competition	Challenge game (no devices)	Physical performance
González et al. (2016)	417	Primary	Collaborative challenges with levels	Level-based game with multiple devices	Motivation and psychological needs
Dólera-Montoya et al. (2021)	20	Primary	Collaborative challenges	Computer-based video game	Physical performance and health
Fernandez-Rio et al. (2021)	54	Secondary	Level-based collaborative challenges	Level-based game with multiple devices	Motivation and psychological needs
Pérez et al. (2021)	275	Secondary	Level-based collaborative challenges	Level-based game on computer	Motivation and psychological needs
Melero-Canas et al. (2021)	36	Secondary	Collaborative challenges	Multi-device challenge game	Physical performance and motivation

Corepal et al. (2019)	58	Secondary	Gamified intervention	Not specified	Strength, difficulties, and prosocial behavior
Lin et al. (2020)	52	Secondary	Competitive challenges with AR	AR board game with devices	Motivation
Segura-Robles et al. (2020)	64	Secondary	Escape room with collaborative challenges	Escape room game with multiple devices	Motivation, psychological needs, and performance
Liu and Lipowski (2021)	127	University	Collaborative challenges with levels	Level-based game on computer	Motivation and academic performance
Mora-Gonzalez et al. (2020)	150	University	Individual challenges without competition	Challenge game (no devices)	Motivation and academic performance
López et al. (2017)	117	University	Collaborative challenges with narrative	Mobile-based challenge game	Physical performance

According to the findings that address our first research question regarding the prevalence of empirical studies at various educational stages, a significant portion of research has been conducted in the later years of compulsory education. Specifically, nearly half (47%) of the studies were situated in secondary education. A considerable 29% of investigations underscored the value of integrating gamified strategies at the earliest stages of education, while 24% advocated for their implementation at the university level. It is thus discernible that research in compulsory education stages is more prevalent compared to university-level studies.

In addressing the second inquiry about the common dynamics and mechanics utilized as educational tools, the methodological gamification approaches employed in the studies were meticulously examined. These included various dynamics, mechanics, and game elements. The findings were split between narratives and challenges, each constituting 47% of the studies, with a single study (6%) leveraging storytelling as the central dynamic. A significant majority, 80%, incorporated a competitive team system enriched with collaborative elements. Only two studies diverged from this approach, opting for individual competition instead of collaboration. Moreover, a substantial majority (76%) of the studies adopted a point, reward, and leaderboard system to showcase individual or team progress. Four studies were identified that exclusively employed point systems, while one study concurrently used points and rewards.

Regarding the third question concerning the types of games (digital or physical) most employed, the reviewed articles predominantly featured challenge-based activities (58%). Level-based games were identified as the second most prevalent form. Each of the following modalities—board games, escape rooms, and video games—was represented by one study. With respect to the devices used to facilitate these games, a multifaceted approach involving various devices such as computers, mobile phones, and specific applications was predominant (86%), indicating a substantial integration of technology. Nonetheless, a minority (14%) of the activities did not necessitate the support of any digital devices.

Finally, answering the fourth and conclusive research question on the potential effects of gamification and game-based learning (GBL) within the context of physical education, a diverse range of variables was taken into consideration. In addressing the fourth and final research question concerning the impact of gamification and game-based learning (GBL) within the context of physical

education, the compiled data highlights a varied set of considered variables. The synthesized results demonstrate that:

- The most commonly reported outcome was motivation regulations, with a majority of studies (8) finding significant positive effects.
- Basic psychological needs were also frequently examined, with five studies reporting significant positive effects, suggesting that gamification and GBL strategies may be influential in fulfilling these needs within educational settings.
- Physical performance outcomes were split, with four studies noting significant improvements, while two studies found non-significant effects, indicating that the impact of GBL on physical performance may be context-dependent.
- The effects on physical health were studied in three instances, with two studies observing significant improvements, endorsing the potential of GBL to enhance physical health parameters.
- Academic performance was investigated by three studies; two found significant improvements, which could advocate for the integration of GBL strategies to bolster academic achievements.
- Variables such as strength and difficulties, as well as pro-social behaviors, were less commonly studied, with one study for each variable reporting significant positive effects.

These outcomes suggest that while the potential benefits of GBL and gamification in physical education are notable, especially in fostering motivation and satisfying psychological needs, their effects on other areas such as physical health and academic performance are promising but may require more targeted investigation to fully understand their scope and limitations. The distribution of these effects, as represented in the data, underscores the multifaceted impact of GBL and gamification, and the need for a nuanced approach to their implementation and study in diverse educational contexts.

The analysis of the potential effects of gamification and GBL within the physical education context reveals differentiated impacts across various motivational and psychological parameters. The concept of motivation regulation, particularly intrinsic motivation, appears to be significantly influenced by GBL strategies, as evidenced by the majority of the included studies. This aligns with the idea that gamification can effectively engage students' inner drive to learn and participate in physical education. Following intrinsic motivation, the levels of introjected regulation, identified regulation, and integrated regulation also show noteworthy improvements, highlighting the capacity of GBL to support more complex forms of motivation that align with students' personal values and goals. Despite these positive trends, extrinsic motivation stands out as an outlier. The data indicates a singular instance where gamification did not yield significant effects on extrinsic motivation, suggesting that the external rewards system commonly associated with GBL may not be as influential as the internal aspects of motivation. When examining basic psychological needs, which include autonomy, competence, and relatedness, all five studies observed significant positive effects. This suggests that GBL environments are conducive to satisfying these foundational needs, likely due to their interactive, choice-driven, and socially connected nature. The impact of GBL on physical performance and health displays a less consistent pattern. Some studies report beneficial outcomes in specific areas such as physical endurance and muscle strength, indicating that GBL can be an effective tool for improving certain aspects of students' physical fitness. However, this is contrasted by other studies that do not report improvements in students' physical or mental health, signaling the presence of factors that may mediate the success of GBL interventions in these domains. Such variability underscores the complexity of measuring health outcomes in educational settings and suggests a need for more nuanced research approaches to capture the multifaceted nature of these variables.

4. Discussion and Conclusions

In the context of physical education, this study meticulously evaluates game-based learning (GBL) and gamification methodologies, including the dynamics and mechanics intrinsic to game design.

Despite the growing body of research, there is a noticeable deficit in studies focusing on the application of these methodologies at the university level. This research probes the multifaceted effects of such pedagogies on students' motivation, physical wellbeing, and overall educational experience. The intricate design elements of educational games are pivotal in maximizing their positive influence on student engagement and learning outcomes. Consequently, a thorough literature review to date can greatly assist both the scientific community and educational practitioners in crafting bespoke gaming experiences within their pedagogical frameworks. Certainly, the study at hand provides a comprehensive analysis of game-based learning (GBL) and gamification within the realm of physical education, highlighting an existing gap in research pertaining to higher education (Moher et al., 2009). It delves into the impact of GBL and gamification on student motivation, physical wellbeing, and educational outcomes, underscoring the significance of well-designed educational games in maximizing student engagement and learning (Prensky, 2001; Illeris, 2003).

Findings from the reviewed literature suggest that GBL and gamification positively influence motivation regulation (Quintas et al., 2020), fulfill basic psychological needs (Sotos-Martínez et al., 2022), and enhance academic performance and physical health (Liu & Lipowski, 2021; López et al., 2017). These strategies are posited to be effective in increasing student participation in physical education classes, indicating the need for continued research, particularly at the university level, where there is a dearth of studies.

The research indicates a notable interest in gamified methodologies among educators and educational institutions, with significant research dedicated to the primary (Yildirim, 2017; Robertson et al., 2018) and secondary education levels (Barba-Martín et al., 2020; Pérez et al., 2021). In contrast, university-level research remains limited, potentially due to misconceptions about the age-appropriateness of gamification (Manzano-León et al., 2021).

Narrative and challenge-based dynamics are found to be the most prevalent within gamification strategies, engaging students in a compelling manner and enhancing motivational outcomes (Huizenga et al., 2009; Kiili, 2005). Collaboration and competition are key components of these strategies, indicating their potential efficacy in pedagogical settings (Erickson & Sammons-Lohse, 2020). Finally, the integration of technology in the form of electronic devices is widespread, with 14 out of 17 studies reviewed employing digital tools to facilitate learning (Cornellà et al., 2020; Fu et al., 2019). This reflects the increasing role of technology in education and the importance of integrating electronic devices meaningfully to bolster student engagement (Manzano-León et al., 2022).

This investigation sought to elucidate the application and efficacy of gamification and game-based learning (GBL) in physical education, with a particular interest in extending the scope to encompass higher education settings. The study scrutinized the prevailing GBL and gamification strategies to determine their adaptability and impact across various educational echelons. A meticulous review of extant literature revealed that these pedagogical approaches confer multiple advantages, including enhanced motor skills, academic achievements, and health benefits. The review underscored the necessity of aligning GBL and gamification with learning objectives within the higher education domain. It detailed prevalent game types, the role of electronic devices, the dynamics and mechanics underpinning these educational tools, and the nature of participant interaction. The findings affirm that GBL and gamification, when integrated thoughtfully into sports education, can foster positive educational outcomes. Furthermore, the applicability of these methods in university settings was substantiated, with the narrative and challenge elements being as pertinent as they are in primary and secondary education. The overarching aim of this review was to bolster the search for empirical evidence that supports the formulation and refinement of playful educational strategies. It is imperative that these strategies evolve and are tailored to meet the nuanced requirements of the learner demographic. Future research should delve into the impact of amalgamating various active learning strategies, such as problem-based learning and the flipped classroom model, to ascertain their collective efficacy in enhancing student engagement and learning outcomes.

For future studies, it is recommended to expand the research on GBL and gamification within the higher education context, exploring their longitudinal effects on student motivation, engagement, and retention. Furthermore, it would be beneficial to investigate the potential for customizing game elements to align with the diverse learning preferences and styles of university students. Finally, qualitative research into student and faculty perceptions of gamified learning could provide valuable insights into the barriers and facilitators of effective implementation in higher education environments.

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