Gamification Approaches to Improve Learning Outcomes among Medical Students: A Systematic Review

Abstract

Introduction: Gamification has increasingly been incorporated into medical education to improve student engagement, motivation, and academic performance. By integrating game-related components, including points, rewards, leaderboards, and interactive challenges, gamification seeks to create a more engaging and student-centered learning environment. However, evidence regarding its effectiveness in improving knowledge acquisition and clinical competence among medical students remains inconsistent. This study aimed to systematically evaluate the effects of gamification-based learning interventions on knowledge outcomes, clinical skills, OSCE performance, and student motivation.

Methods: A systematic review and meta-analysis were conducted following PRISMA 2020 guidelines. Literature searches were performed in PubMed, Scopus, Google Scholar, and citation tracking sources through December 2025. Quantitative studies evaluating gamification interventions among undergraduate or professional medical students were included. Data were synthesized narratively, and meta-analysis was conducted using a random-effects model. Effect sizes were calculated using standardized mean differences with 95% confidence intervals, while heterogeneity was assessed using the I^2 statistic.

Results: Fourteen studies met the inclusion criteria, and six studies were eligible for meta-analysis. The pooled analysis demonstrated a moderate positive effect of gamification compared with conventional teaching approaches. Greater benefits were observed in clinically oriented and skill-based learning activities, although substantial heterogeneity was identified across studies. Gamification also improved collaborative participation, learning satisfaction, and classroom interaction in several studies involving simulation-based educational activities among undergraduate medical education programs.

Conclusion: Gamification appears to be a promising educational strategy in medical education; however, additional high-quality studies are needed to establish more consistent evidence regarding its effectiveness across diverse educational settings.

Keywords: Gamification; Medical Education; Medical Students; Learning Outcomes; Clinical Competence;

Introduction

Medical education is undergoing substantial transformation driven by increasing demands for quality assurance, patient safety, and professional accountability. Modern medical curricula should teach students what they need to know and make sure they learn things that are useful in the real world, such as ethical behavior, clinical performance, and meeting the demands of society. Traditional teaching methods are becoming less effective at getting future doctors ready for the complexity of current healthcare systems. This shows how important it is to come up with new ways to teach that are based on research and improve student engagement and clinical competence (1). Along with these changes to the system, the fast growth of digital technology and the changing ways that medical students study have sped up the use of technology-enhanced learning in medical school. Prior research indicates that digitally facilitated and Internet-based learning modalities can attain educational outcomes that are equivalent to or above those of traditional face-to-face instruction, especially regarding skill acquisition and learner satisfaction (2). These changes make a strong case for looking into new ways of teaching that use digital technology to improve learning results.

In this context, gamification has emerged as a promising educational strategy grounded in motivational and learner-centered principles. Gamification refers to the integration of game design elements, such as points, badges, leaderboards, challenges, rewards, immediate feedback, and storytelling into non-game educational environments to enhance learner engagement, motivation, and knowledge retention. In medical education, gamification has been implemented through a wide range of instructional approaches, including mobile learning applications, simulation-based training, virtual patient platforms, quiz-based learning, digital games, escape rooms, and Objective Structured Clinical Examination (OSCE)-related activities. These approaches have been shown to promote active learning, improve collaboration and critical thinking, and strengthen clinical knowledge and practical skills while creating a more engaging learning experience (3,4). Although related concepts such as game-based learning and serious games are frequently used interchangeably in the literature, this review adopts the term gamification as an umbrella concept encompassing these approaches when they are primarily designed to support learning through game elements rather than as full-scale entertainment games.

Although a growing body of evidence suggests that gamification can improve educational outcomes in medical education, including knowledge acquisition, clinical reasoning, procedural skills, learner engagement, and motivation, the reported findings remain heterogeneous across studies (4,5). Variations in educational settings, learner characteristics, intervention designs, gamification elements, outcome measures, and stages of medical training have produced inconsistent estimates of effectiveness, limiting the generalizability of the findings of individual studies. Furthermore, existing evidence syntheses have primarily focused on describing the implementation and educational benefits of gamification, while less attention has been given to quantitatively examining the magnitude of its effects across multiple learning domains and exploring potential sources of between-study heterogeneity. Therefore, a comprehensive systematic review and meta-analysis are warranted to provide pooled estimates of effectiveness and identify contextual factors associated with successful gamification interventions in medical education (6)(7)(8).

This study conducted a systematic review and meta-analysis to evaluate the effectiveness of gamification in medical education. The primary objective was to determine how

gamified learning interventions influence medical students' educational outcomes, including knowledge acquisition, clinical reasoning, skill performance, and motivation.
The secondary objective was to identify contextual and pedagogical factors that may influence the effectiveness of gamification, such as the level of medical training (preclinical vs. clinical), learning environments (online, blended, or simulation-based), gamification elements used (points, badges, leaderboards, feedback, and challenges), and the outcome domains measured (cognitive, psychomotor, and affective). Unlike narrative or scoping reviews, this study applied meta-analysis to provide a quantitative synthesis, enabling the estimation of overall effect sizes and offering evidence-based recommendations for implementing gamification in medical education.

Methods

Protocol and registration

This systematic review and meta-analysis adhered to the requirements set out by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) and the Structured Approach to Reporting in Healthcare Education of Evidence Synthesis (STORIES) statement. The review protocol was filed ahead of time in 2026 in the International Prospective Register of Systematic Reviews (PROSPERO). This study did not need ethical approval because it combined data from studies that had already been published.

Eligibility criteria

Type of studies

Quantitative research, such as randomized controlled trials (RCTs), cluster randomized controlled trials (cRCTs), quasi-experimental studies, and cohort intervention studies, qualified for inclusion. Studies have to show numbers on how gamification-based interventions affected knowledge acquisition, clinical skills, OSCE performance, or learner motivation. The study did not include editorials, narrative reviews, conference abstracts, qualitative studies, protocol papers, or studies that only looked at the design or development of applications without looking at the results. We only included articles that were published in English.

Type of participants

Eligible participants included undergraduate and postgraduate medical and dental students, as well as interns who engaged in gamification-based learning in academic or clinical education settings. No restrictions were applied regarding age, sex, level of training, or prior experience.

Types of intervention

This study encompassed research that assessed gamification-based learning interventions within medical education. Gamification is the use of game features (such points, challenges, competition, feedback, simulations, or scenario-based activities) in educational settings. Interventions were given in a number of ways, such as through mobile apps, simulation-based learning environments, escape rooms, virtual patient systems, and structured game-based activities to help people get ready for the OSCE. The review did not include studies that only looked at non-medical uses or non-educational fun games.

Types of outcome measures

Eligible studies were required to report quantitative outcomes related to medical students' learning, including knowledge scores, clinical or procedural skills, OSCE performance, and motivational outcomes measured using validated or study-specific instruments. Knowledge acquisition was assessed through written examinations, multiple-choice questions, short-answer tests, or other standardized theoretical

assessments. Clinical or procedural skills referred to practical competencies evaluated through skills checklists, practical examinations, simulation-based assessments, or structured skill stations. OSCE performance was defined as total or domain-specific scores obtained from standardized clinical stations using predefined scoring rubrics. Motivational outcomes included affective-domain measures such as motivation, engagement, and self-efficacy, assessed using validated psychometric instruments or structured questionnaires with reported reliability. When multiple outcomes were reported within the same domain, the most comprehensive or post-intervention score was extracted for analysis.

Search strategy and information sources

A systematic literature search was conducted in two major bibliographic databases, PubMed (MEDLINE) and Scopus. The search covered studies published between January 2013 and December 2025. To ensure comprehensive coverage, a supplementary search was conducted using Google Scholar, including backward and forward citation tracking of the included studies. Google Scholar was used solely as a supplementary source and not as a primary bibliographic database.

The search strategy was applied across two electronic databases (PubMed and Scopus) and supplementary sources (Google Scholar and citation tracking). For transparency and reproducibility, the full PubMed search string is presented below, and equivalent adaptations were used for other databases. ("gamification" OR "game-based learning" OR "serious games") AND ("medical students" OR "medical education" OR "health professions education") AND ("clinical skills" OR "OSCE" OR "learning outcomes" OR "motivation"). The complete search strategies for all databases are provided in the Supplementary Materials.

Selection of studies and data extraction

All retrieved records were imported into a reference management system and duplicates were removed. Two reviewers independently screened titles and abstracts based on predefined eligibility criteria, followed by full-text assessment. Any disagreements during the screening process were resolved through discussion and consensus.

Data extraction was conducted independently by the same reviewers using a standardized Microsoft Excel form. Extracted information included author details, publication year, country, study design, participant characteristics, sample size, intervention and comparator descriptions, outcome measures, quantitative results, and reported limitations. Discrepancies were resolved through discussion until agreement was reached.

Risk of bias assessment

The methodological quality and risk of bias of the included studies were independently assessed by two reviewers. Randomized controlled trials were evaluated using the Cochrane Risk of Bias tool, while non-randomized studies were assessed using the Newcastle-Ottawa Scale (NOS). Any disagreements were resolved through discussion and consensus(9).

Data synthesis and statistical analysis

A narrative synthesis was performed for all the included studies. A meta-analysis was performed using Review Manager (RevMan) version 5.4.1 when studies reported sufficient quantitative data (means and standard deviations or convertible statistics). Continuous outcomes were summarized using standardized mean differences (SMDs) and 95% confidence intervals. A random-effects model was applied owing to the anticipated heterogeneity across study designs, interventions, and outcome measures. Statistical heterogeneity was assessed using the I^2 statistic. Subgroup analyses were

conducted based on learning context (OSCE, emergency medicine, surgical education, and other domains) when sufficient data were available. Statistical heterogeneity was assessed using the I^2 statistic. Subgroup analyses were conducted based on learning context (OSCE, emergency medicine, surgical education, and other domains) when sufficient data were available. Subgroup analyses were additionally performed to explore potential sources of heterogeneity across educational contexts. Given the expected clinical and methodological heterogeneity across included studies, a random-effects meta-analysis model was applied. Given the expected clinical and methodological heterogeneity across included studies, a random-effects meta-analysis model was applied. The standardized mean difference (SMD) was used to allow the pooling of outcomes measured using different instruments but assessing comparable constructs related to knowledge and skills acquisition. In addition to quantitative synthesis, included studies were descriptively categorized based on their primary learning context (e.g., OSCE preparation, emergency medicine training, surgical education, and other medical domains) to facilitate structured narrative reporting of findings.

Results

The literature search identified a total of 18,450 records from bibliographic databases and supplementary sources. Records retrieved from bibliographic databases included PubMed (n = 450) and Scopus (n = 100). In addition, supplementary searches were conducted using Google Scholar (n = 12,300) and citation tracking and other sources (n = 5,600), yielding a comprehensive pool of potentially relevant studies. Prior to screening, 7,200 records were removed during the deduplication process and preliminary filtering of clearly irrelevant records. The remaining 11,250 records were screened based on titles and abstracts. Following this initial screening, 11,100 records were excluded because they were non-English publications (n = 520), had irrelevant titles or abstracts (n = 10,540), or were duplicate records (n = 40).

A total of 150 reports were sought for full-text retrieval. Of these, 30 reports could not be retrieved due to irrelevance identified at the abstract level (n = 18) or unavailability of full texts (n = 12). Consequently, 120 full-text articles were assessed for eligibility. After full-text assessment, 105 articles were excluded due to incomplete or insufficient outcome data (n = 23), irrelevant intervention or population (n = 68), or because they were review articles or conference abstracts (n = 14). Ultimately, 14 studies met the inclusion criteria and were included in the systematic review. The study selection process is illustrated in the PRISMA 2020 flow diagram (Figure 1).

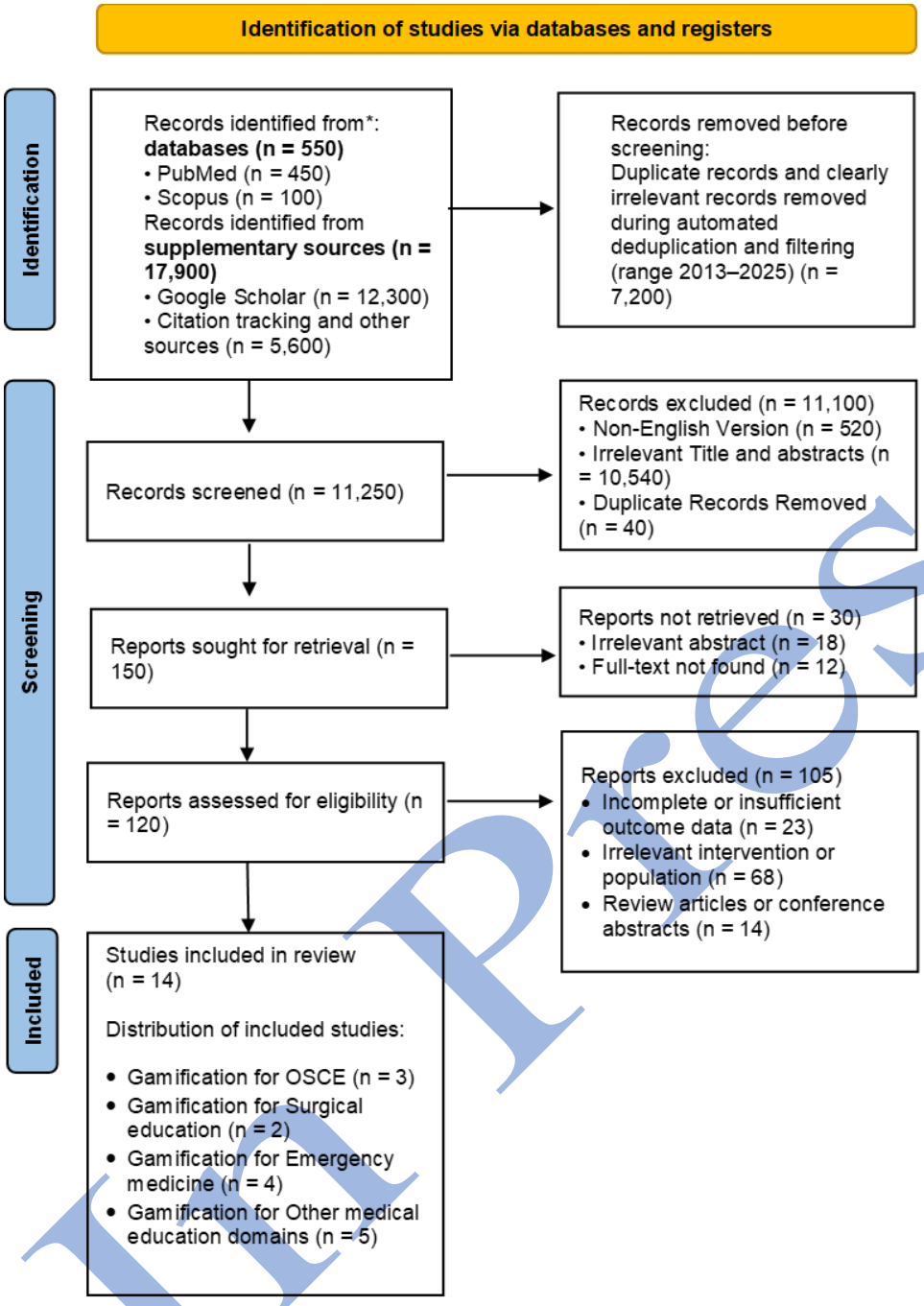

Figure 1. Prisma Flow Chart

Characteristics of included studies

Among the 14 studies reviewed, three focused on the application of gamification in the Objective Structured Clinical Examination (OSCE), two addressed its use in surgical education, four investigated its role in emergency medicine education, and six explored its implementation in various medical education domains. The studies included in this review exhibited diversity in educational context, intervention design, and outcome measures, highlighting the broad application of gamification strategies in medical education settings. The detailed characteristics of these studies, including authorship, publication year, country of origin, study design, population, sample size, intervention specifics, outcome measures, and reported limitations, are comprehensively summarized in the Supplementary Materials.

Risk of bias

Among the 14 studies reviewed, six were eligible for meta-analysis, although several did not report complete statistical parameters such as means or standard deviations. Figure 2 presents the risk-of-bias assessment for studies included in the quantitative synthesis. Overall, many studies demonstrated high or unclear risk of bias across several methodological domains, particularly in allocation procedures and sequence generation. This was mainly due to the use of quasi-experimental designs, time-based allocation, historical cohorts, or participant self-selection rather than strict randomization.

A high or unclear risk of bias was also observed in the blinding of participants and personnel, which is common in educational and gamification-based interventions where blinding is difficult to implement. Several studies did not clearly report whether outcome assessors were blinded, particularly in assessments of OSCE performance and other subjective outcomes. Additionally, studies using perception-based or self-reported measures such as anxiety, motivation, confidence, and engagement often lacked clear reporting on assessor blinding.

In terms of incomplete outcome data, two studies were judged to have a low risk of attrition bias, whereas four studies showed a high risk of bias due to substantial participant attrition or exclusion from the final analysis (10,11). The risk of selective reporting was generally unclear, as most studies did not have a registered protocol. Additionally, several studies exhibited other sources of bias related to methodological limitations, including the use of historical control groups (12), small sample sizes (13,14), temporal bias, potential contamination between intervention and control groups, and reliance on self-reported outcome measures (15,16).

Taken together, the risk of bias assessment revealed that many of the included studies exhibited high or unclear risks in several key methodological domains, particularly in allocation procedures, blinding, and outcome assessment. For randomized trials, concerns were mainly related to randomization and blinding processes, whereas non-randomized studies presented inherent risks related to selection bias and lack of allocation concealment.

The funnel plot of standardized mean differences (SMDs) (Figure 3) showed an asymmetric distribution around the pooled effect estimate, particularly among studies with lower precision. This pattern suggests potential publication bias or small-study effects and may also reflect substantial heterogeneity in study design, outcome domains, and methodological variations across gamification interventions.

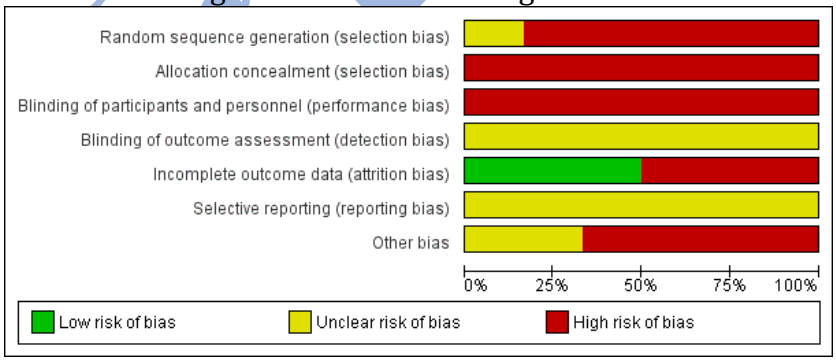

Figure 2. Risk of Bias Study

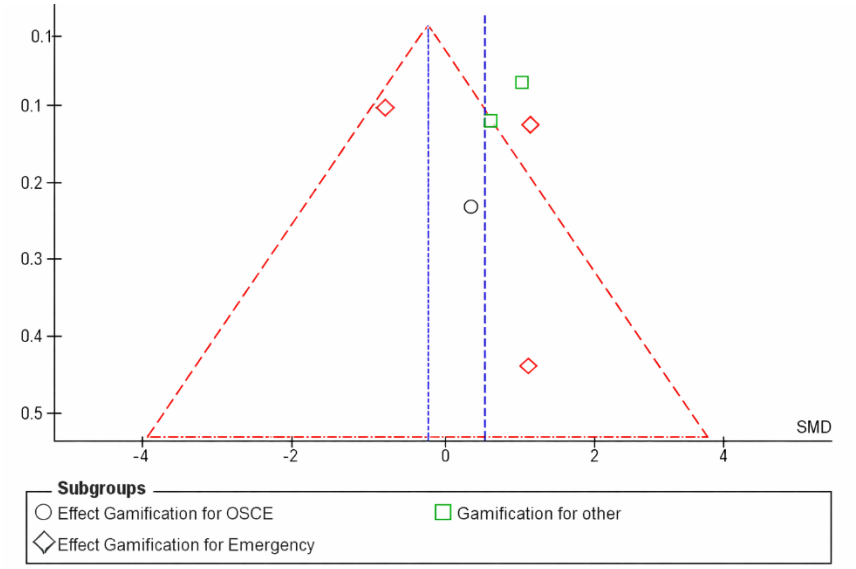

Figure 3. Funnel of gamification effects

Synthesis of results

The review included 14 studies examining the effects of gamification in medical education across different learning contexts. Three studies focused on Objective Structured Clinical Examinations (OSCE), four on emergency medicine, two on surgical procedures, and five on other areas such as radiology, pharmacy, and diagnostics (Table 1). Overall, 13 studies reported positive effects of gamification on medical students' learning outcomes in various countries, including Iran, Colombia, Spain, the Netherlands, the USA, Canada, Japan, Thailand, the United Arab Emirates, and Lebanon. Reported benefits included improvements in clinical performance (OSCE scores), knowledge acquisition, clinical skills, student satisfaction, OSCE preparedness, anxiety reduction, time management, emergency radiology competence, clinical reasoning, teamwork, and overall learning experience.

Gamification has also been explored for improving diagnostic skills in the operating room, particularly related to surgical instruments. However, one study conducted in France reported no statistically significant improvement in OSCE scores following a gamification intervention. Of the 14 eligible studies, only six provided sufficient quantitative data for inclusion in the meta-analysis, while eight were excluded due to incomplete reporting of statistical parameters. The pooled results of the included studies are presented in the forest plot (Figure 4). Because of differences in study design, educational settings, outcome domains, and types of gamification interventions, considerable heterogeneity was expected. Therefore, the meta-analysis findings should be interpreted cautiously and considered alongside the narrative synthesis.

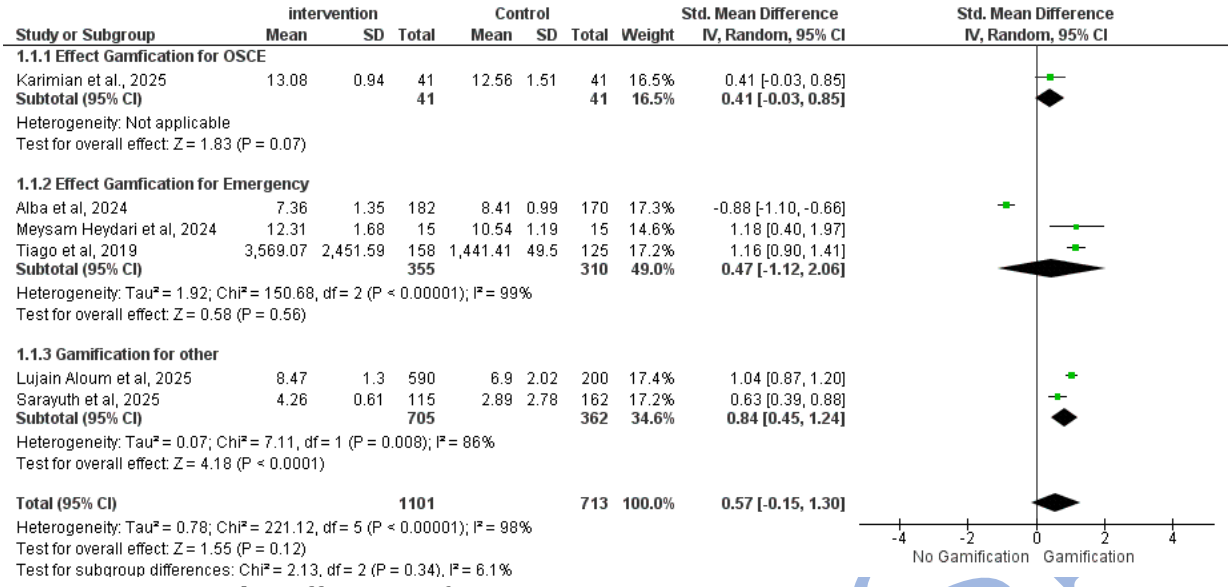

Figure 4. Forest Plot Effect Gamification

Students exposed to gamification-based learning showed a trend toward improved post-intervention outcomes compared with non-gamification groups. The pooled analysis using a random-effects model indicated a moderate effect (SMD = 0.57; 95% CI −0.15 to 1.30; p = 0.12), suggesting a positive trend, although statistical significance was not reached. Inter-study heterogeneity was very high (I^2 = 98%), reflecting substantial differences in educational contexts, intervention designs, and outcome measures.

Subgroup analyses provided further insight into the effectiveness of gamification across learning contexts. In the OSCE subgroup, gamification showed a small to moderate positive effect (SMD = 0.41; 95% CI −0.03 to 0.85; p = 0.07), indicating a trend toward improved clinical performance. In emergency medical education, the pooled effect was positive (SMD = 0.47) but highly variable (95% CI −1.12 to 2.06; I^2 = 99%). In contrast, other medical education domains demonstrated a statistically significant and more consistent effect (SMD = 0.84; 95% CI 0.45 to 1.24; p < 0.0001), although heterogeneity remained substantial (I^2 = 86%).

Overall, despite considerable heterogeneity and the lack of overall statistical significance, the substantial heterogeneity observed across studies likely reflects differences in educational settings, gamification strategies, intervention duration, and outcome assessment methods. Despite this variability, meta-analysis remained appropriate because all included studies evaluated gamification-based interventions aimed at improving medical education outcomes. Subgroup analyses were conducted to explore differences across learning contexts, although these findings should be interpreted cautiously because of the limited number of studies. In addition, the asymmetric funnel plot suggests the possibility of publication bias or small-study effects.

Effect Gamification for OSCE

As shown in Table 1, the effectiveness of gamification on OSCE outcomes varies across studies. Vallet et al. reported the use of an escape room did not yield a significant difference in intermediate OSCE scores between the intervention and control groups (median 13.23 vs. 12.94; P = 0.40). This outcome is likely influenced by the insufficient duration of exposure to the intervention prior to the implementation of the OSCE (17).

In contrast, Karimian et al. found that face-to-face learning combined with gamification significantly enhanced clinical knowledge and skills, with post-exam scores being higher than those of the group without gamification (P < 0.001) (18). Meanwhile, Germa et al

reported in Colombia reported that game-based interventions effectively increased OSCE readiness, particularly by reducing anxiety and improving time-management skills. The impact of the intervention was more pronounced in students who had not previously taken the OSCE than in those who had ($P < 0.05$) (15). Overall, these findings indicate that the effectiveness of gamification on OSCE outcomes and clinical learning is influenced by the context of the intervention, participant characteristics, and timing of the intervention's implementation relative to the evaluation of study results.

Effect gamification for emergency

According to Table 1, several comprehensive studies indicate that gamification effectively enhances learners' competence and engagement in emergency contexts. A study conducted by Pérez-Baena et al. found in Spain reported a significant improvement in the capabilities of teams handling radiology emergency cases, with average scores increasing from 7.36 ± 1.35 in the 2020–2021 academic year to 8.41 ± 0.99 in 2021–2022 ($P < 0.001$)(19). Additionally, student satisfaction with learning and emergency OSCE cases was high, with average scores exceeding 8 out of 10 (19). Similar findings were reported by Heydari et al. reported in Iran, who demonstrated that the gamification group achieved higher post-exam scores than the control group in terms of knowledge, procedural skills (OSCE), and clinical reasoning (13).

Furthermore, T Grangeia et al found that revealed that the game-based intervention group exhibited a higher level of utilization of learning platforms than the control and mixed groups, reflecting more intensive learning involvement and activity (20). Meanwhile, Gue et al. reported in the United States reported that the implementation of a gamification-based curriculum in medical emergency education significantly increased motivation, involvement, and participation among residents, with average scores improving across all indicators following the implementation of gamification ($P < 0.05$) (12). Overall, these findings suggest that gamification is an effective approach to enhancing learning outcomes, engagement, and the learning experience in medical emergencies.

Effect gamification for surgery

Table 1 demonstrates the consistent effectiveness of gamification interventions in educational surgery, particularly in enhancing diagnostic abilities and performance within a surgical context. A study conducted by Masoumian Hosseini et al. found that in Iran revealed no significant difference between groups in pre-exam scores, indicating comparable initial abilities among the participants (21). However, at this stage post-exam, group learning based game show surgical OSCE scores that are significant more tall compared to method teaching traditional, especially in clinical OSCEs, with the strongest effect in OSCE 2 ($P < 0.0001$). These findings are corroborated by Guérard-Poirier et al. reported that study in Canada, which reported that the game-based learning group achieved significantly higher OSCE scores in surgical education than the traditional teaching group in both non-clinical and clinical OSCEs ($P < 0.0001$) (11). Furthermore an advanced evaluation conducted three months later indicated that the surgical OSCE skills in the gamification groups remained intact, whereas those in the control group experienced a significant decline in performance. Overall, these results demonstrate that gamification is effective in enhancing and sustaining OSCE performance in surgical education.

Effect gamification for others

Based on Table 1, various studies have demonstrated that gamification has a positive impact on external, non-specific clinical learning. Ishizuka et al. and Masoumeh et al. reported a significant increase in self-trust in clinical reasoning, learning motivation, and awareness of medical costs following game-based interventions ($P < 0.05$) (14,16). These

results indicate that gamification is effective in enhancing the cognitive and affective aspects of students' learning in medical education. Additionally, Sarayuth et al. reported in Thailand showed that integrating a flipped classroom with gamification significantly increased students' self-trust and satisfaction, and was significantly related to MCQ and OSCE performance (10). Aloum et al. found that in the United Arab Emirates and Marie Claude et al. reported in Lebanon also reported significant improvements in learning scores and positive student perceptions of gamification compared to traditional learning methods (22,23). Overall, these findings confirm that gamification is an effective and flexible approach to enhancing learning outcomes, engagement, and learning experiences in various medical education contexts.

Tabel 1. All Include Review

No	Author, year & country	Outcome of interest	Summary statistics (Percentage of mark/Score by using gamification (Mean±SD,P Value))	Sample size (I: Intervention; C: Control)	Duration	Effectiveness of gamification
Effect Gamfication for OSCE						
1	Nicolas Vallet et al., 2024 (French) (17)	Clinical performance (OSCE score)	Median OSCE score: Escape room group: 13.23 (IQR: 11.67–14.55); Non-escape room group: 12.94 (IQR: 11.60–14.14); No significant difference (P = 0.40);	Total responden: 113; I: 87; Non-C: 26	Prior exposure (>7–12 months before OSCE)	Non Effective
2	Karimian et al., 2025 (Iran) (18)	Knowledge acquisition, clinical skills (OSCE), and student satisfaction	Knowledge scores increased significantly in both groups, with higher post-test scores in the **In-person + Gamification group (13.08±0.94 to 18.52±1.14; P<0.001)** compared with the **In-person group (12.56±1.51 to 16.67±1.45; P<0.001)**, and a significant between-group difference at post-test *(P<0.001)*.	Total participant: 82; I: 41; C: 41	Radiographic interpretation course	Effective
3	Germa A et al., 2020 (Columbia) (15)	OSCE preparedness, anxiety reduction, time management skills	The game reduced OSCE-related anxiety in 60% of all students and improved time management skills in 65%. Significant differences between OSCE-naïve (4th year) and experienced students (5th year) were observed for anxiety reduction (65% vs. 22%, p < 0.001) and time management skills (59% vs. 41%, p < 0.05).	Intervention: undergraduate dental students (4th and 5th year); Control: not applicable (comparative cohort by academic year)	4–6 weeks prior to summative OSCE	Effective
Effect Gamfication for Emergency						
4	Alba et al, 2024 (Spanyol) (19)	Emergency radiology competence, clinical reasoning, teamwork, student perception	Team-based emergency case resolution improved significantly (mean score 7.36 ± 1.35 in 2020–21 vs. 8.41 ± 0.99 in 2021–22; p < 0.001). High satisfaction (>8/10) with emergency OSCE cases and learning experience.	352 students I: 182, C: 170	2 Weeks	Effective
5	Meysam Heydari et al, 2024 (Iran) (13)	evaluate the impact of GBL and gamification in an emergency medicine	Mean score in the intervention (gamification) group: Knowledge (MCQ): Posttest: 12.31 ± 1.68, Procedural skills (OSCE): Posttest: 10.92 ± 0.52, Clinical reasoning (PMP/KF): Posttest: 11.92 ± 1.32, Mean score in the control group:Knowledge (MCQ): Posttest: 10.54 ± 1.19, Procedural skills (OSCE): Posttest: 9.36 ± 1.01, Clinical	I: 15 students C: 15 Students	12 Month	Effective

			reasoning (PMP/KF): Posttest: 10.04 ± 2.23			
6	T Grangeia, 2019 (Netherlands) (20)	clinical performance (emergency)	Mean score in the Game (intervention) group: Platform utilization: 3569.07 ± 2451.59, Mean score in the FACE (mixed) group: Platform utilization: 1960.37 ± 1152.21, Mean score in the Control group: Platform utilization: 1441.41 ± 49.50	Intervensi Group = 158, control group: 125, kelompok campuran : 179	Duration of intervention: 60 hours in the control group, 87 hours in the mixed group, and 140 hours in the intervention group.	Effective
7	Shayne Gue et al, 2022 (USA) (12)	investigate the impact of gamification in emergency medicine	Mean scores in the intervention (gamified curriculum) showed significant improvements in resident engagement, motivation, and participation after the implementation of gamification, with mean motivation increasing from 3.3 to 4.3, engagement from 3.4 to 4.6, and perceived challenge from 3.5 to 4.4 (P < 0.05). In contrast, during the control (pre-intervention) period, lower mean scores of engagement and participation were observed prior to the use of gamification.	Emergency medicine residents (Intervention: gamified period; Control: pre-gamification period)	Longitudinal implementation during residency training	Effective
Effect Gamification for Surgical						
8	Mohsen et al, 2023 (Iran) (21)	Investigated students' diagnostic skills in the Operating Room in the context of surgical instruments	Pretest score:Group A: no significant difference compared with Group B (P=0.907; 95% CI −1.559 to 1.092) and Group C (P=0.937; 95% CI −1.125 to 1.525); Group B vs Group C (P=0.716; 95% CI −0.892 to 1.759), Posttest / OSCE performance: Game-based teaching group showed significantly higher scores than the traditional teaching group in OSCE 1 (non-clinical) and OSCE 2 (clinical), with the strongest effect observed in OSCE 2 (P < 0.0001).	A total of 90 students fell into three groups of 30 participants each	3-month	Effective
9	Natasha et al, 2022 (Canada) (11)	Evaluate the effectiveness of game-based learning compared with traditional teaching in surgical education using OSCE performance	**Mean score in the intervention (game-based) group:** OSCE 1 (non-clinical): significantly higher than traditional teaching *(P < 0.0001)*; OSCE 2 (clinical): significantly higher than traditional teaching *(P < 0.0001)*; OSCE 3 (3-month follow-up): no significant difference compared with OSCE 2, indicating retention of skills. **Mean score in the control (traditional) group:** no significant improvement between OSCE 1 and OSCE 2 *(P = 0.5335)*, with a significant decline in performance at OSCE 3 *(OSCE 1 vs OSCE 3, P < 0.0001)*	Three groups (game-based, mixed, and traditional teaching); exact numbers reported in the article	Immediate post-intervention with 3-month follow-up	Effective
Effect Gamification for Other						

10	Ishizuka et al, 2023 (Jepang) (14)	Effect Gamification on medical students' diagnostic decision making and awareness of medical cost	Confidence of clinical reasoning: Mean score increased significantly from 2.9 ± 0.2 (before) to 3.6 ± 0.2 (after) (P < 0.001), Motivation: Mean score showed a significant improvement from 5.8 ± 0.1 (before) to 6.2 ± 0.2 (after) (P = 0.014), Awareness of medical cost: Mean score increased markedly from 3.3 ± 0.2 (before) to 4.8 ± 0.2 (after) (P < 0.001).	30 Students:14 small groups of 2–3 medical students each	N/R	Effective
11	Masoumeh et al, 2023 (Iran) (16)	Investigate the use of digital games for educational purposes among medical and paramedical sciences	Significant improvements were observed after the intervention in **confidence of clinical reasoning (2.9±0.2 to 3.6±0.2; P<0.001)**, **motivation (5.8±0.1 to 6.2±0.2; P=0.014)**, and **awareness of medical cost (3.3±0.2 to 4.8±0.2; P<0.001)**.	(n = 496)	>10 minutes	Effective
12	Sarayuth et al, 2025 (Thailand) (10)	Integrated flipped classroom strategies with gamification to enhance learning in lower urinary tract symptoms (LUTS) education	**Mean score after gamified flipped classroom:** Confidence level increased from **2.78 to 4.26** *(P < 0.001)* and satisfaction increased from **4.62 to 4.81** *(P = 0.005)*. Higher presession test scores were associated with higher final MCQ pass rates *(P = 0.04)*, and postsession test scores showed a weak but significant correlation with OSCE performance *(r = 0.20, P = 0.03)*	Total **162** students completed presession test; **115** completed postsession test and evaluation (Intervention only)	Single 90-minute LUTS session within course	Effective
13	Lujain Aloum et al, 2025 (UEA) (22)	Gamification in Pharmacology Education	**Mean score in the intervention (gamer) group:** Pretest: **6.20 ± 2.13**; Posttest: **8.47 ± 1.30** *(P = 0.006)*. **Mean score in the control group:** Pretest: **6.05 ± 2.31**; Posttest: **6.90 ± 2.02** *(P = 0.21)*. Student perceptions: **83%** found the games enjoyable, **80%** reported improved understanding, and **70%** believed they learned better with gamification than with lectures	I; 59 C: 20	Weekly sessions during pharmacology course	Effective
14	Marie Claude et al, 2025 (Lebanon) (23)	Gamification offers a powerful tool to foster engagement and enhance the educational journey of medical professionals	**Mean score in the intervention (gamification) group:** Posttest scores were significantly higher than pretest scores *(P < 0.05)* and higher than the control group. **Mean score in the control group:** No significant improvement was observed *(P > 0.05)*	100 participants : NR (Intervention and control groups reported)	NR	Effective

Discussion

The primary objective of this systematic review and meta-analysis was to evaluate the effectiveness of gamification in improving medical students' learning outcomes, including knowledge acquisition, clinical and procedural skills, OSCE performance, and motivational outcomes. Although the pooled meta-analysis demonstrated a moderate positive effect favoring gamification over conventional teaching methods (SMD = 0.57), the overall effect did not reach statistical significance, primarily because of the considerable heterogeneity across the studies (I^2 = 98%). Nevertheless, the narrative synthesis consistently indicated that most of the included studies reported improvements in knowledge acquisition, clinical performance, learner engagement, motivation,

teamwork, and confidence. These findings suggest that gamification has substantial educational potential, although its effectiveness depends on the educational context, instructional design, intervention characteristics, and outcome measures rather than producing uniform effects across all learning environments (24,25).

These findings are consistent with those of recent systematic reviews demonstrating that gamification promotes active participation, learner engagement, knowledge retention, and higher-order cognitive skills in health professions education. Van Gaalen et al. reported that gamification positively influences learner motivation, satisfaction, and behavioral engagement, particularly when game elements are intentionally aligned with educational objectives rather than implemented solely to increase enjoyment (26). Similarly, Huang et al. and Salehi et al. concluded that gamification enhances knowledge acquisition and practical learning outcomes through learner-centered instructional strategies that incorporate immediate feedback, progressive challenges, collaboration, and repeated practice (6,7). More recently, Khazaei et al. highlighted that the educational effectiveness of gamification in medical sciences depends largely on pedagogical quality, curriculum integration, and meaningful assessment strategies rather than on the use of game mechanics alone (27).

From a theoretical perspective, the educational benefits of gamification can be explained by constructivist learning theory, experiential learning, and self-determination theories. Well-designed gamified learning environments promote autonomy, competence, and relatedness while providing continuous feedback and opportunities for deliberate practice, thereby enhancing intrinsic motivation and sustaining engagement. Recent educational reviews have further emphasized that combining gamification with immersive technologies, such as virtual reality and simulation-based learning, can strengthen experiential learning and facilitate the acquisition of clinical reasoning and procedural skills (28). Likewise, recent developments in game-based learning demonstrate that educational games are most effective when integrated into competency-based curricula and aligned with clearly defined learning outcomes rather than functioning as stand-alone educational activities (29,30).

The substantial heterogeneity observed in this meta-analysis is likely attributable to differences in participant characteristics, learning environments, intervention duration, gamification components, comparison methods, and outcome measurements. Similar methodological variability has been consistently reported in previous systematic reviews, which identified wide variation in educational content, game mechanics, implementation strategies, and assessment instruments across studies (24,26). Furthermore, the studies included diverse educational contexts, ranging from emergency medicine and OSCE preparation to radiology, surgery, pharmacology, and diagnostic reasoning, each requiring different competencies and assessment approaches. Consequently, although the overall direction of the evidence favors gamification, the magnitude of its educational effect appears to be context-dependent and should be interpreted cautiously (30).

Another important finding is that the educational benefits of gamification were more apparent in clinically oriented and skills-based learning than in theoretical instruction. Studies involving OSCE preparation, emergency medicine, surgical training, radiology, and diagnostic reasoning have generally demonstrated improvements in clinical performance, decision-making, teamwork, and learner confidence. Recent systematic reviews on gamified resuscitation education and immersive educational technologies have similarly reported improvements in procedural competence, collaborative learning, and learner engagement, particularly when simulation and scenario-based learning are integrated into the intervention (29). Furthermore, recent educational innovations,

including interdisciplinary escape rooms and communication skills training, have demonstrated that gamified activities provide authentic learning experiences that foster collaboration, clinical reasoning, and communication competencies that are essential for modern medical practice (31).

Collectively, these findings support the integration of pedagogically sound gamification strategies into undergraduate medical education, while emphasizing that successful implementation requires careful instructional design, alignment with curriculum objectives, and valid assessment methods. Future randomized controlled trials should adopt standardized outcome measures, longer follow-up periods, and theory-informed intervention designs to reduce methodological heterogeneity and strengthen the evidence regarding the effectiveness of gamification in medical education (32,33).

Study limitations and future avenues of research

This review should be interpreted considering several methodological limitations. The asymmetry observed in the funnel plot suggests the potential presence of publication bias, reflecting the common tendency for studies with positive findings to be published. In addition, only a limited number of studies could be included in the meta-analysis due to incomplete statistical reporting. Nevertheless, the available data still allowed the identification of general trends and the estimation of pooled effects.

Considerable heterogeneity was observed among the included studies, likely due to differences in educational settings, participant characteristics, intervention types, duration, and outcome measures. Rather than weakening the findings, this diversity highlights the wide applicability of gamification across various medical education contexts. Future research should focus on well-designed randomized controlled trials with standardized intervention reporting, larger sample sizes, and longer follow-up periods to better evaluate long-term clinical competence and identify the most effective gamification strategies in medical education.

Conclusion

Systematic reviews and meta-analyses indicate that gamification is a potentially effective approach for enhancing learning outcomes, particularly in medical education, where it is applied in the context of clinically based skills training. Generally, gamification-based learning demonstrates a consistent trend towards improved academic and clinical performance compared to conventional learning methods, although statistical significance is not always achieved due to high study heterogeneity. The effect is notably strong and consistent in specific domains, such as Objective Structured Clinical Examinations (OSCE), emergency medical education, and surgical education. Overall, these findings support the integration of gamification as a complementary strategy in medical education curricula, particularly to enhance student engagement, motivation, and clinical readiness. With more standardized intervention designs and robust methodological support from further studies, gamification has the potential to become an important component of modern, active, competence-based medical education, fostering long-term clinical practice readiness.

Lessons for Practice

Gamification-based learning may enhance student engagement and clinical performance in medical education settings. Gamified educational interventions appear particularly beneficial in OSCE preparation and simulation-based training. Standardized gamification frameworks and outcome measures are needed to improve the consistency of future medical education research.