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iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 20 No. 5 (2026) | OPEN ACCESS

https://doi.org/10.3991/ijim.v20i05.58407

PAPER

Personalized Adaptive Gamification and Learning Styles in Digital and Mobile Learning Environments: A Systematic Review

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ABSTRACT

This study examines how personalized gamification relates to learning styles by identifying theoretical models, gamification approaches, and empirical evidence in education. A PRISMA-based systematic review was conducted across Scopus, Web of Science, and ScienceDirect, with an additional open-access screening phase. Thirty-four empirical studies from 2015–2025 were analyzed. The Felder-Silverman (FSLMS) model is the most frequently applied, followed by multiple intelligences (MI), Kolb, VARK, and cognitive-style frameworks. Gamification approaches include game-based learning, points–badges–leaderboards, customized and adaptive designs, hybrid structures, and technology-integrated systems, though some lack theoretical grounding. Experimental and quasi-experimental designs predominate, often relying on learning-style and perception questionnaires. Findings highlight five trends: personalized gamification increases motivation; learner profiles align with different game-element preferences; adaptive systems enhance attention and performance; learning styles influence satisfaction and engagement; and some cognitive profiles show neutral effects. Overall, evidence indicates a clear shift toward hybrid and adaptive personalized gamification supported by digital and mobile learning environments.

KEYWORDS

personalized adaptive gamification, learning styles, digital learning environments, mobile learning

1 INTRODUCTION

Gamification has been increasingly adopted in educational settings as a strategy to enhance student motivation and engagement. However, its implementation is often generic, overlooking the diversity of ways in which learners process information and construct meaning. Real innovation lies not in adding game elements per se, but in aligning gamified dynamics with individual learning preferences [1].

Tomaylla-Quispe, Y., Gutierrez-Aguilar, O., Chicana-Huanca, S., Pérez-Postigo, G. (2026). Personalized Adaptive Gamification and Learning Styles in Digital and Mobile Learning Environments: A Systematic Review. *International Journal of Interactive Mobile Technologies (iJIM)*, 20(5), pp. 4–23. https://doi.org/10.3991/ijim.v20i05.58407

Article submitted 2025-08-26. Revision uploaded 2025-12-21. Final acceptance 2025-12-21.

The design of gamified experiences is supported by theoretical frameworks such as self-determination theory and flow theory, which explain the motivational effects of autonomy, competence, and feedback [2]. Learning-style models, including Felder-Silverman (FSLSM), VARK, and Kolb, have demonstrated utility in adapting instructional content to cognitive profiles, improving attitudes and learning outcomes [3]. FSLSM is also considered one of the most operationally robust frameworks in adaptive gamification research, given its consistent empirical application across disciplines [4]. Yet, limited research has articulated how these models connect conceptually and methodologically with adaptive gamification. Integrating both perspectives allows gamified systems to move beyond motivational triggers and anchor game elements in pedagogical coherence, especially in digital and mobile learning environments [5].

Emerging developments in AI-enhanced ICT and cloud infrastructures further reinforce the relevance of personalization. Lifelong learning ecosystems increasingly rely on person-oriented approaches that support flexible adaptation to individual learner characteristics [6]. Complementing this, cloud-based educational infrastructures have been shown to enable scalable, data-driven personalization and real-time adaptation in digital learning environments [7]. Within this landscape, adaptive gamification becomes a concrete mechanism for operationalizing personalized learning.

Current studies show growing interest in customizing points, challenges, rewards, and narratives according to learning styles or proficiency levels [8], [9]. Gamified environments often incorporate missions, simulations, storytelling, and empirical evidence—predominantly from experimental and quasi-experimental designs—and report positive effects on motivation, performance, and satisfaction [10]. Mixed-methods research increasingly contributes insights into students' perceptions regarding alignment between gamification and cognitive styles [11].

Adaptive gamification is particularly relevant in mobile-first contexts. Frameworks that adjust challenges, assessments, and pathways according to learner traits [12], [13], demonstrate that mobile environments offer additional opportunities for personalization through multimodal interaction and continuous real-time data. Active learners tend to benefit from interactive and competitive designs, while reflective learners respond more favorably to structured narratives and gradual progression [14], [15].

Despite these advances, theoretical integration remains incomplete. Several studies highlight mismatches between game mechanics and pedagogical objectives [16], as well as methodological constraints such as small samples and short interventions, limiting the generalizability of findings [17]. Previous systematic reviews have synthesized outcomes related to engagement, motivation, and behavioral trends [18], [19], but have not focused on personalization or learning styles. In contrast, our review examines the intersection between learning style frameworks and adaptive gamification models, clarifying conceptual, methodological, and practical implications within digital and mobile ecosystems aligned with the scope of iJIM. Accordingly, we pose the following research questions:

RQ1: Which learning theories integrate gamification and learning styles?
RQ2: Which gamification models and elements are used for personalization?
RQ3: What methodologies, instruments, and samples predominate in the studies?
RQ4: How does personalized gamification affect motivation, performance, and engagement?
RQ5: What limitations and research gaps exist in current studies?

2 MATERIALS AND METHODS

This systematic literature review aims to identify, analyze, and synthesize empirical studies that explore the relationship between gamification and learning styles in educational contexts. To do this, we use the guidelines recommended by the PRISMA model (see Figure 1) for the search, filtering, and rigorous analysis of the information [20]. The review protocol was not preregistered in repositories such as PROSPERO or OSF; this decision was mainly due to the exploratory scope and time constraints of the project and is acknowledged as a methodological limitation that readers should consider when interpreting the findings.

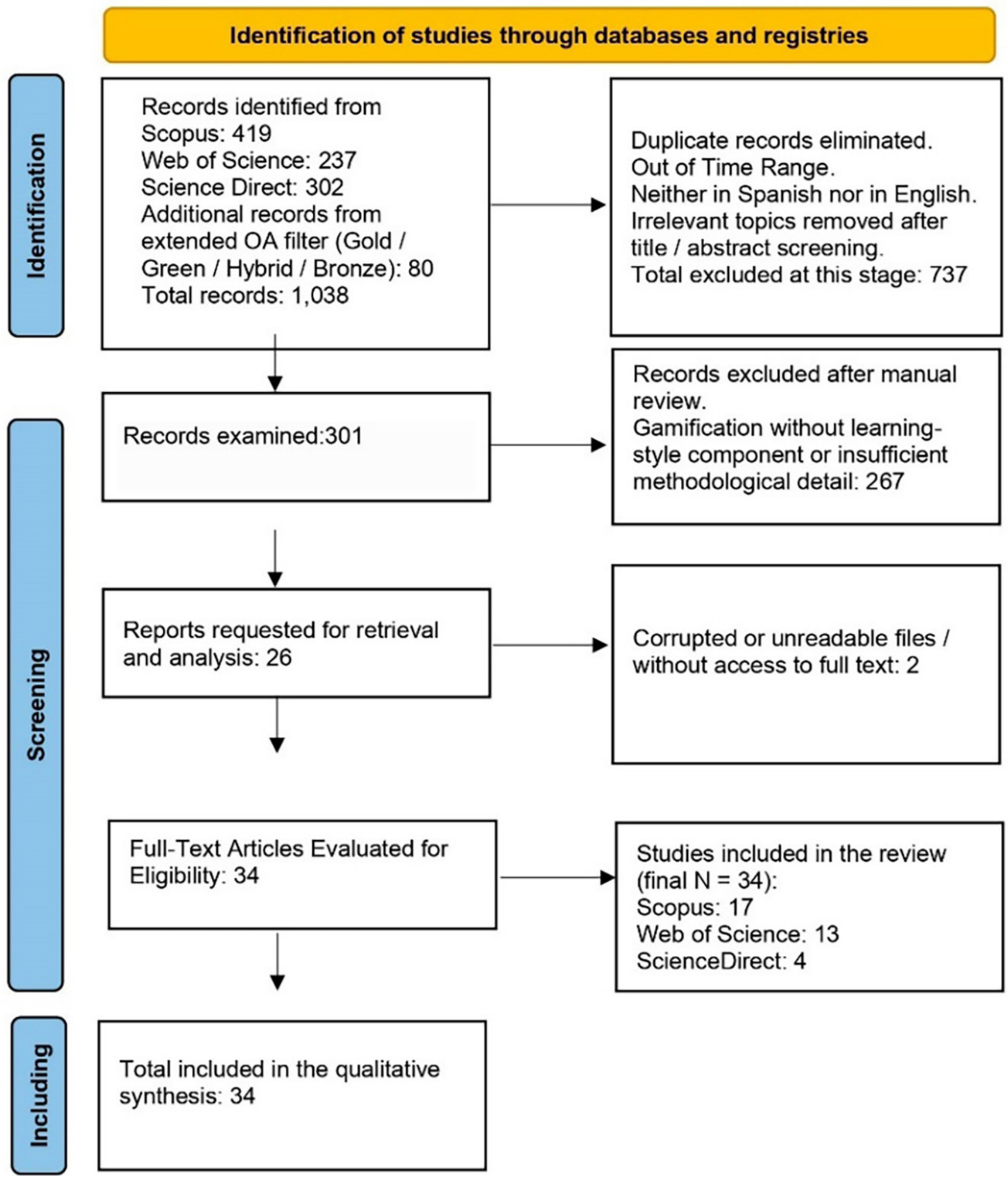

Fig. 1. PRISMA flow diagram

The literature search was carried out in November 2025 in three high-impact scientific databases: Scopus, Web of Science (WoS), and ScienceDirect. For the search strategy, a chain was structured that combines terms related to gamification, learning styles, and educational environments, using Boolean operators.

Scopus: Advanced search

(TITLE-ABS-KEY (gamification OR gamified OR "game-based learning" OR "serious games") AND TITLE-ABS-KEY ("learning styles" OR "cognitive styles" OR "VARK" OR "multiple intelligences" OR "learning preferences") AND TITLE-ABS-KEY (student* OR school OR education OR university OR classroom))

The initial result was 419 documents, and after filtering by language (English and Spanish), type of access (open access), and manual reading, 11 relevant studies were selected.

Web of Science:

TS = (gamification OR "game-based learning" OR "serious games") AND TS = ("learning styles" OR "Felder-Silverman" OR "VARK" OR "Kolb" OR "cognitive styles" OR "individual differences") AND TS = (education OR student* OR classroom OR "higher education")

The initial result was 237 documents, and after the application of filters (scientific articles, not including RSL, proceedings, or book chapters, open access, etc.), 10 final articles were selected.

ScienceDirect: Two search combinations were applied.

(gamification OR "game-based learning") AND ("learning styles" OR "VARK") AND (education OR students) = 802 results.

("serious games" OR gamification) AND ("Felder-Silverman" OR "Kolb") = 302 results.

After manual filtering, abstract reading, and relevance assessment, only 3 studies were initially selected. Once the inclusion and exclusion criteria were applied, the final set comprised 24 empirical papers. Searches were limited to open-access publications because the research team lacked institutional funding to access paywalled articles. Although this pragmatic decision ensured feasibility, it may have excluded relevant studies from subscription-based journals, introducing a potential selection bias addressed as a limitation. In the second phase, a broader filtering procedure was conducted in Scopus. The Open Access filter was refined by activating all OA policy categories (Gold, Green, Hybrid, and Bronze), allowing retrieval beyond fully OA publications while still ensuring legally accessible versions. This adjustment yielded 80 records, each screened using the same criteria (2015–2025, empirical research, student populations, explicit measurement of learning styles, and integration of gamification or game-based learning). Through manual review and full-text inspection, 10 additional empirical studies were identified and incorporated, expanding the evidence base from 24 to 34 works. This second phase partially mitigates the initial OA restriction and aligns the corpus more closely with the state of the art.

2.1 Inclusion and exclusion criteria

We reviewed open-access, peer-reviewed articles (2015–2025) in English or Spanish examining links between gamification or game-based learning and learning styles or preferences in school or university students. We included empirical quantitative, qualitative, or mixed-methods studies using defined instruments. We excluded book chapters, proceedings, theses, abstracts, reviews, pre-2015 publications, and studies in other languages. We also removed research outside educational contexts, involving non-student populations, lacking direct focus on learning styles, or offering only theoretical or editorial content. Limiting to open access was pragmatic but may introduce bias.

After applying these criteria, 34 studies met the requirements (see Figure 1). We then conducted a qualitative content analysis following Braun and Clarke's guidelines for thematic analysis [21]. Each article was examined in depth to extract information across five dimensions aligned with our study questions: (1) theoretical learning model, (2) type and elements of gamification, (3) methodological design, (4) relationship between gamification and learning styles, and (5) study limitations. These dimensions served as a primarily deductive coding frame while allowing inductive insights to emerge. All data were organized in an Excel matrix. The principal investigator performed the full coding, and a second researcher reviewed the matrix for coherence and potential omissions. No double coding or inter-rater reliability coefficients were calculated, a limitation acknowledged in the discussion.

2.2 Quality appraisal and risk of bias

Alongside data extraction, we conducted a descriptive appraisal of methodological quality. Rather than applying a formal scoring tool initially, we reviewed study design, sample characteristics, transparency in reporting gamification and learning-style instruments, and adequacy of data analysis. No studies were excluded; observed weaknesses—small samples, short interventions, and limited reporting—were documented to contextualize evidence strength. The 10 additional studies from the extended OA filtering underwent the same appraisal and showed comparable variability in methodological rigor.

In addition to this descriptive process, we applied an adapted version of the Mixed Methods Appraisal Tool (MMAT 2018) to evaluate the methodological quality of the 34 included studies. Five criteria were considered: clarity of research questions, appropriateness of study design, adequacy of data collection methods, quality of data analysis, and transparency of reporting. The MMAT was used only as a descriptive tool, and no studies were excluded based on their scores. Table 1 summarizes the results.

Table 1. Quality appraisal using an adapted MMAT checklist (N = 34)

MMAT Criterion	Description	% Meeting the Criterion
1. Clarity of research questions	The study explicitly states objectives or hypotheses.	91% (31/34)
2. Appropriateness of study design	Design aligns with research questions (experimental, quasi-experimental, etc.).	85% (29/34)
3. Adequacy of data collection methods	Instruments (FSLSM, VARK, Kolb, GEFT, and surveys) are appropriate and described.	76% (26/34)
4. Quality of data analysis	Analytical techniques (statistical tests, SEM, and thematic coding) are suitable and reported.	71% (24/34)
5. Transparency of reporting	Results, limitations, and procedures are clearly documented.	68% (23/34)

3 RESULTS

As for the year of publication, the studies analyzed cover a period between 2015 and 2025, with a notable increase in research from 2022 onwards. There has been an upward trend that reflects a majority academic interest in the intersection between gamification and learning styles in recent years. According to the socio-demographic profile, with respect to the country or context of origin of the studies, we have seen a wide geographical diversity. Most of the research comes from Asian countries, including China, Taiwan, Indonesia, Malaysia, Hong Kong, South Korea, India, Pakistan, Turkey, and Macao (n = 16; 47.1%). In second place is Europe, with studies carried out in Spain, Germany, Ireland, France, the United Kingdom, Switzerland, Greece, and Romania (n = 12; 35.3%). The Americas are represented by only two studies (n = 2; 5.9%), while Africa has research by authors from Morocco, Tunisia, Egypt, and South Africa (n = 4; 11.8%). No studies from Latin America or Oceania were identified, which indicates a deficit in this geographical area in the current literature on the subject.

Most studies were conducted in higher education (n = 23; 67.6%), mainly in undergraduate and graduate programs across engineering, computing, medicine, business, and teacher training. Primary education appears in fewer cases (n = 5; 14.7%), followed by secondary education (n = 3; 8.8%). One study focused on early childhood learning (n = 1; 2.9%), and two studies covered multiple educational levels from primary to high school (n = 2; 5.9%). Overall, research on gamification and learning styles remains concentrated in university settings and mainly in Asian and European regions, highlighting opportunities for expansion into other educational levels and underrepresented geographical contexts.

3.1 Theoretical models of learning

A review of the 34 empirical studies included in this synthesis (refer to Table 2) reveals a clear predominance of the FSLMS Learning Styles Model (FSLSM/ILS/FSLM), which appears in 13 studies (38.2%). FSLSM remains the most widely used framework due to its multidimensional structure (active/reflective, sensing/intuitive, visual/verbal, and sequential/global), making it highly compatible with adaptive gamification systems, especially those that personalize game elements, pathways, or feedback according to learner profiles [22], [23], [24], [25], [26], [27].

Kolb's Experiential Learning Theory constitutes the second most frequently used model, appearing in five studies (14.7%), particularly in the design of mobile adaptive systems, geometry learning pathways, simulation-based interactions, and task cycles involving concrete experience and reflective observation [28], [29], [30], [31], [32]. Its relevance persists because the experiential cycle aligns naturally with gamification mechanics such as feedback loops, challenges, and narrative progression.

The Theory of Multiple Intelligences (MI) appears in four studies (11.8%), predominantly in primary education and game-based environments aiming to develop logical-mathematical, visual-spatial, or kinesthetic skills [33], [34], [35], [36]. MI-based gamification facilitates multimodal instructional design aligned to learners' cognitive strengths. Studies grounded in cognitive-style models—including Witkin's Field Dependence-Independence and GEFT-based visual-spatial processing classifications—were identified in three publications (8.8%), typically in contexts involving immersive visuals, simulations, or perceptual tasks [37], [38]; an additional GEFT-based mobile study. These approaches support the study of perceptual preferences within gamified interactions.

Two studies (5.9%) employed VAK/VARK classifications to design or evaluate gamified activities aligned with visual, auditory, or kinesthetic learning tendencies [14], [39]. Although simpler than FSLSM, VAK/VARK remains relevant in adaptive interfaces and school-level gamified tasks.

Other models appear less frequently but expand the conceptual heterogeneity of the field: Big Five personality traits: 3 studies (8.8%), often combined with FSLSM to enhance adaptive gamification [25], [27], [40]. Kolb + cognitive affective elements: appears in reflective practice studies. Honey & Mumford: 1 study (2.9%) [41]. Self-regulation and goal orientation: 1 study (2.9%) [42]. GenderMag cognitive archetypes: 1 study (2.9%) [43], used to examine inclusivity and cognitive personal differences.

Table 2. Theoretical model

Model	n	%
Felder–Silverman (ILS/FSLSM/FSLM)	13	38.2
Kolb (Experiential Learning)	5	14.7
MI (Gardner)	4	11.8
Cognitive Styles (GEFT/FD-FI)	3	8.8
VAK/VARK	2	5.9
Big Five (Personality Traits)	3	8.8
Honey & Mumford	1	2.9
Self-regulation/Goal Orientation	1	2.9
GenderMag Cognitive Archetypes	1	2.9
Total	34	100

Overall, the expanded corpus shows that FSLSM clearly dominates, not only due to its flexibility but also because it integrates seamlessly with adaptive gamification mechanisms. Nonetheless, the inclusion of Kolb, MI, cognitive styles, VAK/VARK, personality models, and socio-cognitive approaches demonstrates a progressively diverse theoretical landscape that supports multiple avenues for personalization in digital and mobile gamified learning.

3.2 Gamification models and game elements

The analysis of the 34 studies shows in Table 3 a considerable diversity in the theoretical and technological approaches used to structure gamified learning. A significant number of publications adopt personalized or adaptive gamification models (n = 8; 23.5%), often integrating learning styles (e.g., FSLSM or Kolb) and player profiles to tailor game elements such as feedback, difficulty, or thematic pathways [23], [25], [27]. These approaches reflect a shift toward learner-centered design, where adaptivity is linked to measurable learner characteristics.

Game-Based Learning (GBL) remains widely used (n = 7; 20.6%), particularly in simulations, virtual scenarios, and subject-specific applications such as mathematics, science, or finance [34], [44]. Meanwhile, classic PBL structures—points, badges, and levels—appear in 17.6% of studies (n = 6), maintaining prominence due to their ease of integration into LMS platforms and their immediate recognizability by students.

Some studies employ mixed or hybrid models (n = 3; 8.8%), combining narrative design, adaptive elements, and collaborative mechanics. Others rely on technology-integrated frameworks (n = 6; 17.6%), such as TAM-based gamified interfaces, mobile learning engines, cloud-based systems, or AI-supported adaptivity [26], [39]. A smaller group (n = 4; 11.8%) presents functional gamification without an explicit theoretical model, typically embedding playful elements directly into existing learning platforms.

Table 3. Gamification model

Gamification Model	Short Description	n	%
Game-Based Learning (GBL)	Pedagogical use of full games or simulations	7	20.6
Classic PBL (points, badges, levels)	Extrinsic rewards and progression structures	6	17.6
Customized/Adaptive	Tailored to learning styles or player profiles	8	23.5
Mixed or hybrid	Combined strategies integrating multiple approaches	3	8.8
Integrated technology	LMS gamification, AI, TAM, mobile platforms	6	17.6
Unspecified	Gamification without formal theoretical grounding	4	11.8
Total		34	100

As shown in Figure 2, the most frequently used elements are points, badges, and rankings (PBL), appearing in more than half of the studies (54.2%). Their prevalence is attributed to their straightforward implementation and their capacity to provide immediate and trackable reinforcement. Challenges, missions, and tasks appear in 41.7% of the studies, often forming the core structure of gamified activities. These elements support progressive goal achievement and align well with experiential and skill-based learning. Narrative, avatars, and simulation environments are present in 25% of the corpus. These elements introduce thematic coherence and immersive learning, supporting engagement through storyline continuity and identity construction [22]. Their use is more frequent in studies incorporating MI or Kolb's experiential cycle.

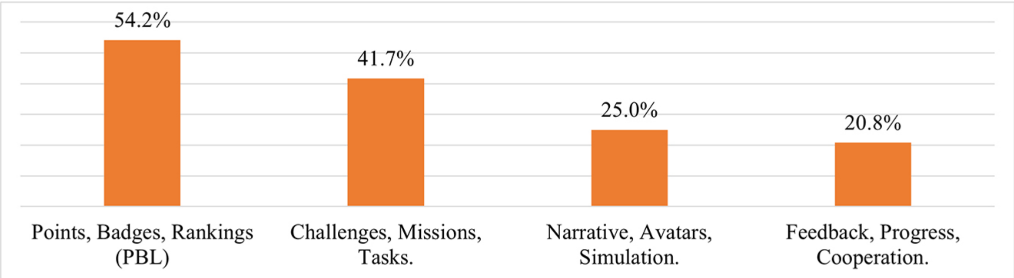

Fig. 2. Gamification elements

Finally, feedback, progress indicators, and cooperation mechanisms appear in 20.8% of studies, reinforcing reflection, peer interaction, and real-time monitoring [37]. These elements are especially relevant in adaptive systems where feedback is dynamically adjusted to learner performance.

Overall, the evidence indicates that most studies do not rely on a single gamification element. Instead, they combine classic PBL mechanics with adaptive, narrative, or collaborative structures, creating hybrid designs that seek to balance extrinsic and intrinsic motivation while aligning game elements with students' learning styles and cognitive preferences.

3.3 Designs, evaluation, and sampling instruments

When reviewing the studies, we observe (refer to Table 4) that researchers show a clear preference for experimental and quasi-experimental designs, which together represent 58.8% (n = 20) of the corpus. This methodological trend reflects the need to rigorously evaluate the impact of personalized gamification on motivation, engagement, and academic performance [24]. About 14.7% of the studies (n = 5) adopt applied designs aimed at testing or validating gamified tools or adaptive learning platforms. Mixed-methods approaches account for 11.8% (n = 4), providing richer interpretive depth by combining behavioral data with qualitative insights [45]. A smaller group employs correlational analyses or factorial SEM models (8.8%), while randomized controlled trials remain uncommon (5.9%).

Table 4. Study designs, instruments, and sample sizes

Design	Fr.	%	Instruments	Fr.	%	Sample	Fr.	%
Experimental/ Cuasi-experimental. (pre-and post-test, control)	20	58.8	Learning Styles Questionnaires (FSLSM, ILS, VARK, Kolb, MI)	15	44.1	≤ 50	6	17.6
Applied Design/Tool Evaluation gamified	5	14.7	Motivation, attitude, perception, and satisfaction questionnaires	13	38.2	51–150	15	44.1
Mixed study. (qualitative-quantitative triangulation)	4	11.8	Cognitive/perceptual tests (GEFT, CEFT, D2, FD/FI)	4	11.8	151–300	9	26.5
Quantitative correlational Factorial (SEM)	3	8.8	System logs, in-game performance	5	14.7	> 300	4	11.8
Randomized controlled trial	2	5.9	Interviews, forums, qualitative analysis	6	17.6	–	–	–
Total	34	100	Total	34	100	Total	34	100

Regarding instruments, questionnaires remain the predominant evaluation tool. Almost 44.1% of the studies (n = 15) used learning-style inventories—particularly FSLSM, Kolb, VARK, or MI—while 38.2% (n = 13) incorporated motivation, satisfaction, or perception scales to capture subjective learner experiences. Cognitive or perceptual assessments (e.g., GEFT, CEFT, attentional processing tests) appear in 11.8% (n = 4), and system logs or in-game performance metrics are used in 14.7% (n = 5). Interviews or qualitative methods support triangulation in 17.6% of the studies (n = 6), often complementing adaptive system evaluations [37].

Sample sizes vary considerably. Most studies fall within the 51–150 participant range (44.1%, n = 15), typical of higher-education research. Larger studies (151–300 participants) represent 26.5% (n = 9), while smaller investigations with ≤ 50 participants (17.6%, n = 6) provide more detailed observations of learning processes, particularly in primary education or pilot implementations. Only 11.8% (n = 4) exceed 300 participants, mainly in large-scale mobile learning or survey-based studies. This methodological diversity illustrates ongoing efforts to analyze not only the effects of gamification but also the mechanisms and contexts that shape learners' experiences.

An extended matrix detailing the learning-style models, gamification types, and device classifications for all 34 studies is provided in Appendix A, Table A1.

The MMAT appraisal indicated that most studies demonstrated medium to high methodological quality, with 91% clearly stating research questions and 85% applying designs aligned with their objectives. However, only 68% provided fully transparent reporting, and fewer than three-quarters detailed analytical procedures adequately.

3.4 Gamification and learning styles

The analysis of the 34 studies (refer to Table 5) shows that the relationship between gamification and learning styles is neither uniform nor incidental. Instead, learning styles operate as a relevant moderating or adaptive variable that conditions how learners respond to gamified instruction. Across the corpus, studies grounded in frameworks such as FSLSM, Kolb, VARK, MI, and cognitive-style models consistently report differentiated motivational and performance outcomes according to learner profiles [24], [46], [47].

Table 5. Learning styles and gamification

No	Author	Key Finding (Learning Styles and Gamification)
1	[35]	Gamified robotics improved motivation across varied learner profiles.
2	[24]	Active/visual learners preferred competitive-collaborative gamification.
3	[46]	FSLSM-based adaptation improved content alignment.
4	[22]	Automatic style-based adaptation increased motivation.
5	[37]	Field-independent learners performed better in gamified reading.
6	[43]	Storytelling is preferred by the Tim cognitive archetype.
7	[50]	Learning styles moderated engagement and performance effects.
8	[33]	Games adapted instruction to diverse learning profiles.
9	[34]	MI-based games increased attention and motivation.
10	[51]	GBL activated MI.
11	[41]	Activist/pragmatist styles improved teamwork attitudes.
12	[28]	Styles influenced intrinsic and extrinsic motivation.
13	[47]	Style-based adaptation improved motivation and engagement.
14	[49]	VAK styles influenced gamification engagement intent.
15	[45]	Gamification supported learning across most styles.
16	[40]	The Big Five traits shaped gamified acceptance.
17	[38]	Different cognitive styles achieved similar performance.
18	[48]	Experiential gamification showed differentiated engagement.
19	[39]	VARK-aligned gamification improved satisfaction.
20	[32]	Convergent Kolb learners showed the highest achievement.
21	[52]	In-game adaptation supported style transitions.
22	[53]	Active/global learners perceived gamification positively.
23	[23]	Gamified detection identified learning styles effectively.
24	[42]	Styles shaped self-regulation in gamified settings.
25	[30]	Reflective/doing styles benefited via video gamification.
26	[36]	MI-based gamification showed differentiated engagement.
27	[25]	FSLSM and the Big Five enhanced motivation and performance.
28	[31]	Kolb-based adaptive geometry improved learning outcomes.
29	[27]	Reduced FSLSM/Bartle guided adaptive gamification.
30	[26]	Learning styles moderated gamified engagement.
31	[44]	Experiential styles influenced motivation in simulations.
32	[54]	Wordwall effectiveness is linked to style alignment.
33	[55]	Game elements interacted with learning-style differences.
34	[56]	FSLSM-based adaptive gamification improved engagement.

A dominant pattern indicates that active, visual, sensing, and intuitive learners tend to experience higher motivation and engagement in instructional designs incorporating competitive, interactive, or collaborative elements. These learners benefit from frequent feedback, dynamic challenges, and reward-based progression systems that align with their preference for continuous stimulation and action-oriented tasks [24], [39]. Similarly, studies using MI-based or experiential learning frameworks show that students with visual-spatial or kinesthetic tendencies respond more positively to game mechanics involving imagery, simulation, or hands-on exploration [34], [36].

Overall, the findings indicate that gamification is most effective when aligned with In contrast, learners with reflective, verbal, or field-dependent profiles may require structured progression, lower cognitive load, and clearer task sequencing. Several studies report reduced performance or increased cognitive strain when these learners face high-complexity gamification without appropriate scaffolding [37], [41]. These findings indicate that gamification cannot be assumed to be universally effective and may produce unequal outcomes if design choices do not match learner characteristics. More advanced implementations, particularly those integrating FSLSM-based adaptive systems [25], [27], [46], Kolb-aligned adaptive pathways [31], [48], or VARK profiling [39], [49], demonstrate improvements in motivation, satisfaction, and, in several cases, academic performance. The evidence suggests that personalization mechanisms grounded in learning styles contribute to more coherent instructional alignment, facilitating better goal orientation, self-regulation, and perceived usefulness [26], [42].

At the same time, studies adopting a broader view of individual differences—such as those incorporating personality traits (Big Five)—show that learning styles form part of a constellation of learner factors that shape the reception of gamification [40]. These results underscore the need to interpret learning styles not as deterministic categories but as meaningful tendencies that interact with other cognitive and motivational variables.

Learners' cognitive preferences and its impact diminishes when applied as a uniform strategy. While effects on academic performance are not consistently significant across all studies, improvements in motivation, engagement, and attentional focus appear repeatedly across adaptive designs. Consequently, gamification emerges as a flexible pedagogical approach whose value increases when used as a mechanism for personalized learning rather than as a universal solution detached from individual differences.

3.5 Limitations

The studies included in this review present several methodological limitations that must be considered when interpreting the findings. Many investigations were conducted in highly specific contexts—individual schools, single university courses, or small and homogeneous cohorts—with limited sample sizes (26–56 participants) and, in several cases, without appropriate control groups. These constraints weaken external validity and restrict the generalizability of results [39], [40].

Theoretical approaches also remain uneven. A substantial proportion of studies rely almost exclusively on the Felder–Silverman model, overlooking other relevant learner characteristics such as motivation, emotions, metacognition, or personality traits. This narrow focus limits understanding of how cognitive preferences interact with gamified environments [16]. Likewise, many implementations are only partially adaptive, relying on basic elements such as points, badges, or rankings, with limited personalization for diverse learning profiles [53]. Temporal limitations further affect the evidence: most studies use short-term pretest–posttest designs, leaving it unclear whether gains in motivation, engagement, or performance persist over time. Longitudinal research remains rare despite its importance [46].

There are also notable technical and measurement challenges. Real-time adaptation requires robust data collection mechanisms and algorithmic decision rules, which are not consistently implemented. Measurement relies heavily on self-report instruments for learning styles and motivational constructs, increasing risks of bias, response inconsistency, or misclassification [47]. Few studies triangulate these data with behavioral analytics or observational evidence.

Finally, this review presents limitations of its own. The protocol was not preregistered, reducing procedural transparency. The initial search was restricted to open-access publications due to funding constraints, which may have introduced selection bias, although a second screening phase partially addressed this issue. Coding was carried out by a single researcher with only a secondary coherence check and no inter-rater reliability measures. Moreover, no formal quality appraisal tool was applied, limiting the depth of bias assessment.

3.6 Practical implications for mobile and digital education

Adaptive gamification can be effectively applied in mobile learning through personalized feedback, multimodal interaction, and real-time adjustment of difficulty. Educators may select narrative, collaborative, or challenge-based elements aligned with learners' cognitive preferences, while designers can use mobile analytics to tailor rewards, feedback, and pathways. Mobile-first implementation also requires consideration of accessibility, device variability, connectivity, and cultural factors to ensure equitable engagement across diverse student populations.

4 DISCUSSION

The findings of this review confirm patterns reported in earlier research: the Felder–Silverman model (FSLSM) remains the predominant framework for personalizing gamified learning due to its compatibility with adaptive instructional design [4]. Other models such as MI and VARK also appear frequently, highlighting the relevance of sensory and cognitive variation in shaping engagement [3]. Approaches based on Kolb or Honey and Mumford are less common, and several studies still lack a clear theoretical foundation, limiting their explanatory consistency and instructional coherence [57]. Nonetheless, the overall trend is positive: gamification is increasingly embedded within adaptive, data-driven systems rather than used as an isolated motivational mechanism. Although traditional game-based learning remains prevalent, there is clear evidence of a shift toward hybrid and personalized designs that align game elements with learner profiles [8], [9]. However, more systematic frameworks are needed to fully capitalize on the pedagogical potential of adaptive gamification [58].

With respect to game elements, points, badges, and leaderboards continue to dominate, consistent with evidence supporting their value as extrinsic motivators and feedback structures [10], [14]. At the same time, narrative features—missions, storylines, avatars, and simulated worlds—are becoming more prominent and are associated with deeper cognitive and emotional involvement. Designs that combine these elements with collaboration and immediate feedback appear to produce the most robust motivational gains. Methodologically, the field remains largely quantitative, with quasi-experimental and pretest–posttest designs representing most studies. Although effective for measuring performance and motivation, these approaches limit insight into subjective experiences. Only a small subset incorporated qualitative analyses, despite their relevance for capturing perceptions and emotional responses to adaptive systems [59]. Sample sizes also vary widely, but the average (around 112 participants) restricts generalizability, especially across educational levels or diverse cultural contexts [42].

Across the corpus, personalized gamification produces generally positive—though differentiated—effects. Visual and kinesthetic learners benefit from multimodal stimuli, hands-on interaction, and collaborative challenges [24], [28], [32]. Active or pragmatic profiles tend to prefer competitive structures, immediate feedback, and goal-oriented mechanics (Buckley and Doyle, 2017). Reflective and global learners respond more favorably to narrative progression and exploratory pacing. However, several studies report neutral effects for learners with more structured or less common cognitive profiles [43], [45], suggesting that alignment between game design and cognitive preference is critical. Geographic concentration is another limitation: most studies were conducted in Asia and Europe, with limited representation from Latin America or Oceania, restricting cultural generalizability.

Practical implementation challenges also persist. Many studies rely on superficial reward structures without deeper personalization processes [17], [53]. Longitudinal assessments remain rare, limiting knowledge about whether benefits endure over time. Technical challenges include developing systems capable of real-time personalization and integrating analytics to adjust difficulty, pacing, and narrative flow dynamically [47]. These limitations reinforce the need for broader samples, more balanced methodological designs, and the integration of multimodal data.

Finally, our findings align with recent reviews showing an excessive reliance on learning-style questionnaires such as FSLSM or VARK—tools whose psychometric properties continue to be debated. Although widely used, these instruments require triangulation with behavioral, qualitative, or analytics-based evidence. The observed geographical imbalance further underscores the need to extend research into diverse cultural contexts, where technological access and pedagogical practices may influence adaptive gamification. Unlike broader reviews of gamification, this study centers on adaptive personalization linked to learning styles, extending recent international work [12], [60], [61], [62]. In doing so, it highlights the need for integrative frameworks that connect gamification, adaptivity, and learner variability to enhance educational impact.

5 CONCLUSIONS

RQ1. The review confirms a strong predominance of the Felder–Silverman model for adapting gamification to learning styles, followed by MI, VARK, and Kolb. This diversity reflects a growing interest in personalization, although several studies still show limited methodological integration between theoretical frameworks and gamified design. Most models remain partially implemented in mobile or ubiquitous environments, where real-time data and adaptive feedback could enable deeper alignment between cognitive profiles and gameplay.

RQ2. Classic game elements such as PBL remain dominant, but there is increasing adoption of mixed and adaptive designs incorporating narratives, missions, and simulations. Aligning game elements with learning styles appears essential for improving motivation and engagement. Mobile-first gamification—using push notifications, location-aware tasks, and instantaneous feedback—offers further opportunities for personalization that extend beyond traditional desktop-based approaches.

RQ3. Quantitative designs, particularly experimental and quasi-experimental studies, predominate, focusing mainly on measuring observable effects of gamification. Qualitative and mixed-methods approaches remain limited. Most studies rely on validated instruments such as the FSLSM and perception scales, providing consistency but restricting methodological diversity. Samples remain mostly university-based and relatively small (50–150 participants), reducing external validity, especially for mobile contexts that serve broader populations.

RQ4. Overall, adaptive gamification produces positive effects on motivation, engagement, and performance, although these effects vary by learning style. Visual, kinesthetic, and active learners often benefit more from gamified designs, while reflective or less common profiles may show weaker responses. Mobile ecosystems may help mitigate these disparities by enabling multimodal interactions—touch, audio, augmented reality, and motion sensors—that align more flexibly with diverse cognitive and sensory preferences.

RQ5. Studies on gamification and learning styles present recurring methodological limitations, including small samples, context-specific implementations, superficial reward-based designs, and scarce longitudinal evaluations. The predominance of FSLSM also limits consideration of emotional, motivational, and personality factors that are central to deeper personalization. Research rarely examines adaptive gamification in mobile or ubiquitous learning settings, despite their growing relevance. Future studies should adopt more robust designs, include culturally diverse samples, and integrate learning analytics, AI-driven adaptivity, and mobile interaction patterns to advance personalized gamification models.

6 CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest to report regarding the present study.

7 AI USAGE DECLARATION

The authors declare that no generative artificial intelligence tools were used for writing, editing, or improving the text of this manuscript.

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9 APPENDIX A

Table A1. Matrix of learning styles, gamification types, and device used

No	Author	Learning Style Model	Gamification Type	Device
1	[35]	Implicit profiles	Robot-based gamification	Mobile
2	[24]	FSLSM/VARK profiles	Competitive and cooperative LMS gamification	Desktop
3	[46]	FSLSM	Adaptive gamification	Desktop
4	[22]	FSLSM	Adaptive serious game	Desktop
5	[37]	Cognitive style (FD/FI)	Gamified reading tasks	Desktop
6	[43]	GenderMag	Gamified interface evaluation	Desktop
7	[50]	Learning styles (moderator)	Gamified behavioral model (SEM)	Desktop
8	[33]	MI	Video game-based learning	Desktop
9	[34]	MI	Serious game	Desktop
10	[51]	MI	GBL simulation	VR/Desktop
11	[41]	Honey & Mumford	Teamwork gamification	Desktop
12	[28]	Kolb	Experiential gamification	Desktop
13	[47]	FSLSM	Adaptive hybrid gamification	Hybrid
14	[49]	VAK	Mobile gamification intention	Mobile
15	[45]	–	Gamified LMS practice	Desktop
16	[40]	Big Five	Gamified acceptance study	Desktop
17	[38]	Cognitive style	Gamified cognitive tasks	Desktop
18	[48]	Kolb	Gamified experiential learning	Desktop
19	[39]	VARK	Adaptive VARK gamification	Desktop
20	[32]	Kolb	Gamified learning tasks	Desktop
21	[52]	FSLSM	In-game adaptive system	Hybrid
22	[53]	FSLSM tendencies	Gamified LMS activity	Desktop
23	[23]	FSLSM	Gamified style detection	Hybrid
24	[42]	Learning styles (moderator)	Gamified smart-learning	Hybrid
25	[30]	Kolb	Interactive video gamification	Mobile
26	[36]	MI	Planetarium gamification	Mobile
27	[25]	FSLSM + Big Five	Adaptive vocabulary gamification	Mobile
28	[31]	Kolb	ALPRS adaptive gamification	Mobile
29	[27]	FSLSM + Bartle	Adaptive gamification themes	Mobile
30	[26]	Learning styles (moderator)	Gamified engagement model	Mobile
31	[44]	Kolb tendencies	Finance simulation gamification	Hybrid/VR-capable
32	[54]	Learning styles (implicit)	Wordwall gamification	Mobile
33	[55]	VARK tendencies	Gameful learning	Mobile/Hybrid
34	[56]	FSLSM	Adaptive gamified e-learning	Mobile

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