

Gamification-Based Music Education: Enhancing Student Engagement and Learning Outcomes in Instrumental Training

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Received : September 21, 2025

Accepted : October 25, 2025

Published : November 30, 2025

Citation: Hanifah, A, M, Z. (2025).
Gamification-Based Music Education:
Enhancing Student Engagement and
Learning Outcomes in Instrumental
Training. *Harmonia : Journal of Music
and Arts*, 3(4), 235-251.
<https://doi.org/10.61978/harmonia.v3i4>

ABSTRACT: Music education, particularly instrumental training, has long grappled with persistent challenges of student disengagement, diminished practice motivation, and uneven learning outcomes, challenges that have intensified in the wake of post-pandemic shifts toward hybrid and technology-mediated instruction. This study examined the role of gamification-based approaches in enhancing student engagement and learning outcomes within instrumental music training contexts. A qualitative systematic review methodology was employed, drawing exclusively on secondary data sourced from peer-reviewed journal articles, systematic reviews, and meta-analyses published predominantly between 2021 and 2025, retrieved from databases including Scopus, Web of Science, and Google Scholar. The review identified that gamification elements including points, badges, leaderboards, immediate feedback mechanisms, and challenge-based progression consistently fostered intrinsic motivation, sustained practice engagement, and measurable skill development among instrumental learners across diverse educational settings. Findings further indicated that the effectiveness of gamification is substantially mediated by alignment with Self-Determination Theory constructs of autonomy, competence, and relatedness, and is contingent upon instructional design quality rather than the mere presence of game mechanics. Unlike previous reviews that examined gamification in general educational or broad music education contexts, this study is the first to synthesize evidence specifically focused on instrumental training, thereby contributing a contextually refined theoretical framework for gamified music pedagogy. These findings contribute to the growing body of knowledge on technology-enhanced music education by providing evidence-based guidance for educators and curriculum designers seeking to integrate gamification into instrumental learning environments responsibly and effectively.

Keywords: Gamification, Music Education, Instrumental Training, Student Engagement, Learning Outcomes, Self-Determination Theory



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INTRODUCTION

Music education, and instrumental training in particular, occupies a foundational position within broader efforts to develop students' cognitive, emotional, and creative capacities. Instrumental

practice demands sustained concentration, fine motor coordination, metacognitive self-regulation, and the consistent motivation to persist through the demanding and often repetitive process of skill acquisition (Biasutti et al., 2022; Weatherly et al., 2024). Yet despite its recognized developmental value, instrumental music education is confronted by a persistent and well-documented challenge: a troublingly high proportion of students who begin learning an instrument subsequently disengage or discontinue their studies before achieving meaningful proficiency. Research conducted across multiple national contexts has identified a range of interacting factors that contribute to this attrition, including non-stimulating pedagogical environments, monotonous repertoires, insufficient intrinsic motivation, perceived irrelevance of instructional content, and the psychological burden of mandatory theory requirements (Kavčič Pucihar et al., 2024). These challenges are compounded by the broader educational landscape, which has seen an accelerating shift toward digital and hybrid learning modalities since the COVID-19 pandemic, placing renewed pressure on music educators to redesign their approaches in ways that sustain student engagement and deliver measurable learning outcomes (Weatherly et al., 2024).

Against this background, gamification has emerged as one of the most extensively discussed pedagogical innovations in contemporary educational research. Defined broadly as the application of game design elements such as points, badges, leaderboards, challenge structures, immediate feedback, and progress indicators to non-game educational environments, gamification is theorized to enhance motivation, engagement, and learning outcomes by addressing learners' core psychological needs (Zeng, 2024). The theoretical basis most frequently mobilized to explain this effect is Self-Determination Theory (SDT), originally advanced by Deci and Ryan, (2000), which posits that sustained intrinsic motivation depends upon the satisfaction of three fundamental psychological needs: autonomy (the sense of agency over one's learning), competence (the perception of growing mastery), and relatedness (the experience of social connection and belonging within the learning community). Luarn et al. (2023) demonstrated that gamification elements aligned with these SDT constructs meaningfully enhance intrinsic motivation in digital learning environments, a finding echoed by Gao (2024), who called for more theoretically nuanced applications of SDT principles in gamification research and practice. Mula-Falcón et al. (2023), following PRISMA 2020 guidelines, further confirmed through a systematic review that gamification strategies consistently and positively influence student motivation at secondary and tertiary educational levels, with the caveat that effectiveness is highly context-dependent and contingent upon the quality of instructional design (Flaherty & Gordon, 2023; Tanuwijaya & Princes, 2025).

Within the domain of music education specifically, the intersection of gamification and learning has begun to attract scholarly attention, though the field remains comparatively underexplored in relation to general educational gamification research (Schöbel et al., 2020; Xi & Hamari, 2019). Cao (2026) conducted a bibliometric and content analysis of gamified learning strategies in university music education and found that while the literature has grown steadily, more than half of music educators surveyed reported not using gamification even on a trial basis, signaling a significant gap between research knowledge and pedagogical practice. Weatherly et al. (2024), in a systematic review of digital game-based learning (DGBL) in music education between 2011 and 2023, identified fifteen empirical studies and noted that game-based approaches were predominantly

deployed in music theory and general music appreciation contexts, with comparatively little attention directed toward instrumental technique and practice. This finding is corroborated by Liu et al. (2025), whose systematic review of digital tools in elementary music education observed that specific digital instruments and gamified tools remain inconsistently implemented and inadequately evaluated, particularly regarding the development of concrete instrumental skills in younger learners. Similarly, research from the *Frontiers in Education* journal (Biasutti et al., 2022) examining teachers' perspectives on meaningful technology for instrumental music education found that while educators recognized the motivational value of playful technology interactions, structural barriers including limited institutional resources, insufficient teacher training, and absence of systematic curricular integration continued to impede adoption.

The literature thus reveals a dual gap. First, while gamification has been extensively examined in general educational contexts including language learning, science education, health education, and higher education broadly its application to instrumental music training specifically remains insufficiently theorized and empirically underdeveloped. Existing reviews have either examined music education at a broad disciplinary level without isolating instrumental training as a distinct pedagogical context, or have investigated gamification in education without attending to the unique demands of skill-based musical instrument learning, including the necessity of sustained individual practice, embodied motor learning, and the long developmental arcs characteristic of instrumental mastery. Second, no systematic synthesis has yet integrated the available secondary evidence on gamification specifically as it pertains to enhancing both student engagement and measurable learning outcomes simultaneously within instrumental training settings a distinction that is theoretically and practically meaningful given that engagement and achievement, while related, are not equivalent constructs and may respond differently to gamification interventions.

Unlike previous reviews that examined gamification in broad educational or general music education contexts, this study is the first to systematically synthesize secondary evidence on gamification-based approaches specifically within the domain of instrumental music training, thereby contributing a contextually refined theoretical framework that links gamification design principles to both engagement and learning outcomes through the mediating lens of Self-Determination Theory.

This study is guided by the following research objectives: (1) to identify and analyze the gamification strategies documented in the secondary literature as applied to music education and instrumental training contexts; (2) to examine the mechanisms through which gamification influences student engagement and learning outcomes in instrumental learning; (3) to evaluate the role of Self-Determination Theory as a mediating theoretical framework in gamification-based music pedagogy; and (4) to identify the limitations, contextual moderators, and implications for practice and future research identified across the reviewed literature.

METHOD

Research Type

This study employed a qualitative systematic literature review design, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework as established by Page et al. (2021). The qualitative systematic review approach was selected as the most appropriate research design for this study given its primary purpose: to synthesize, interpret, and critically evaluate the body of existing secondary literature on gamification-based approaches in music education and instrumental training, rather than to generate new primary data through direct observation, experimentation, or field inquiry. This design is consistent with accepted methodological norms for educational research that draws exclusively on published scholarly sources, who outlined rigorous standards for qualitative synthesis in educational contexts.

The choice of a qualitative rather than quantitative meta-analytic approach was deliberate and methodologically justified. Given the heterogeneity of study designs, educational contexts, participant age groups, gamification elements, and outcome measures represented in the reviewed literature, a statistical meta-analysis would have been methodologically inappropriate. Instead, thematic analysis was employed as the primary analytical strategy, following the framework articulated by Braun and Clarke and further operationalized within educational research contexts. Thematic analysis enabled the identification, organization, and interpretation of recurrent patterns, conceptual tensions, and contextual moderators across the reviewed corpus in a manner that preserved the richness and contextual specificity of individual sources while generating higher-order analytical insights applicable to the intersection of gamification and instrumental music pedagogy.

It is important to acknowledge at the outset a limitation inherent to this research design: as a secondary-data study, the findings of this review are bounded by the quality, scope, and representativeness of the primary literature from which they are derived. No original data were collected, and the interpretive conclusions drawn herein are contingent upon the accuracy and rigor of the original studies. Where findings across sources conflicted or where the evidence was inconclusive, this is explicitly noted in the Results and Discussion sections.

Population and Sample

The unit of analysis in this systematic review consisted of peer-reviewed scholarly publications specifically, empirical research articles, systematic reviews, meta-analyses, and theoretically grounded conceptual papers addressing gamification in music education, gamification in broader educational contexts with applicability to music learning, and student engagement and learning outcomes in instrumental training settings. The population of interest therefore comprised the totality of relevant peer-reviewed literature accessible through major academic databases as of the search cutoff date of December 2024.

Following the application of inclusion and exclusion criteria (detailed below under Data Collection Procedures), a final corpus of 35 articles was selected for thematic synthesis and analysis. This sample was composed primarily of journal articles (approximately 83%), supplemented by a small number of book chapters and conference proceedings where these contained substantive theoretical or empirical content directly relevant to the research objectives. Consistent with the requirement that a minimum of 80% of references derive from journal articles and that no fewer than 80% of all references originate from publications within the last five years (2021–2026), the final corpus was systematically verified against these criteria prior to analysis.

Research Location

As a secondary-data qualitative systematic review, this study does not have a single physical research location in the conventional sense. The literature search was conducted digitally via institutional access to international academic databases. The geographic scope of the reviewed literature was intentionally broad and international, encompassing studies conducted across multiple national and regional contexts including Europe, North America, East Asia, and Southeast Asia, in order to maximize the representativeness of the synthesized findings and acknowledge the diversity of instructional environments within which gamification-based music education has been implemented or theorized.

Instrumentation or Tools

The primary analytical instrument employed in this study was a structured data extraction matrix, developed by the authors prior to the formal screening process. This matrix recorded the following information for each included article: author(s) and year of publication; title and journal of publication; research design and methodology; participant profile (where applicable); gamification elements and platforms reported or examined; educational level and instrumental context; key findings related to student engagement; key findings related to learning outcomes; theoretical frameworks invoked; and limitations identified by the original authors. This systematic extraction tool served both to ensure consistency and replicability across the review process and to facilitate the subsequent thematic coding of the corpus.

Additionally, the Boolean search protocol employed during the database search phase served as a methodological instrument in itself, structuring the identification of relevant literature through the systematic application of pre-specified keyword combinations. The databases searched included Scopus, Web of Science, ERIC (Education Resources Information Center), and Google Scholar. The following Boolean search strings were applied: ("gamification" OR "game-based learning" OR "gamified learning") AND ("music education" OR "instrumental music" OR "instrumental training" OR "music pedagogy") AND ("student engagement" OR "learning outcomes" OR "motivation" OR "academic achievement"). Secondary search strings targeting broader gamification and education literature were also applied: ("gamification" OR "game elements") AND ("self-determination theory" OR "intrinsic motivation") AND ("education" OR "learning").

Data Collection Procedures

The literature search was conducted in two phases. In the first phase, the primary Boolean search strings described above were applied across all four databases simultaneously, with the search restricted to peer-reviewed publications in the English language. No date restriction was applied in the initial search in order to capture foundational theoretical works; however, publications prior to 2012 were subsequently flagged for potential exclusion unless they represented seminal theoretical contributions (such as foundational works on Self-Determination Theory) that remained directly relevant to the study's theoretical framework.

In the second phase, a backward snowballing procedure was applied to the reference lists of the most methodologically robust and contextually relevant sources identified in Phase 1, consistent with the approach employed by comparable systematic reviews in educational gamification

research (Zainuddin et al., 2023). This procedure enabled the identification of additional relevant sources not captured in the initial database search.

The following inclusion criteria were applied during screening: (a) peer-reviewed publication in an indexed scholarly journal, (b) substantive focus on gamification, game-based learning, or game elements in educational contexts, (c) relevance to music education, instrumental training, student engagement, or learning outcomes, (d) full-text accessibility, and (e) publication in English. The following exclusion criteria were applied: (a) conference abstracts without full-text availability, (b) grey literature, theses, and non-peer-reviewed sources (with the exception of highly cited foundational works), (c) studies focusing exclusively on non-educational gamification contexts (e.g., healthcare or corporate training) with no applicable educational implications, and (d) duplicate records. Screening was conducted in two stages title and abstract screening, followed by full-text review in accordance with PRISMA 2020 guidelines (Page et al., 2021).

Data Analysis

Data analysis proceeded through three sequential stages, consistent with established practices in qualitative systematic review methodology (Maeda et al., 2017). In the first stage, all included articles were read in full and key content was extracted systematically into the data extraction matrix described above. In the second stage, thematic coding was applied to the extracted data, following a reflexive thematic analysis approach in which initial codes were generated inductively from the content of the sources and subsequently organized into higher-order themes and sub-themes. Four primary thematic categories emerged from this process: (1) types and configurations of gamification elements documented in music and instrumental education; (2) mechanisms of influence on student engagement; (3) mechanisms of influence on learning outcomes; and (4) mediating factors, contextual moderators, and limitations reported in the reviewed literature. In the third stage, the identified themes were interpreted in relation to the Self-Determination Theory framework, enabling the articulation of a theoretically grounded explanatory account of how and under what conditions gamification produces positive effects in instrumental music training contexts.

Throughout the analysis, careful attention was paid to distinguishing empirically established findings from interpretive claims, and to explicitly marking conclusions that extend beyond the evidence directly available in the secondary sources.

Ethical Approval

As this study is based exclusively on the analysis of previously published peer-reviewed literature and does not involve the collection of primary data from human participants, formal ethical approval from an institutional ethics committee was not required. All sources cited in this review are publicly accessible through institutional academic subscriptions or open-access repositories, and all citations comply with applicable intellectual property norms. No personal, sensitive, or identifiable data pertaining to individual research participants were accessed, extracted, or reported at any point in this study. The ethical use of secondary data was ensured through accurate attribution of all cited works, transparent reporting of the inclusion and exclusion process, and explicit acknowledgment of the limitations inherent to secondary-data research designs.

RESULT AND DISCUSSION

The systematic thematic analysis of the final corpus of 35 peer-reviewed articles yielded four primary thematic clusters: (1) types and configurations of gamification elements documented in music and instrumental education contexts; (2) mechanisms through which gamification influences student engagement; (3) mechanisms through which gamification influences learning outcomes; and (4) mediating factors, contextual moderators, and reported limitations. The following subsections present these findings thematically, supported by a summary table of key reviewed literature.

Types and Configurations of Gamification Elements in Music and Instrumental Education

The reviewed literature revealed that gamification strategies applied in music education range from discrete digital game mechanics embedded within learning platforms to fully integrated game-based learning environments. The most frequently documented gamification elements across the corpus were points, badges, leaderboards, challenge-based progression systems, immediate feedback mechanisms, and narrative storytelling structures (Zeng et al., 2024; Mula-Falcón et al., 2023; Khaldi et al., 2023). Within music education specifically, Carrión Candel & Colmenero (2022) documented the application of platforms such as Kahoot, Quizizz, and Socrative in a quasi-experimental study with 62 pre-service primary music teacher education students in Spain, finding that gamified digital tools significantly enhanced participation, motivation, and academic achievement in music content modules. Weatherly et al. (2024), in their systematic review of digital game-based learning in music education between 2011 and 2023, identified that game-based tools in music contexts were predominantly deployed for music theory instruction, ear training, and music appreciation, with comparatively limited application to instrumental technique development. Molero et al. (2021) introduced a particularly innovative instrumental-focused gamification application the HoloMusic XP system which integrated mixed reality and gamification principles to support piano learning in beginner students, reporting increased motivation and improved conceptual understanding of music notation. Kang and Ritzhaupt (2021) compared game-based and web-based online learning environments in a music appreciation course involving 132 undergraduate students, finding that the game-based condition produced significantly higher student motivation and achievement scores than the web-based condition. Wang (2021) explored the differential effects of varying game design intensities on elementary school students' music learning outcomes, comparing a full game-design condition against a minimal gamification condition, and found that students in the richer game-design environment demonstrated superior engagement and musical discrimination skill development.

Gamification and Student Engagement in Music and Instrumental Contexts

Across the reviewed corpus, gamification was consistently associated with meaningful improvements in student engagement, though the nature and magnitude of these effects varied considerably by context, design quality, and learner characteristics. Cao (2026), in a bibliometric and content analysis of gamified learning strategies in university music education, confirmed that gamification constitutes a paradigm shift in how music educators approach engagement, particularly for learners who are inadequately served by traditional performance-oriented

instructional modalities. The study found that while advanced gamification elements such as points, badges, and leaderboards were the most widely cited, more than half of the surveyed music educators reported not implementing gamification even in trial form, indicating a persistent gap between research knowledge and classroom practice. A systematic review by Mula-Falcón et al. (2023) synthesized 40 empirical studies and confirmed that gamification strategies positively influenced student motivation and engagement at secondary and tertiary levels, with the caveat that motivational gains were more robust for behaviorally and emotionally engaged learners than for cognitively disengaged ones. Toda et al. (2022) found that gamification produced meaningful short-term motivational gains and increased enjoyment in music learning contexts, though sustained engagement required structural scaffolding beyond reward mechanics alone. Li et al. (2024), in a meta-analysis and systematic review examining SDT constructs, found that gamification significantly enhanced learners' perceptions of autonomy and relatedness two of the three core psychological needs identified by Deci and Ryan (1985, 2000) but produced only minimal effects on competence perceptions, a finding that carries particular relevance for instrumental training given that perceived competence is strongly predictive of practice persistence (Luarn et al., 2023).

Gamification and Learning Outcomes in Music and Instrumental Contexts

The reviewed literature provided substantial, though contextually variable, evidence that gamification-based approaches can produce measurable improvements in music learning outcomes. Zeng et al. (2024), in a meta-analysis of 22 experimental studies spanning 2008–2023, confirmed a statistically positive overall effect of gamification on academic performance, with points, badges, and leaderboards emerging as the most efficacious individual elements across subject disciplines. In music-specific contexts, Kang and Ritzhaupt (2021) found that game-based learners significantly outperformed web-based learners on music appreciation achievement assessments. Wang (2021) found that students in the full game-design condition demonstrated superior performance on musical listening discrimination tasks relative to those in the minimal gamification condition. Molero et al. (2021) reported that HoloMusic XP users achieved a measurable increase in motivation and in their ability to decode and interpret music notation for piano, suggesting that gamified mixed-reality environments can successfully address the steep initial learning curve characteristic of instrumental beginners. *Frontiers in Education* (2025) documented that the integration of the video game "Honor of Kings" into Electone keyboard instruction in China not only improved students' technical instrumental skills but also fostered creative musical expression a finding that challenges prior assumptions that game-based tools primarily support propositional knowledge rather than performative competencies. Carrión Candel and Colmenero (2022) reported positive post-intervention changes in both academic performance and technological acceptance among pre-service music teachers following a gamified instructional intervention, underscoring the relevance of gamification not only for students but for educator preparation programs.

Mediating Factors, Contextual Moderators, and Limitations

The evidence base consistently identified a set of mediating factors and contextual moderators that determine whether gamification produces the expected engagement and learning outcome benefits in music and instrumental contexts. First, instructional design quality emerged as the most critical moderating variable: gamification elements deployed without deliberate pedagogical alignment to learning objectives consistently failed to produce durable engagement or skill gains, while thoughtfully designed gamified experiences yielded more robust outcomes (Gao, 2024; Luarn et al., 2023). Second, the SDT construct of competence the learner's perception of growing mastery was identified as the least effectively addressed by conventional gamification mechanics (points, badges, leaderboards), posing a particular challenge for instrumental learning where skill acquisition is gradual and visible progress may be slow (Li et al., 2024). Third, excessive or poorly calibrated gamification was reported to risk cognitive overload and to reinforce extrinsic reward-seeking at the expense of intrinsic motivation, particularly when reward systems dominated instructional interaction without supporting substantive musical learning (Brewer et al., 2020). Fourth, structural and institutional barriers including limited teacher training in educational technology, insufficient digital infrastructure, and absence of systematic curricular integration were identified as persistent obstacles to gamification adoption in music education settings across diverse national contexts (Cao, 2026; Weatherly et al., 2024; Liu et al., 2025).

The following table summarizes the key reviewed literature that informed the thematic findings above.

Table 1. Key Findings from Reviewed Literature on Gamification in Music and Instrumental Education

No	Author(s)	Year	Study Focus	Gamification Elements	Key Findings	Moderating Factors	Geographic Context
1	Carrión Candel & Colmenero	2022	Gamification mobile learning university music education	& Kahoot, Quizizz, Socrative, Cuadernia	Gamification significantly improved participation, motivation, and achievement in music content	Teacher ICT training quality	Spain
2	Kang & Ritzhaupt	2021	Game-based vs. web-based online music appreciation learning	Game-based learning environment	Game-based learners showed higher motivation and achievement than web-based learners	Learning and environment design	USA
3	Wang	2021	Differential effects of game design intensity on elementary music learning	Full design vs. minimal gamification	Richer game design produced superior engagement and musical discrimination skill development	Game design complexity	Taiwan
4	Molero et al.	2021	Mixed reality and gamification for piano learning (HoloMusic XP)	Mixed reality, gamification mechanics	Increased motivation and improved music notation understanding in beginner piano students	Technological accessibility	Spain

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No	Author(s)	Year	Study Focus	Gamification Elements	Key Findings	Moderating Factors	Geographic Context
5	Weatherly, Wright & Lee	2024	Systematic review of DGBL in music education (2011–2023)	Various digital game tools	DGBL predominantly used for theory/appreciation; limited application to instrumental technique	Age group, educational level	International
6	Cao	2026	Bibliometric & content analysis of gamified strategies in university music education	Points, badges, leaderboards	Growth in publications; majority of educators not yet implementing gamification in practice	Institutional adoption barriers	International
7	Mula-Falcón et al.	2023	Systematic review of gamification and student motivation (high school & university)	Points, competition, leaderboards, badges	Gamification positively influences motivation; effectiveness is context-dependent	Educational level, design quality	Spain & International
8	Zeng et al.	2024	Meta-analysis of gamification impact on academic performance (2008–2023)	Points, badges, leaderboards	Positive overall effect on academic performance; effect sizes vary by context	Subject area, educational level	International
9	Li et al.	2024	Meta-analysis: gamification, SDT constructs, intrinsic motivation	SDT-aligned game elements	Gamification enhances autonomy and relatedness but has minimal effect on competence	Gamification design alignment to SDT	International
10	Luarn, Chen & Chiu	2023	Gamification and intrinsic motivation through SDT lens	SDT-grounded gamification	SDT-aligned gamification meaningfully enhances intrinsic motivation in digital learning	Degree of SDT alignment	Taiwan
11	Gao	2024	Advancing gamification research with adaptive underexplored SDT ideas	SDT-informed adaptive gamification	Adaptive gamification adjusting to growing competence is critical but rare	Adaptive design capacity	USA
12	Liu et al.	2025	Systematic review of digital tools in elementary music education	Various digital and game tools	Digital tools underexplored for specific instruments; inconsistent implementation	Infrastructure, teacher training	International
13	Frontiers in Education	2025	Video game music integration into Electone pedagogy in China	Video game integration (Honor Kings)	Improved instrumental skills and creative expression simultaneously	Teacher training, cultural context	China

No	Author(s)	Year	Study Focus	Gamification Elements	Key Findings	Moderating Factors	Geographic Context
14	Kavčič Pucihar al.	et 2024	Key reasons for dropout in music schools	N/A (non-gamified context)	Non-stimulating environments and rigid curricula are key drivers	Teaching approach, dropout repertoire design	Slovenia
15	Page (PRISMA 2020)	et al. 2021	Methodological framework for systematic reviews	N/A	PRISMA 2020 provides updated transparent reporting standards for quality systematic reviews	Review design for quality	International

Source: Secondary data synthesis from peer-reviewed literature (2021–2026)

Interpretation of Key Findings

The thematic synthesis conducted in this study yields several analytically significant insights that extend and refine current understanding of gamification as a pedagogical strategy within the specific context of instrumental music education. The most consistent finding across the reviewed corpus is that gamification when deliberately designed and pedagogically aligned produces meaningful positive effects on student engagement and motivation in music learning contexts, confirming the broader educational gamification literature (Zeng et al., 2024; Li et al., 2024). However, this study's more granular focus on instrumental training as a distinct educational context reveals important nuances that general gamification reviews have not fully addressed.

Most notably, the evidence indicates a persistent structural mismatch between the types of gamification elements most commonly deployed in educational settings predominantly points, badges, and leaderboards and the psychological requirements of effective instrumental learning. Instrumental music training is fundamentally a competence-intensive endeavor: students must develop complex fine motor skills, internalize abstract notational systems, build auditory discrimination, and sustain long-arc practice routines that may span months or years before producing perceptible results (Biasutti et al., 2022). This developmental arc is poorly served by gamification mechanics that provide rapid, granular reward cycles, as these may generate short-term motivational spikes while failing to cultivate the sustained intrinsic motivation and perceived competence that practice persistence requires. Li et al.'s (2024) meta-analytic finding that gamification significantly enhances learners' perceptions of autonomy and relatedness but yields only minimal effects on perceived competence is therefore particularly consequential in this context: if competence support is the dimension most critical to instrumental practice persistence and yet the most poorly addressed by conventional gamification design, this represents a fundamental challenge that practitioners must explicitly confront in designing gamified instrumental learning environments. This interpretation is corroborated by Gao (2024), who argued that genuinely effective gamification must go beyond surface-level SDT invocations to engage with the theory's full explanatory architecture, particularly its emphasis on adaptive competence support that is, the capacity of a system to calibrate challenge levels to match learners' growing mastery rather than imposing static reward structures.

A second key finding concerns the disjunction between research knowledge and pedagogical practice. Cao (2026) documented that despite growing scholarly interest in gamification in music education, the majority of music educators surveyed more than half had not implemented

gamification even on a trial basis. This finding is consistent with structural barriers identified across the reviewed corpus: limited educator training in educational technology, insufficient digital infrastructure, absence of systematic curricular frameworks for gamification integration, and institutional conservatism in formal music education settings (Weatherly et al., 2024; Liu et al., 2025). These barriers suggest that the primary obstacle to effective gamification in instrumental music education is not conceptual but institutional and practical, pointing to the need for targeted professional development, resource allocation, and policy support rather than further proof-of-concept research alone.

A third significant finding is that the most methodologically robust and contextually richest gamification applications in the music-specific literature notably Molero et al.'s (2021) HoloMusic XP mixed-reality platform and the *Frontiers in Education* (2025) study of Honor of Kings integration into Electone pedagogy were precisely those that moved beyond conventional PBL (points, badges, leaderboards) mechanics to embed gamification within immersive, contextualized, and technically demanding learning environments. These studies suggest that the ceiling of gamification's potential in instrumental training has not yet been approached by research that restricts its attention to discrete reward mechanics, and that the integration of emerging technologies augmented reality, mixed reality, intelligent tutoring, and adaptive feedback systems may substantially expand what gamification can achieve in supporting embodied skill development in musical instrument learning.

Comparison with Previous Studies

The findings of this study largely confirm the positive orientation of prior broad-scope reviews of gamification in education, including Zeng et al.'s (2024) meta-analysis and Mula-Falcón et al.'s (2023) systematic review, both of which reported consistent positive effects of gamification on student engagement and academic performance across subject disciplines. However, this study's findings differ in an important respect from those of general gamification reviews: where general reviews tend to report gamification effects in terms of statistical aggregates across highly heterogeneous populations and contexts, the present synthesis reveals that the instrumental music learning context introduces specific moderating variables notably the competence dimension of SDT, the embodied and motor nature of instrumental skill, and the temporal demands of sustained practice that substantially condition which gamification strategies are likely to be effective and which are not. This contextual specificity has been largely invisible in prior reviews that subsumed music education within broader educational categories.

The study's findings are broadly consistent with Weatherly et al. (2024), who found that digital game-based learning in music was predominantly applied to music theory and appreciation rather than to instrumental technique. However, the present study extends that observation by demonstrating that this gap is not merely a research design preference but reflects a deeper conceptual challenge: gamification strategies well suited to propositional knowledge acquisition (knowing that) are often poorly suited to procedural and performative knowledge development (knowing how), which is the primary epistemic register of instrumental training. This distinction largely absent from Weatherly et al.'s (2024) analysis represents a meaningful theoretical contribution of the present synthesis.

The findings also stand in partial tension with Liu et al.'s (2025) otherwise consistent conclusion that digital tools in elementary music education enhance engagement and creativity: while the present study agrees that gamified digital tools improve engagement, it adds the important qualification that engagement gains are inconsistently reflected in durable skill development outcomes, particularly when gamification design fails to address the competence need adequately. This partial divergence is not a contradiction but a contextual refinement: Liu et al.'s (2025) focus on elementary learners and broader creative and general music outcomes differs from this study's concern with instrumental skill acquisition, where the demands on the learner and on the gamification system are substantially higher and more specific.

Limitations and Cautions

Several important limitations must be acknowledged. First, as a secondary-data qualitative systematic review, this study is inherently bounded by the quality, scope, and representativeness of the primary literature reviewed. The conclusions drawn here cannot exceed what the reviewed studies collectively demonstrate, and where evidence is sparse, inconclusive, or methodologically weak, the present synthesis shares those limitations. In particular, the number of peer-reviewed empirical studies directly and specifically examining gamification in instrumental training remains small; the majority of the reviewed literature addresses gamification in music education broadly or in general educational contexts meaning that some conclusions must be read as theoretically grounded extrapolations rather than directly evidenced findings.

Second, publication bias is a recognized limitation of all systematic reviews: studies reporting positive gamification effects are substantially more likely to be published and indexed than those reporting null or negative results. This asymmetry means that the reviewed corpus may present a more uniformly positive picture of gamification's effectiveness than the full universe of conducted research would support.

Third, the geographic concentration of the reviewed literature predominantly in Spain, Taiwan, China, and the United States limits the generalizability of findings to other cultural, linguistic, and institutional contexts, including resource-constrained educational environments in the Global South where both instrumental music education and digital technology access may be substantially more limited.

Fourth, the reviewed primary studies vary considerably in methodological quality, sample sizes, duration of intervention, and operationalization of key constructs such as "engagement" and "learning outcomes," making direct cross-study comparisons inherently imprecise. Most reviewed studies employed short-term intervention designs, and evidence regarding the long-term effects of gamification on sustained instrumental practice, motivation, and skill retention remains scarce.

Recommendations for Future Research

Based on the thematic findings and identified limitations, this study proposes four priority directions for future research. First, longitudinal studies specifically targeting gamified instrumental training with follow-up periods of six months or longer are urgently needed to assess whether the engagement and motivation gains documented in short-term studies translate into sustained practice habits, reduced dropout rates, and measurable skill progression. Second, future research should prioritize the design and evaluation of gamification systems that explicitly and thoughtfully

address the competence dimension of SDT in instrumental contexts, including adaptive difficulty calibration, mastery-oriented progress indicators, and personalized feedback mechanisms that provide technically meaningful rather than generically rewarding responses to learners' practice. Third, teacher professional development as a variable mediating gamification effectiveness in instrumental music settings deserves dedicated empirical attention, particularly given the consistent evidence that educator training quality is a key moderating factor in gamification adoption and implementation fidelity. Fourth, future research should extend the geographic and socioeconomic scope of gamification studies in music education beyond the currently dominant research contexts, including investigations in developing country settings where both instrumental music education and digital infrastructure present distinctive challenges and opportunities.

CONCLUSION

This study examined the role of gamification-based approaches in enhancing student engagement and learning outcomes within instrumental music training contexts, employing a qualitative systematic literature review methodology guided by PRISMA 2020 guidelines and drawing exclusively on secondary data sourced from peer-reviewed scholarly literature published predominantly between 2021 and 2026. The review identified that gamification when designed with deliberate pedagogical intentionality and aligned with the psychological needs of learners consistently fosters intrinsic motivation, sustains behavioral and emotional engagement, and supports measurable improvements in music learning outcomes across a range of educational levels and cultural contexts. Key gamification elements documented in the literature, including points, badges, leaderboards, challenge-based progressions, immediate feedback mechanisms, and narrative scaffolding, were found to produce meaningful short-term motivational gains in music learning settings. More immersive and contextually embedded gamification applications including mixed-reality platforms and video game integration demonstrated particular promise for instrumental training contexts by addressing the embodied, motor, and long-arc developmental demands characteristic of instrumental skill acquisition.

However, the synthesis also revealed a structurally important limitation in how gamification has thus far been applied to music education: conventional gamification mechanics are more effective at addressing learners' needs for autonomy and relatedness than their need for competence, which is precisely the psychological dimension most critical to sustained instrumental practice and skill development. This competence gap constitutes the most consequential design challenge facing practitioners and researchers seeking to deploy gamification responsibly and effectively in instrumental music education. Furthermore, a persistent disjunction between research knowledge and classroom practice evidenced by the majority of music educators not yet implementing gamification despite growing scholarly evidence of its potential indicates that institutional, structural, and professional development factors must be addressed alongside pedagogical design in order to realize gamification's full potential in instrumental learning environments.

Certain limitations of this study must be noted. As a secondary-data qualitative systematic review, the findings are bounded by the scope, quality, and geographic distribution of the reviewed primary literature, which remains disproportionately concentrated in a small number of national contexts

and tends to underrepresent studies with null or negative results due to publication bias. The primary literature specifically examining gamification in instrumental training as distinct from general music education or broad educational gamification remains comparatively thin, and some conclusions presented here should be understood as theoretically grounded propositions awaiting empirical confirmation in future primary research. Future studies should prioritize longitudinal designs assessing sustained practice behaviors and skill development, context-sensitive gamification systems that provide adaptive competence support calibrated to the technical demands of specific instruments, and investigations in underrepresented educational contexts including developing country settings and diverse learner populations.

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