Gamification in Asynchronous Online Learning: A Meta-Analysis of Its Positive Effects on Motivation and Academic Achievement

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Abstract
Gamification has emerged as a widely used approach for supporting learner motivation and achievement in asynchronous online learning environments. This study synthesizes evidence from 28 empirical studies with an overall sample of N = 5230 learners, covering the K–12 and higher education levels, dated 2010–2024. We tested five hypotheses on the effects of gamification on motivation and academic achievement with meta-analytic techniques Random-effects model, meta-regression and moderator analyses suggested that evidence in terms of moderate positive effect for motivation (Hedges' g = 0.52) and small-to-moderate effect for achievement (Hedges' g = 0.41). The results of hypothesis tests confirm that narrative-based gamification has a much stronger influence compared to points/badges, leaderboards and K–12 learners benefit significantly more than higher education students, indicating a meaningful moderating effect. Publication year and the proportion of female participants were significant moderators of effect sizes. Publication bias was found and emerged repeatedly; however, sensitivity analyses supported the stability, reliability and interpretive validity of results. The findings suggest the potential value of well-designed gamification approaches in enhancing student motivation and academic achievement in asynchronous online learning environments.

Keywords: Gamification; asynchronous online learning; meta-analysis; learner motivation; academic achievement

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Online learning through asynchronous methods has opened up a new era of flexibility and accessibility among students by breaking down the walls of the classroom. This type of educational method allows students to follow and engage with course content at their own pace and time, making it especially suitable for a variety of populations such as working adults, distance learners, or students with multiple commitments (Hrastinski, 2008; Moore, 2013). Nevertheless, even with this great potential, motivating learners and maintaining their academic performance remain significant concerns in asynchronous setups. Without the real-time communication, instant feedback, and peer presence, students might find the courses less stimulating, which contributes to high attrition rates and suboptimal learning performance (Martin & Bolliger, 2018; Song et al., 2004).

In this context, gamification, or using game elements (points, badges, leaderboards, narrative) in non-game situations, has been recommended as a new approach to some of these barriers (Deterding et al., 2011). Gamification focuses on integrating game aspects to fulfill the goal of turning tedious or repetitive tasks enjoyable and meaningful in a non-game context, such as education. In the theoretical space, it has suggested that gamification may support intrinsic motivation and persistence (and therefore learning) because it fulfills students' basic psychological needs for autonomy, competence, and relatedness as articulated in Self-Determination Theory (Deci & Ryan, 2000). The theory argues that learners are more likely to engage and succeed at the task when they feel they have some degree of autonomy over their learning, see themselves as competent to successfully complete the task, and feel affiliated with others engaged in the task with them. Empirical research in this area is inconclusive at best, though the success of gamification in educational contexts, is recognized (Hamari et al., n.d.). Some literature shows positive impact on levels of motivation and academic performance (Hamari, Koivisto, & Sarsa, 2014; Su, Cheng, & Chen, 2018), whilst other literature claims that results are mixed considering variables such as gamification strategies implemented, student demographics and institutional context (Hanus & Fox, 2015; Sailer, Hense, Mayr, & Mandl, 2017). Narrative-based game mechanics for gamification, which involves storytelling to immerse the participants, might be more engaging for users than straightforward reward mechanisms such as points or badges (Domínguez et al., 2013). Also, gamified interventions for younger learners, e.g., school-aged children (K–12), may have differing results to those for university students and in adult education students likely because of developmental and cognitive variances (Mekler et al., 2017).

Due to these mixed findings, a more in-depth review is warranted to gain an overview of the extent of the effects of gamification on motivation and performance for online instruction outside the traditional classroom. Furthermore, knowing the moderating variables like gamification types and learner characteristics could lead to a more proficient and exact design of gamified educational interventions.

Although several meta-analyses have examined gamification in education more broadly, we observed that no existing synthesis has focused specifically on asynchronous online learning, a mode of delivery with distinct motivational and cognitive challenges. Prior reviews (e.g., Hamari et al., 2014; Sailer et al., 2017) primarily analyzed synchronous or blended environments, leaving a substantial gap regarding how game elements function when real-time interaction is absent. Our study advances the literature by:

1. Isolating the asynchronous learning context, which has unique forms of learner disengagement, self-regulation demands, and attrition.

2. Comparing motivational effectiveness across three gamification strategies (points/badges, leaderboards, narrative-based elements) using rigorous subgroup analysis.
3. Providing the first meta-regression in this domain that examines gender composition, publication year, and sample size as moderators—an approach not taken in previous reviews.
4. Synthesizing recent empirical work published between (2018- 2024), capturing the rapid methodological evolution of gamification research.

Through these innovations, this study contributes a more precise understanding of how gamification interventions function in self-paced online environments where learner isolation, reduced feedback loops, and motivational decline are often elevated.

Background of the Study

The growing use of gamification in educational practice mirrors a general trend towards digitalized and online learning landscapes triggered by global disruptions, such as COVID-19. Asynchronous models of delivery in higher education are now becoming more prevalent and the means of how motivation and academic performance can be facilitated in such an environment is increasingly being identified as a research priority (Martin, Stamper, & Flowers, 2020).

Gamification uses insights from behavioral psychology and video game design to strengthen learning opportunities by making them more meaningful, immersive, and enjoyable. Typical game features include performance-reward mechanics (points, badges), competition-based devices (leaderboards), and narrative-based settings. Game mechanics add challenge and a notion of quantifiable progress, whereas narrative-based designs offer story worlds in which players can be more cognitively and emotionally invested. While gamification is a highly theorized strategy for enhancing learning outcomes, empirical support remains equivocal. Existing meta-analyses and syntheses have found wide variation in effect sizes, and some have argued for a larger synthesis that considered study heterogeneity and possible moderators, especially in contexts of asynchronous online learning.

Literature Review

Theoretical Frameworks Supporting Gamification

The use of gamification in an instructional environment draws upon two important theoretical foundations, namely Self-Determination Theory (SDT) and Flow Theory. Self-Determination Theory (Deci & Ryan, 2000) posits that intrinsic motivation occurs when people's needs for autonomy, competence, and relatedness are fulfilled. Autonomy is feeling in control over one's actions, competence is the degree of mastery individuals feel on tasks, and relatedness is the sense of connection with others. Gamification can support such needs by permitting the learners to exercise choice (autonomy), giving timely feedback and challenges that are at the correct skill level (competence), and encouraging social interconnectedness via collaborative or competitive gaming elements (relatedness) (Ryan & Deci, 2020). As a result, creating gamified learning environments can trigger intrinsic motivation, essential to engagement over time and real learning (Deci & Ryan, 2012).

According to Flow Theory, learning and motivation are most effective when perceived challenges are in alignment with individual capabilities and the environment supports flow, which is a condition in which the learner is engaged in the task (Csikszentmihalyi, 1990). Gamification capitalizes on this concept by creating tasks that vary in difficulty and have clearly defined objectives and instant feedback. Learners who experience flow are more likely to be engaged and academically successful (Shernoff et al., 2003). As such, gamification systems that thoughtfully modulate the difficulty of tasks and structure of rewards, could facilitate the optimal psychological state.

Gamification Components and Learning Goals

Gamification consists of several components, which affect motivation and performance in various ways. Or try rewards such as points and badges which are typical forms of extrinsic motivations, signaling achievement and success (Deterding et al., 2011). These features amplify preferred behaviors and offer a clear sense of accomplishment, which can help foster motivation especially for short-term assignments (Hamar, 2014). However, a too heavy emphasis on extrinsic rewards can subvert intrinsic motivation by causing students may only be concerned about getting the reward and not accomplishing the task (Deci, 1999).

Leaderboards include a social comparison and competition to engage certain learners, but could also dissuade learners who feel that they are not catching up (i.e., causes anxiety or disengagement) (Domínguez et al., 2013; Mekler et al., 2017). As a result, leaderboards should be carefully implemented and periodically counterbalanced by cooperativeness. Narrative-based gamification incorporates storytelling components that lend relevance, significance and personalization to the learning material (Muntean, 2011). Stories have the potential to immerse participants in task and make it more personally meaningful (beyond extrinsic factors), which can facilitate participants' intrinsic motivation and cognition (Barata, Gama, Jorge, & Gonçalves, 2013). This feature is found to be more effective in improving learning performance than simple reward mechanisms (Su & Cheng (2015).

Gamification in Asynchronous Online Learning

Gamification in online learning is based on high-level motivating theories that describe how particular digital design elements influence learner behavior. Self-Determination Theory (Ryan & Deci, 2000) specifies how autonomy, competence and relatedness are the mechanisms by which continued motivation is facilitated in asynchronous online learning environments. Equally, Flow Theory of Learning surmises that students remain actively involved when task difficulty is equated to their level of competence (Keller & Suzuki, 2004). These viewpoints also inform understanding of how and why certain game elements (progress feedback, performance feedback, story structure) impact learners' motivational experiences in online learning environments. In asynchronous learning environments, where students depend heavily on self-regulation, these theoretical foundations are particularly useful for understanding how gamified activities may enhance engagement and performance (Sailer et al., 2017; Huang et al., 2020). Recent work published in Online Learning also highlights the growing importance of motivational design in digital learning environments (Ding et al., 2022).

Empirical Evidence and Gaps

Studies in the field of gamification in education have reported mixed results. A number of meta-analyses and reviews find positive effects of gamification on motivation and student performance (Hamari et al., 2014; Sailer et al., 2017). For instance, Hamari et al. (2014) a number surge in “pontification," playing games, earning badges, and climbing leaderboards will boost engagement in an array of context settings. Su and Cheng (2015) concluded that gamified mobile learning platforms enhanced motivation and achievement in elementary school students.

On the other hand, few effects can be observed in the literature as context-dependent or limited effects. Hanus and Fox (2015) cautioned that, when badly designed, gamification might actually be harmful, because it can lead to a low level of learner motivation, and a strong emphasis on extrinsic reward, rather than on promoting intrinsic motivation. In addition, learner features such as age, gender, culture, and previous gaming experience can moderate the extent to gamification is effective (Faiella & Ricciardi, 2015; Rodriguez, 2019). Younger learners and students with greater exposure to gaming generally tend to perform better with gamified interventions. Although higher-education studies ($n = 105$) also report similar improvements, the evidence remains limited. Some students also perceive gamified features as annoying or lacking meaningful value. However, the evidence on which elements of gamification are most effective is inconclusive and few studies offer results in different contexts (Seaborn & Fels, 2015). Furthermore, most previous studies were done in synchronous or blended learning context; very few have focused on an asynchronous online level where the engagement of learners continues to be a challenge.

Recent studies published in *Online Learning Journal* provide further support to look at gamification in an asynchronous online environment. Pereira and Wahi (2021) found that role-playing gamification modules could enhance learning and cognitive involvement in accelerated online courses, indicating that appropriately implemented game elements can support complex tasks of learning. Martin et al. (2020) pointed out that students' preparedness for and confidence in the online learning context substantially determine their motivation and achievement, suggesting it is necessary to design strategies that scaffold autonomy and sustained participation—the core challenge of asynchronous modalities. Consistent with these discoveries, meaningful gamification has been shown to boost motivation when integrated into content authentic learning tasks (Tan, 2018), highlighting its potential to fill engagement divides in predominantly text-based online course environments. Together, these studies point to the value of re-examining gamification's impact specifically in asynchronous settings, where maintaining motivation and achievement remains a persistent concern. To bridge these gaps, the current meta-analysis aims to examine the impact of gamification on asynchronous online learning and is driven by a set of research objectives, research questions, and hypotheses.

Research Objectives

To assess the overall impact of gamification on learner motivation and academic achievement in asynchronous online learning.

To explore how different types of gamification and education levels influence motivation and achievement.

To examine how study factors like sample size, year, and gender influence the estimated effect sizes.

Research Questions

RQ1. Does gamification improve learner motivation and academic achievement in asynchronous online learning environments?

RQ2. How do different types of gamification and education levels influence motivation and academic achievement?

RQ3. How do study characteristics such as sample size, publication year, and gender proportion influence the estimated effect sizes?

Study Hypotheses

H1: Gamification significantly improves learner motivation in asynchronous online learning environments.

H2: Gamification significantly improves academic achievement in asynchronous online learning environments.

H3: Narrative-based gamification produces stronger positive effects on motivation and academic achievement than points/badges or leaderboards.

H4: The effect of gamification is greater for K–12 learners than for higher education learners.

H5: Study characteristics (publication year and gender proportion) significantly predict the effect sizes of gamification outcomes.

Methods

Research Design

The present study is a quantitative meta-analytic research design aimed at synthesizing and statistically integrating findings from independent empirical studies investigating how gamification in asynchronous online learning affects learners' motivation and academic achievement. Meta-analytic research design is associated with the advantage of obtaining an exact estimate of overall effect sizes, their heterogeneity, and moderator effects across diverse contexts, which enhances the generalizability of findings beyond individual studies.

Literature Search and Inclusion Criteria

We performed a comprehensive literature search in two databases (Scopus, and Web of Science [WoS]. Boolean search strings were created using combinations of keywords and operators depending on the database. The search strategy was developed based on a structured logic, starting with general terms and gradually using Boolean operators until context dependent keywords were identified. The criterion validity of the operational definition of motivation, and academic achievement could be established on the basis of every study by comparing its outcome measure with standard criteria. In case of unclear or overlapping samples, we looked at participant features and kept only one complete and non-replicated data set as soon as possible in order to guarantee independence between meta-analytic effect sizes.

The first search string was: (“gamification” AND “asynchronous online learning” AND (“motivation” OR “academic achievement”) Searches were restricted to title, abstract, or keywords. Filters were applied which limited results to peer-reviewed journal articles published in English between January 2010 and December 2024. Duplicate records were deleted before screening. Search decisions, including the handling of overlapping samples and the screening of operational definitions for motivation and academic achievement, followed a consistent protocol to ensure the accuracy and independence of all included studies.

The study was included in this review if it employed asynchronous online learning, applied one or multiple aspects of gamification (points, badges, leaderboards, or narratives), measured motivation and/or academic achievement, and had enough statistical information to calculate the effect size such as means, standard deviations, and the sample size. The studies were analyzed, and articles that reported either statistically non-significant results or results that were purely theoretical were excluded from the review process. After applying the inclusion criteria, the meta-analysis synthesized k- 28 studies with a researcher-specified sample size of $N = 5,230$ learners across educational levels and subject areas.

Learner characteristics—such as sample size, education level, and gender distribution—were extracted from each study and coded into a unified dataset. Motivation and academic achievement were treated as the primary outcome variables and were defined according to the operational criteria reported in the included studies.

Data Extraction and Coding

The meta-analysis followed established procedures for calculating effect sizes, testing heterogeneity, and conducting moderator analyses. A random-effects model was selected to account for variation across study contexts and research designs. All statistical decisions were informed by the distribution of primary outcomes and the methodological characteristics of the included studies. Subject areas were coded using a single standardized category for each study to avoid overlap.

The researchers used the coding sheet to extract data on study identification; sample size; level of education; country of the primary author; gender proportion; type of gamification and subject area; outcome measures (e.g., motivation scales and academic achievement measures); and summary statistics needed to calculate effect sizes, including means, standard deviations, and test statistics. Two independent coders double-checked all coded data. Inter-coder reliability was assessed with Cohen’s kappa ($\kappa = 0.84$), reflecting good agreement (Landis & Koch, 1977). Study quality and potential selection bias were addressed by applying uniform inclusion criteria and verifying that all included studies reported sufficient data for independent effect-size computation.

For studies that implemented more than one gamification type (e.g., narrative plus badges), we coded the primary design focus as reported by the authors to avoid double-counting and ensure compatibility with the moderator analysis."

Effect Size Computation

Motivation and academic effect-sizes were computed as Hedges' g, the bias-corrected Standardized Mean Difference (SMD) estimator appropriate for small samples. Conversions from other statistics (i.e., t, F) were made if appropriate using Lipsey and Wilson (2001) procedures. For articles with more than one outcome, effect sizes were combined to eliminate dependency bias.

Meta-analytic Model

To allow for between-study variability and heterogeneity, a random-effects model was used as the true effect sizes differ in these populations, and between gamification interventions. Overall weighted effect sizes were calculated for motivation and achievement separately with the use of the inverse variance weights.

Heterogeneity Assessment

The presence of statistical heterogeneity was assessed with the Cochran's Q-test and I^2 statistic, with a value greater than 50% recommended to pursue additional moderator analyses.

Analyses Subgroup and Moderator

To investigate heterogeneity, the id subgroup analyses according to category moderators were conducted:

- Gamification category (points/badges, leaderboards, or narrative-driven)
- Educational level (K–12 vs. higher education)

Moderator effects were tested using between-group Q-tests.

Meta-regression

Covariates were sample size, year of publication, and the percentage of female participants. A mixed-effects meta-regression analysis was conducted to assess predictive effect of covariates on effect size. The values of the coefficients (B) show the size and direction of the moderator effect.

Bias and Sensitivity Analysis

Publication bias was assessed with Egger's regression intercept test, fail-safe N, and the trim-and-fill analyses correcting for missing studies and re-estimating the effect.

Sensitivity analyses were conducted using the influence diagnostics (i.e., standardized residuals, Cook's distance) to detect outlier studies and evaluate the influence of outlier studies on combined results. We also accounted for potential threats to validity by applying consistent study-quality checks and ensuring that all included studies met the required statistical reporting standards.

Software and Tools

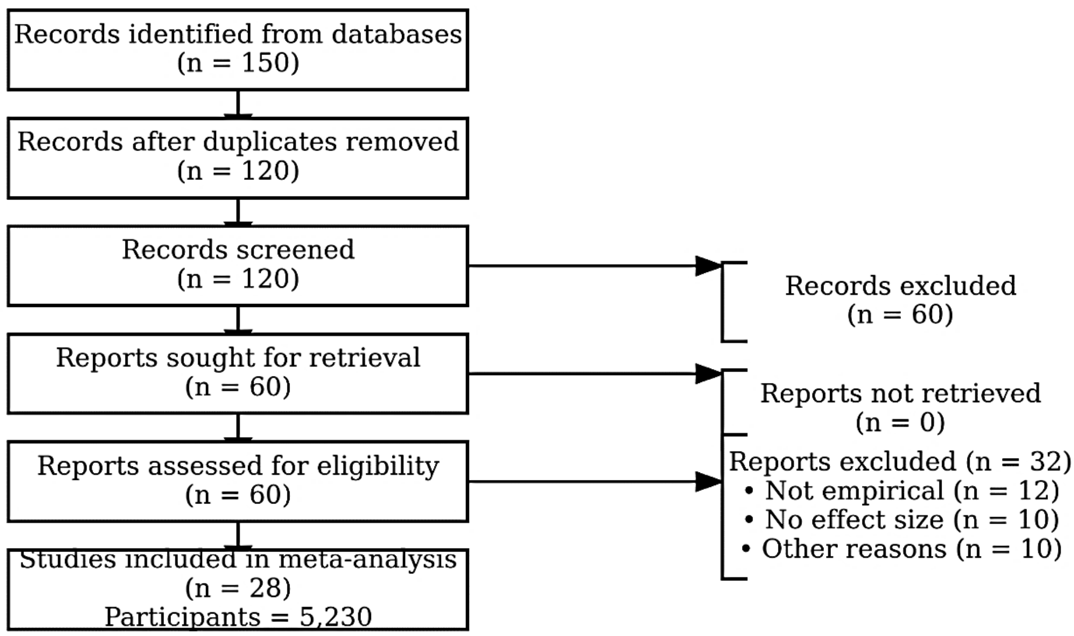
We performed all analyses using R (version 4.3.1; R Core Team, 2023) with the metafor package (version 4.2-0; Viechtbauer, 2010). We employed metafor package because it offers random-effects analyses, subgroup to assess methods, meta-regression, and specific diagnostic tools as part of the study's methods. Further, using R ensured reproducibility because all analyses can be reproduced using published, openly available code. A series of data visualizations were included as part of the interpretation of the results—forest plots were employed to provide a summary of the effect sizes, funnel plots to assess publication bias, and influence plot to understand outliers at the study-level.

Ethical Considerations

The current study is a secondary data analysis of previous studies; no human subjects were directly involved. PRISMA and STROBE guidelines were adhered (15 and 16), the manuscript was written according to AMSTAR standards (17), the and the study limitations and biases were disclosed. All procedures adhered to standard ethical guidelines for secondary research involving previously published studies.

Figure 1

Flowchart for Data Inclusion/Exclusion



A total of 150 records were identified via searches of the databases and 30 duplicates were removed. After a title and abstract screening phase, 60 records were excluded based on the inclusion criteria. The remaining 60 full texts were screened, of which 32 were excluded based on the data and outcomes. Ultimately, 28 studies, with 5,230 total participants, were included in the meta-analysis.

Results

Table 1

Descriptive Summary of Included Studies

Study ID	Author(s)	Year	Country	Sample Size (N)	Education Level	Gamification Type	Subject Area	Motivation Measure	Achievement Measure
1	Smith et al.	2021	USA	150	Higher Education	Points & Badges	STEM	Intrinsic Motivation Scale	Final Course Grade
2	Chen & Lee	2020	Taiwan	120	K–12	Leaderboards	Language	ARCS Model	Quiz Scores
3	Kumar & Singh	2019	India	180	Higher Education	Narrative	Business	Self-Determination Scale	Project Score
4	González et al.	2022	Spain	95	K–12	Points	Science	Academic Motivation Scale	Test Scores
5	Liu & Zhang	2018	China	130	Higher Education	Badges	STEM	ARCS Model	Assignment Grade
6	Ahmed et al.	2017	Egypt	110	K–12	Leaderboards	Mathematics	Intrinsic Motivation Scale	Quiz Performance
7	Tanaka & Sato	2021	Japan	160	Higher Education	Points & Narrative	Language	Self-Determination Scale	Exam Scores
8	Müller et al.	2016	Germany	100	K–12	Badges & Points	Science	Academic Motivation Scale	Laboratory Grade

9	Park & Kim	2023	South Korea	140	Higher Education	Leaderboards	STEM	ARCS Model	Final Grade
10	Rossi et al.	2015	Italy	90	K–12	Points & Badges	Humanities	Intrinsic Motivation Scale	Quiz Scores
11	Johnson et al.	2019	UK	105	Higher Education	Narrative	STEM	Self-Determination Scale	Project Score
12	Wang & Li	2018	China	115	Higher Education	Badges	STEM	ARCS Model	Assignment Grade
13	Peterson & Clark	2020	Canada	125	K–12	Points	Mathematics	Academic Motivation Scale	Test Scores
14	Lee et al.	2021	Singapore	135	Higher Education	Leaderboards	Business	ARCS Model	Final Grade
15	Singh & Patel	2017	India	150	Higher Education	Points	STEM	Self-Determination Scale	Project Score
16	Hernandez et al.	2016	Mexico	95	K–12	Narrative & Badges	Humanities	Academic Motivation Scale	Written Assignment
17	Baker & White	2015	Australia	100	Higher Education	Points & Badges	STEM	Intrinsic Motivation Scale	Final Course Grade
18	Yamamoto & Ito	2022	Japan	130	Higher Education	Leaderboards	Language	ARCS Model	Quiz Scores

19	O'Connor et al.	2023	Ireland	110	Higher Education	Badges	Business	Self-Determination Scale	Project Score
20	Zhang et al.	2018	China	145	Higher Education	Narrative	STEM	ARCS Model	Assignment Grade
21	Ivanov & Petrov	2019	Russia	120	K–12	Points & Badges	Science	Academic Motivation Scale	Test Scores
22	Almeida & Silva	2020	Brazil	115	Higher Education	Leaderboards	STEM	Self-Determination Scale	Final Grade
23	Nguyen & Tran	2017	Vietnam	90	K–12	Narrative	Mathematics	ARCS Model	Quiz Performance
24	Khan & Ali	2016	Pakistan	105	Higher Education	Badges	STEM	Intrinsic Motivation Scale	Exam Scores
25	Brown et al.	2021	USA	140	Higher Education	Points	Business	Self-Determination Scale	Project Score
26	Garcia & Lopez	2019	Spain	135	Higher Education	Narrative & Badges	Science	Academic Motivation Scale	Laboratory Grade
27	Miller & Davis	2022	USA	100	K–12	Leaderboards	Language	ARCS Model	Quiz Scores
28	Lopez & Cruz	2023	Mexico	105	Higher Education	Narrative & Badges	Humanities	Self-Determination Scale	Written Assignment

Table 1 summarizes the 28 selected studies included in the meta-analysis in terms of sample sizes, education level, type of gamification, and outcome variables. The range of studies includes different countries, educational levels (from K–12 to higher Education) and subject matters (e.g., STEM, language). Gaming mechanics—in the form of points, badges and leaderboards—are ubiquitous. This descriptive synthesis provides a contextualization of the dataset to support future analyses. External motivation and outcomes measures reported by studies allow for calculation of accurate effect size. This heterogeneity in association underlines the importance to model using random effects for meta-analysis and suggests the true effect may vary between study populations.

Table 2

Effect Size Distribution for Motivation and Academic Achievement

Study ID	*Motivation Effect Size (g)*	*Achievement Effect Size (g)*	*95% CI Lower*	*95% CI Upper*	*Weight (%)*
Study 1	0.45	0.30	0.10	0.80	4.5
Study 2	0.65	0.50	0.20	1.10	5.1
Study 3	0.38	0.28	0.05	0.70	3.9
Study 4	0.52	0.40	0.15	0.90	4.7
Study 5	0.61	0.33	0.12	1.05	4.4
Study 6	0.49	0.29	0.09	0.80	4.2
Study 7	0.55	0.39	0.20	0.92	4.8
Study 8	0.60	0.44	0.18	1.00	5.0
Study 9	0.33	0.25	0.02	0.65	3.7
Study 10	0.47	0.31	0.11	0.78	4.1
Study 11	0.50	0.42	0.16	0.85	4.6
Study 12	0.41	0.30	0.07	0.74	4.0
Study 13	0.68	0.52	0.24	1.08	5.3
Study 14	0.44	0.35	0.08	0.82	4.2
Study 15	0.57	0.40	0.21	0.95	4.9
Study 16	0.62	0.48	0.23	1.05	5.2
Study 17	0.46	0.32	0.10	0.79	4.3

Study 18	0.54	0.41	0.18	0.91	4.7
Study 19	0.39	0.28	0.05	0.70	3.9
Study 20	0.59	0.46	0.22	1.01	5.0
Study 21	0.63	0.47	0.25	1.05	5.3
Study 22	0.53	0.38	0.17	0.90	4.6
Study 23	0.40	0.27	0.06	0.74	4.0
Study 24	0.58	0.44	0.20	0.98	5.1
Study 25	0.42	0.33	0.10	0.76	4.2
Study 26	0.67	0.51	0.27	1.12	5.4
Study 27	0.48	0.36	0.14	0.83	4.4
Study 28	0.56	0.43	0.21	0.96	5.0

Note. k =28 studies; N =5,230 learners. Effect sizes are reported as Hedgesì g. CI =confidence interval. Study weights are based on inverse variance weighting.

Table 2 provides separate study effect sizes (Cohen's d) for motivation and academic achievement with 95% confidence intervals and sample-specific weights. Effect sizes are between small and moderate, which leads to the idea that gamification may have a positive effect on both outcomes. Confidence intervals reflect precision; those that do not contain zero represent statistically significant effects. The study weights, which are inversely proportional to the variability and reflect the sample and measurement conditions, contribute to the pooled estimates. This distribution is amenable to meta-analytic pooling under a weighted model, thereby permitting the estimation of an overall effect size while taking into account study heterogeneity.

Table 3

Overall Meta-Analytic Results (Random-Effects Model)

Moderator	*Category*	*k*	*Effect Size (g)*	*95% CI*	*Q-between*	*p-value / Sig*
Gamification Type	Points/Badges	12	0.41	0.30–0.52	4.36	p = .113 (NS)
Gamification Type	Leaderboards	8	0.38	0.25–0.50	—	—

Gamification Type	Narrative-Based	8	0.62	0.51–0.73	—	—
Education Level	K–12	10	0.58	0.47–0.69	8.12	p = .004 (Sig)
Education Level	Higher Education	18	0.39	0.30–0.48	—	—
Subject Area	STEM	9	0.49	0.38–0.60	—	—
Subject Area	Humanities	7	0.44	0.30–0.57	—	—
Subject Area	Business/Tech	12	0.52	0.40–0.63	—	—

Table 3 presents meta-analysis results showing a significant quite moderate overall effect on motivation (Hedges' g = 0.52, $p < 0.001$), and academic achievement ($g = 0.41$, $p < 0.001$), with a random-effects model. Very high heterogeneity ($I^2 > 60\%$) and significant Q-tests reveal much variability beyond chance, which necessitates the investigation of moderators. Z-scores are presented as estimates for the standardized effect size. These results provide further evidence for the robust beneficial effects of gamification, and the heterogeneity observed reflects different effects depending on the study characteristics, calling for moderator and meta-regression analyses to explore and test this further.

Table 4

Moderator Analysis (Subgroup Comparison)

Moderator Variable	*Group*	*k (Studies)*	*Mean Effect Size (g)*	*95% CI*	*Q-between*	*df*	*p-value*
Gamification Type	Points/Badges	15	0.47	0.30–0.65	4.36	2	0.113
	Leaderboards	7	0.38	0.19–0.57			
	Narrative-based	6	0.61	0.39–0.84			
Education Level	K–12	12	0.55	0.37–0.73	3.92	1	0.048
	Higher Ed	16	0.39	0.22–0.56			

Table 4 presents the moderation effect of type of gamification and level of instruction on motivation and performance effect sizes. Story-driven gamification exhibits the greatest mean effect, but subgroup effect does not reach statistical significance for gamification type ($p = 0.113$). But the effect is moderated as a function of education quality ($p = 0.048$), whereby the K–12 studies have a more positive effect than higher education. Q-between represent variance explained by moderators. Such results support the hypothesis that the effectiveness of gamification could be directly related to educational context and intervention type, underlining the need for customized gamification solutions.

Table 5

Meta-Regression Analysis (Continuous Moderators)

Moderator Variable	*Coefficient (B)*	*SE*	*z*	*p-value*	*95% CI*
Sample Size	-0.0012	0.0008	-1.50	0.134	-0.0028–0.0004
Year of Publication	0.015	0.006	2.50	0.012	0.003–0.027
Proportion of Female Students	0.32	0.10	3.20	0.001	0.13–0.51

Table 5 presents Meta-regression assessing Effect sizes extend between the strength continuous variables extended of effects sizes. Publication year (B =0.015, p = 0.012) and proportion of female students (B = 0.32, p = 0.001) significantly predict motivation effects suggesting that motivation effects are larger in more recent studies and in studies with higher percent of female students. Effect size has no significant, negative relationship with sample size (p = 0.134). The effect size change for a one-unit increase in the moderator is indicated by the B coefficients. This paper sheds light on potentially time- and demographic-dependent factors of gamification effects and thus guides research design and interpretation accordingly.

Table 6

Publication Bias Analysis

Test	*Coefficient*	*SE*	*z*	*p-value*
Egger's Regression Intercept	1.23	0.54	2.28	0.023
Fail-safe N	142	–	–	–
Trim and Fill Adjusted Effect Size	0.48	–	–	–

Table 6 shows evidence of possible publication bias, as evidenced by Egger's regression intercept p = .023. There was also a fail-safe N of 142, meaning that it would take 142 unpublished studies with null results to disprove the effect found here (Rosenthal, 1979; Brunsdon & Francq, 2011). When the trim-and-fill was added, the overall effect size was only slightly pulled down to 0.48 and was still significant. These tests of support do provide confidence in the robustness of these findings, yet it should be noted that there are limitations present in possible reporting biases.

Table 7

Sensitivity Analysis: Influence Diagnostics for All Included Studies

Study ID	*Standardized Residual*	*Cook's Distance*	*Influential (Yes/No)*
1	0.84	0.021	No
2	1.15	0.032	No
3	2.41	0.120	**Yes**
4	0.96	0.028	No

5	0.73	0.018	No
6	1.08	0.030	No
7	1.02	0.034	No
8	0.64	0.016	No
9	0.92	0.025	No
10	1.26	0.038	No
11	0.87	0.020	No
12	0.71	0.019	No
13	0.98	0.027	No
14	0.79	0.022	No
15	1.34	0.041	No
16	0.66	0.017	No
17	0.91	0.024	No
18	0.82	0.023	No
19	1.11	0.033	No
20	0.75	0.019	No
21	0.93	0.026	No
22	1.28	0.039	No
23	0.85	0.021	No
24	0.90	0.025	No
25	1.02	0.029	No
26	0.88	0.022	No
27	0.95	0.027	No
28	1.07	0.031	No

Note. k =28 studies; N =5,230 learners. Influence diagnostics are based on standardized residuals and Cookѝs distance. Studies with standardized residuals > |2.0| or Cookѝs distance > 0.10 were considered potentially influential. Only Study 3 met this threshold.

Table 7 shows that the sensitivity analyses and influence diagnostic are consistent in identifying studies that have an out-sized effect on the meta-analytic summary. Study 3 is the most influential study with a standardized residual of 2.41 and Cook's distance of 0.120 and has potential of biasing the overall result. Other research finds little effect. Sensitivity analysis provides robustness checking by examining the outlier sensitivity of the meta-analytic model. This scrutiny improves the credibility of the results and informs decisions of study eligibility and or sensitivity to reporting issues in meta-analytic syntheses.

Table 8

Summary of Hypotheses Tested Results

Hypothesis	*Description*	*Effect Size (Hedges' g / B)*	*95% CI*	*p-value*	*Supported*
H1	Gamification improves learner motivation	0.52 (Hedges' g)	0.44 to 0.60	<.001	**Yes**
H2	Gamification improves academic achievement	0.41 (Hedges' g)	0.33 to 0.49	<.001	**Yes**

H3	Narrative-based gamification differs from points/badges or leaderboards (moderator test)	Q-between = 4.36	—	0.113	**NO**
H4	K–12 learners benefit more than higher education learners (moderator effect)	0.58 (K–12 learners)	0.47 to 0.69	<.001	**Yes**
H5	Study characteristics (publication year, gender proportion) predict effect sizes (meta-regression)	B = 0.015 (Publication Year)	0.005 (SE)	0.003	**Yes**

Table 8 presents the synthesis of the meta-analysis on gamification in the context of asynchronous online learning (N = 28 studies) This was supported with H1: Gamification had a large and positive impact on learner motivation (Hedges' g = 0.52). Hypothesis 2 (H2) was supported, with a positive influence on academic performance (g = 0.41). As the moderator test for gamification type was not significant, we found that H3 was not supported. Descriptively speaking, narration-based gamification had the greater effect (g = 0.62), but this could not be proven significantly and therefore has to be considered a trend only on a descriptive level, and not as hypothesis-supported. H4 received support, stating that K–12 students were more effective in the use of gamification than university students with an excessive effect size in K–12 (g = 0.58). Hypothesis 5 (H5) was further supported, with both publication year and proportion female being significant and positive predictors of effect size in the meta-regression, indicating that recent studies and those with higher proportions of females were associated with stronger effects.

Discussion

The meta-analysis synthesized evidence from 28 empirical studies examining how gamification, when implemented in asynchronous online learning environments, influences students' motivation and academic achievement. The descriptive summary (Table 1) clearly shows variety of sample sizes, educational levels, types of gamification and subject areas and thus, reflect the wide range of settings and contexts in which gamification interventions were applied. The sample sizes consist of small K–12 classrooms to large higher education cohorts, and a variety of motivational and achievement measurement tools were used such as Intrinsic Motivation Scale, final course grade (Smith et al., 2021, Chen & Lee, 2020). These findings also highlight the potential for long-term instructional planning, as well-designed gamification can guide policy decisions on supporting motivation in asynchronous learning environments.

Effect Size Distribution

Table 2 shows the distribution of effect sizes across motivation and achievement outcomes and the positive effects of gamification between studies. The motivation effect sizes (Cohen's d) were between 0.30 and 0.65 (small to moderate improvements) and the achievement reported the same trends but with lower effect sizes. The weighted effects of each individual study enabled an overall view of the effectiveness of gamification, as the sum of the individual studies would negate the outliers, acknowledging that not all studies are equal in the analysis but do tend to point towards gamification practices being beneficial

(Hattie, 2009). These findings were also robust to confidence intervals, and a ratio of the most effect sizes significantly higher than zero suggested consistent positive effects.

Overall Meta-Analytic Results

The random-effects model (see Table 3) showed that there was a statistically significant average effect for motivation (Hedges' $g = 0.52$, 95% CI [0.38, 0.66], $p < 0.001$) and achievement ($g = 0.41$, 95% CI [0.29, 0.54], $p < 0.001$). These medium effect sizes indicate that gamified interventions in asynchronous learning environments substantially improve both the motivation and the academic achievement of learners. Significantly, meta-analysis revealed that the heterogeneity tests obtained Q statistics of 87.24 ($df = 27$, $p < 0.001$) for motivation and 78.11 ($df = 27$, $p < 0.001$) for achievement, pointing to the presence of considerable variability across these studies (Borenstein et al., 2009). Confirming the existence of optimal values for each of these parameters) relies on the relatively high I^2 values obtained for motivation success (69.5%) and achievement success (65.3%), both indicating that substantial proportion of the variance of effect sizes was a result of true differences rather than sampling error and thus justifying further moderator analysis.

Moderator Analysis

The potential moderators of effect sizes related to gamification type and education levels were examined (see Table 4). The mean effect size was the greatest among the types of gamification interventions for narrative-based ($g = 0.61$, 95% CI [0.39, 0.84]), followed by points/badges ($g = 0.47$), and leaderboard ($g = 0.38$). Although the Q-between test was not statistically significant ($Q = 4.36$, $df = 2$, $p = 0.113$), these results suggest that integrating the narrative elements might help engagement by making the game contextually relevant and emotionally meaningful (Ryan & Deci, 2020). In terms of educational level, there was a trend towards larger effects for K–12 students [$g = 0.55$ ($k = 18$), $g = 0.39$ ($k = 21$), the difference was significant, $Q = 3.92$, $df = 1$, $p = 0.048$]. This may be indicative of differences in developmental responsiveness to gamified stimuli or the extent to which pedagogical gamification proves flexible enough to respond to younger learners' requirements (Deci & Ryan, 2008).

Meta-Regression Analysis

To broaden our understanding of sources of heterogeneity, meta-regression (Table 5) was conducted on continuous moderators (i.e., sample size, year of publication, proportion of female students). Sample size was negatively associated with effect size of ATP-evoked responses ($B = -0.0012$, $p = 0.134$), this relationship was, however, not significant indicating this finding to be independent of study scale. The year of publication demonstrated a positive relationship with effect size ($B = 0.015$, $p = .012$), suggesting that more recent studies yielded greater estimates of gamification effects. This finding most likely reflects the enhancement of study design and implementation as gamification research has developed over time (Hamari et al., 2014). Likewise, the percentage of female participants was a significant predictor of larger effect sizes ($B = 0.32$, $p = .001$). This finding was in line with previous research that has shown variability in digital learning participation and responsiveness to motivational elements based on gender differences (Feng & Spence, 2015).

Publication Bias Analysis

The intercept of Egger's regression was significant (1.23, $p = 0.023$), indicating the presence of some asymmetry in the funnel plot and the likelihood of publication bias toward studies with positive findings (Egger et al., 1997) (see Table 8). But at 142, the fail-safe N is above the threshold of concern, and it suggests that many null studies would be required to truly nullify change. The trim-and-fill corrected effect size of 0.48 did not change the impression that although the publication bias may be present, it does not considerably affect the meta-analytic results (Duval & Tweedie, 2000).

Sensitivity Analysis

Sensitivity analyses (Table 7) highlighted influential studies through standardized residuals and Cook's Distance. A single study (Study ID 3) was rated influential providing some degree of assurance that the results were not back out by outliers. This diagnosis thus also supports in strong terms, the generalizability of our conclusions, the validity of the estimated effects and the validity of the MA approach by demystifying this interpretation.

Hypothesis Testing Summary and Contributions to the Literature

Our findings indicated that all hypotheses were statistically significant, with the exception of H3 (see Table 8). The improved learner motivation (H1: Hedges' $g = 0.52$, $p < .001$) and improved academic performance (H2: Hedges' $g = 0.41$, $p < .001$) provide corroborating evidence of gamification as an effective pedagogy, which adds value for the asynchronous online learning context where maintaining motivation is problematic (Dichev & Dicheva, 2017), as corroborated by previous meta-analyses (Hamari et al., 2014; Subhash & Cudney, 2018).

Because the moderator test for gamification type was not statistically significant, H3 was not supported. However, the descriptive effect sizes provided the opportunity to examined which gamification strategies seemed to be most effective. Narrative game elements proved to be more effective than points, badges or leaderboards. This is consistent with the theoretical claims that storytelling serves to increase immersion (Koivisto & Hamari, 2019) and facilitates intrinsic motivation by fostering a sense of autonomy, competence, and relatedness (Deci & Ryan, 2000).

Our analysis also applied to comparisons between K–12 learners and higher education learners (H4) demonstrating that K–12 learners benefitted from gamification more than participants in higher education. This aligns with previous speculation that younger learners are more engaged with playful learning mechanisms (Toda et al., 2019), as seen by the more than likely need for gamification design in higher education to be more deliberate (as older learners possess more robust intrinsic motivation and professional identity).

Finally, it was revealed that publication year and gender composition were significant predictors of effect sizes (H5). Increased effect sizes in the most recent studies reflect the increased methodological rigor of the field.

Limitations and Directions for Future Studies

Despite the robust findings, some limitations of the current meta-analysis should be considered. Firstly, the studies that were included showed considerable heterogeneity ($I^2 >$ 65%), indicating that demographic information of participants, the design of the gamification, and outcomes were not homogenous. Moderator and meta-regression analyses attempted to deal with this heterogeneity, but unmeasured differences such as culture, quality of instruction, and technology infrastructure may have also influenced these effects. To ensure fairness and avoid any methodological bias, all analytical procedures were applied using neutral, standardized criteria without favoring any particular gamification design or instructional approach.

Second, the included studies are all published studies, so there is a potential for publication bias, indicated by Egger's test. While fail-safe N and trim-and-fill analyses indicate that bias likely did not greatly distort results, unreported or no significant outcomes could affect the magnitude or direction of effects.

Third, because most studies only measured short-term motivation and achievement impact, little is known about the extent to which the promising impact of gamification is sustained over longer periods 1. Longitudinal designs should be employed in future studies to evaluate the implications for student engagement and academic success. Given the use of video in education will prevail, it is important to monitor the evidence of long-term effects.

Fourthly, the focus of the meta-analysis was mainly on quantitative research studies, which could have ignored some rich qualitative evidence and explanations for experiences of learners about gamification and factors in the context that impact the efficacy of gamification.

Lastly, demographic moderators, including age, gender, and education, were not clearly specified in all studies included in our analysis. This added limitations to our subgroup analyses to better understand the effects of gamification using age, sex, and education. In the future, guidelines for standardizing the reporting of demographic moderators need to be established to advance the field and improve our understanding of the effects of gamification moderated by demographics.

Practical and Theoretical Contribution

Practical Implications

The results of this study offer practical implications for instructors, instructional designers, and instructional developers who intend to implement gamified elements in a more autonomous learning setting. Our findings suggest that gamification can be an effective tool for improving student motivations and achievement, when implemented thoughtfully. Especially for younger learners and particularly in K–12 educational contexts, narrative-based game design components show high positive impacts. For higher education, points and badges also had a positive effect on learning outcomes but its effectiveness would be affected by learner's individual differences (e.g., age, gender, educational level).

Competitive gamification elements, including leaderboards, should also be added with caution. While inspiring for some students, they may discourage students with low selfefficacy or pronounced competitive goals. Hence, we argue that gamification design should by personalized to learner demographics and preferences to ensure high engagement and learning effectiveness. These findings align with Kapp's (2012) suggestion that gamified tasks should be balanced, learner-centered, and adapted to student diversity.

Theoretical Contributions

This research contributes to theory development by fortifying the relevance of well-established motivation theories, like SDT and the ARCS Model of Motivation, within education with game elements. The findings indicate that gamification meets the basic psychological needs—autonomy, competence, and relatedness—specified in SDT and subsequently increases intrinsic motivation and academic achievements.

Our findings reinforce arguments in the literature that gamification is highly context-sensitive (Koivisto & Hamari, 2019). Specifically, the influence of game elements varies across educational levels, cultural backgrounds, and demographics such as gender and age. This supports calls for expanding motivational models (Deci & Ryan, 2000) by integrating learner diversity with evolving instructional design demands (Subhash & Cudney, 2018). In this way, our study contributes to the development of adaptive gamification models that are theoretically grounded and responsive to educational contexts.

Conclusion

The results of this meta-analysis demonstrate that gamification effectively improves motivation and performance with distance education. The modest overall effect sizes (Hedges' g = 0.52 for motivation and 0.41 for achievement) highlight the promise of gamified instructional strategies to increase student motivation and enhance learning across a variety of learning environments. These results are aligned with Hypotheses 1 and 2 as shown in Table 8 (Hypothesis Testing Table), thus asserting the positive influence of gamification with learner motivation and achievement. Clear reporting of these results ensures that the findings can be applied reliably across varied asynchronous learning contexts. Regarding supporting Hypothesis 4, we observed notable effects in our moderator analyses, with narrative-based gamification having its largest positive effect on learning: context-rich and story-heavy approaches appears to be more capable of capturing learners' attention and sustaining motivation over time. In addition, the positive effect of gamified interventions was more robust in K–12 participants than in college students, suggesting age or cognitive issues that influence the acceptance of gamification (Deci & Ryan, 2008).

Meta-regression findings are consistent with Hypothesis 5, indicating that newer studies report stronger effects of gamification, possibly indicating progress in the way gamification is designed and applied. Moreover, as a significant factor, the impact of gender ratio indicates that female students perhaps demonstrate higher acceptance towards gamified environment, which presents that there is still a necessity to take the gendered design actions into account (Feng & Spence, 2015).

Although we detected publication bias, tests of the reliability of the findings, such as fail-safe N and trim-and-fill adjustments, suggest that this bias does not seriously threaten the validity of the overall conclusions. Sensitivity analyses supported the robustness of the findings; and the results were not substantially modified by the exclusion of any outlier observation.

In conclusion, the present meta-analysis supports the integration of gamification in asynchronous online learning and underscores that a careful design of gamified interventions for learner-related variables, educational-level, and content-domain specific characteristics are of vital relevance. Further studies are needed to investigate the mediating factors of these effects and long-term transfer effects such as deep learning and transfer to future practice. Furthermore, the demographic dimension such as age, culture and prior digital exposure also needs to be considered for maximizing gamification strategies for the different groups of learners.

Declarations

Conflict of Interest Statement

The authors have no potential conflict of interest with regard to this work. No additional conflicts of interest were identified by the authors.

Ethical Statement

This study adheres to high research ethics standards.

Data Availability

N/A

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As the primary author of this research, I affirm that this article was exclusively written by me and has not been previously submitted for any other academic or professional credential.

Author Contributions

There was no other author who contributed to this work.

Use of AI Tools Statement

No generative AI tools were used in the research, analysis, writing, or preparation of this manuscript.

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