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Implications of Gamification for Student Learning Motivation: Meta-Analysis Study

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Background of the study: Gamification is increasingly applied in education to stimulate engagement and motivation, yet empirical findings on its effectiveness remain mixed.

Aims: This study aims to determine the overall effect of gamification on students' learning motivation and to examine whether education level, sample size, and publication year moderate this effect.

Methods: A meta-analysis was conducted using Scopus-indexed journal articles published between 2015–2024. Studies were included if they reported motivation outcomes with sample size, mean, and standard deviation. Effect sizes (Hedges' g) were calculated and synthesized using a random-effects model with OpenMEE.

Results: Twenty-five articles (26 outcomes) met the criteria. Gamification demonstrated a significant and very strong overall effect on learning motivation (ES = 1.061). Moderator analysis showed stronger effects at the senior high school level, while the influences of sample size and publication year were comparatively smaller.

Conclusion: Gamification substantially enhances students' learning motivation compared with non-gamified approaches. These results support the careful and contextual integration of gamified elements in teaching to optimize learner engagement and instructional quality.

A. Introduction

Over the past few years, the application of gamification in educational contexts has attracted growing scholarly attention (Kabilan et al., 2023; Nyćkowiak & Kołodziej, 2023). Within the field of education, gamification refers to the integration of game-design elements into learning settings to enhance student engagement and participation. This approach encourages active interaction between learners and instructional content, thereby supporting the development of students' curricular understanding as well as their cognitive and social skills (Manzano-León et al., 2021). Gamification has become popular to increase engagement, and the classroom is no exception (Ab. Rahman et al., 2018; Chu & Fowler, 2020; Loganathan et al., 2019). In the classroom, learners have implemented game elements and even combined several variations of these games, such as Quizizz which allows teachers to test students' knowledge through crossword puzzles and matching games rather than traditional quizzes (Abdul Rahim et al., 2020; Forssell et al., 2023). In simple terms, gamification refers to the incorporation of game-design elements into contexts that are not traditionally associated with games. (Deterding et al., 2011), with the aim of improving the learning process, learning experience (Aldalur & Perez, 2023; Alzahrani & Alhalafawy, 2023), and student motivation (Alsawaier, 2018; D Cuervo-Cely et al., 2022; Ferriz-Valero et al., 2020; Sadeghi et al., 2022).

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Gamification in the context of learning, is used as a driver of learning related to student performance and engagement (Moliner-Heredia & Abellán-Nebot, 2023; Qiao et al., 2023). In addition to these two, gamification also has the potential to strengthen innovation, and lead to improved processes, learning outcomes and student motivation (Ebrahimi & Alhumairi, 2023; Kapp, 2012; Lyons et al., 2023; Oliveira et al., 2023).

Integrating gamification into instructional practices represents one viable response to the rapid advancement of information and communication technologies (ICT) in education. The implementation of gamification offers several notable advantages. First, it evokes a range of emotional responses, including curiosity, frustration, excitement, optimism, and other positive affective experiences that support learning (Elshiekh & Butgerit, 2017). Second, gamification has been shown to enhance students' engagement and motivation in classroom settings two essential factors for effective learning (Cuervo-Cely et al., 2022; Ferriz-Valero et al., 2020; Lee & Hammer, 2011; Sadeghi et al., 2022). Third, gamified learning environments create inclusive spaces that encourage reserved students to participate more actively while enabling all learners to express their identities more openly (Lee & Hammer, 2011). Fourth, gamification allows learners to experiment, fail, and retry without facing negative consequences, thereby fostering a safe and supportive learning atmosphere (Pavlus, 2010).

Despite its potential advantages, the application of gamification in educational settings is not without challenges. Several limitations have been identified, including difficulties in managing virtual classrooms, the incompatibility of gamified approaches with certain learning styles, monotony caused by repetitive activities, inappropriate task difficulty, limited instructional time, the emergence of negative emotions such as anxiety, frustration, and nervousness, as well as inadequate access to internet services (Alzahrani & Alhalafawy, 2023). Nevertheless, numerous studies conducted between 2015 and 2022 have consistently reported that gamification exerts a positive influence on students' learning motivation (Alharthi. Saleh, 2020; Sailer & Sailer, 2021; Sanmugam et al., 2021; Saraubon, 2021).

From a pedagogical perspective, gamification aims to enhance both intrinsic and extrinsic forms of motivation in learning contexts (Buckley & Doyle, 2016). Intrinsic motivation refers to engagement in activities for inherent enjoyment or personal satisfaction, whereas extrinsic motivation is driven by external rewards or reinforcements (Fischer et al., 2019). Consequently, effective gamification design requires careful consideration of intrinsic motivational factors that sustain learners' engagement over time. This perspective aligns with Self-Determination Theory, which emphasizes three fundamental psychological needs: autonomy, reflecting the degree of self-directed behavior; competence, representing learners' perceptions of their ability to perform tasks successfully; and relatedness, referring to meaningful connections with others (Ryan, 2017). In addition, gamification frameworks should account for learner typologies, such as the RAMP model, which highlights relatedness, autonomy, mastery, and purpose as key motivational drivers (Marczewski, 2015).

The integration of gamification into classroom instruction has been shown to foster greater student participation, particularly when game elements incorporate clear objectives and reward mechanisms. For example, in a study by Gurjanow et al. (2019) reported that students who engaged with gamification-based applications demonstrated higher motivational scores than those in traditional learning environments, although the differences were not statistically significant. In contrast, Kaya & Ercag (2023) provided empirical evidence that gamification-based instructional approaches significantly enhance both academic achievement and overall student motivation.

Against this backdrop, the present study seeks to examine the effectiveness of gamification-based learning in comparison with conventional instructional methods and alternative learning media through a meta-analytic approach. Although gamification has emerged as a prominent topic in educational research, findings across studies remain inconsistent, underscoring the need for systematic synthesis to clarify its overall effectiveness. Prior meta-analytic evidence suggests that gamified instructional designs generally yield more favorable learning outcomes than non-gamified approaches, as demonstrated in an analysis of 30 empirical studies (Bai et al., 2020). Similarly, a systematic review of 26 studies concluded that gamification can be strategically employed to enhance learner motivation, facilitate skill development, and improve learning effectiveness (de Sousa Borges et al., 2014).

Building on the existing literature, this study aims to evaluate the comparative effectiveness of gamification-based learning across international educational contexts. The findings are expected to provide a comprehensive synthesis of evidence regarding the impact of gamification on student learning motivation and contribute to a clearer understanding of its pedagogical value.

B. Research Methods

This research is a meta-analysis that summarizes the results of similar studies and concludes them globally (Arlinwibowo et al., 2022). The theme of this research is the effectiveness of gamification on student learning motivation. Thus, the data population in this study is all studies that compare the results of the learning process by integrating gamification, conventional and other approaches. This study used the Scopus database as the data source, which is one of the most reputable scientific databases that combines a wide range of global coverage by ensuring the highest quality data (Baas et al., 2020; Pranckutė, 2021). Some specific criteria were set to obtain documents that were suitable for this study. First, the title, abstract and keywords contained "gamification" OR 'gamefied' AND "learning motivation". Second, the documents were written in English. Third, the documents are sourced from journal sources. Fourth, the documents were published in the period 2015-2024. The screening process was subsequently conducted using the PRISMA 2020 flow diagram, as presented in the following figure.

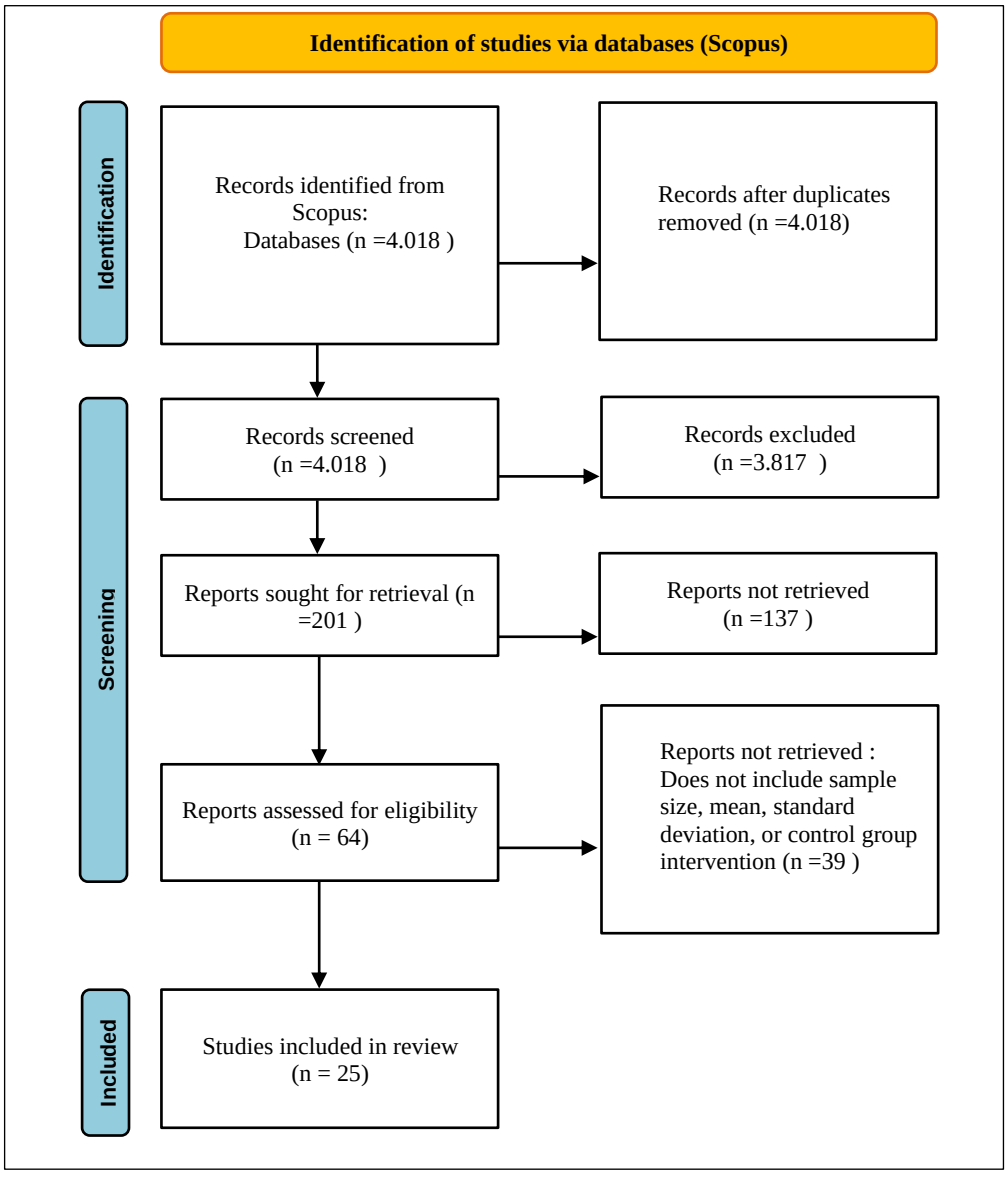


Figure 1. PRISMA Flow Diagram 2020

There were 4,018 articles identified. The screening process is divided into 3 stages. The first stage of the article was selected based on the suitability of the title, abstract and keywords. Published in 2015 to 2024, in English, sourced from journals, and have final article status. Any articles that did not comply with the defined selection criteria were excluded from the review process. In the second stage, after reviewing the

research methods, non-experimental publications were excluded. In the third stage, non-experimental publications that did not include sample size, mean, standard deviation and control group intervention were excluded, resulting in 25 articles to be reviewed in this study. In these 25 articles, there is one article that contains more than one research result so that from the final collection of research results there are 26 research results that will be analyzed using meta-analysis techniques.

This study applies a random-effects model to allow the findings to be generalized to a broader population (Barr et al., 2013; Borenstein et al., 2010). The selection of this model is based on evidence of heterogeneity, indicated by a p-value of less than 0.001. Furthermore, this meta-analysis employs a group contrast approach to examine differences between gamification-based learning and conventional or other instructional media.

In this meta-analytic investigation, effect sizes for individual studies were computed using Hedges' g, following the approach outlined by Borenstein & Higgins (2013). The analysis was supported by OpenMEE (Open Meta-Analyst for Ecology and Evolution), an open-access, open-source statistical program specifically designed for conducting meta-analyses (Wallace et al., 2017). To estimate the overall pooled effect, a random-effects model was applied. This model was selected based on the assumption that true effect sizes differ across studies and reflect variations among multiple underlying populations with distinct sampling distributions (Borenstein et al., 2010). The criteria used to interpret the magnitude of the resulting effect sizes are presented in Table 1.

Table 1. Cohen's Classification of Effect Size

Effect Size	Interpretation
ES ≤ 0,20	Weak
0,20 < ES ≤ 0,50	Medium
0,50 < ES ≤ 1,00	Strong
ES > 1,00	Very Strong

In this study, heterogeneity was assessed using a random-effects framework to evaluate the presence of variability among the effect sizes of the included studies. A p-value of less than 0.001 indicates significant heterogeneity among effect sizes. Consistent with the criteria proposed by Lipsey & Wilson (2001), when the p-value falls below the established significance threshold, the assumption of homogeneity is rejected, indicating that the effect sizes are drawn from multiple underlying distributions.

Publication bias was examined using the Fail-Safe N (FSN) technique. If the calculated FSN value surpasses the threshold of (5k + 10), where k represents the total number of included studies, the meta-analytic findings may be regarded as stable and unlikely to be meaningfully influenced by publication bias (Borenstein et al., 2010).

C. Results and Discussion

1. Results

This meta-analysis included 26 research results drawn from 25 articles, as one article reported more than one outcome. Effect size estimation constituted the first stage of analysis and was conducted using OpenMEE software to ensure accuracy. Table 2 provides an overview of the estimated effect sizes and variances for each study, categorized by country.

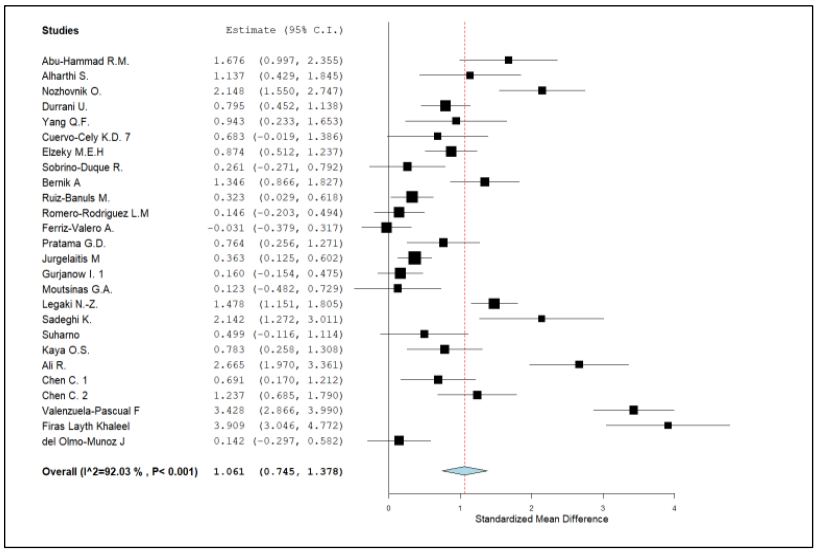
Table 2. Effect Size and Variance of Study

No	Study	Region	Effect Size	Variance	Criteria
1	Abu-Hammad R.M. (2023)	Jordan	1.676	0.120	Very Strong
2	Alharthi S. (2022)	Saudi Arabia	1.137	0.130	Very Strong
3	Nozhovnik O. (2023)	Ukraine	2.148	0.093	Very Strong
4	Durrani U. (2022)	Uni Emirat Arab	0.795	0.031	Strong
5	Yang Q.F. (2023)	China	0.943	0.131	Strong

No	Study	Region	Effect Size	Variance	Criteria
6	Cuervo-Cely K.D. (2022)	Colombia	0.683	0.128	Strong
7	Elzeky M.E.H. (2022)	Mesir	0.874	0.034	Strong
8	Sobrino-Duque R. (2022)	Spain	0.261	0.074	Medium
9	Bernik A (2020)	Croatia	1.346	0.060	Very Strong
10	Ruiz-Bañuls M. (2021)	Spain	0.323	0.023	Medium
11	Romero-R L.M. (2019)	Mexico	0.146	0.032	Weak
12	Ferriz-Valero A. (2020)	Spain	-0.031	0.032	Weak
13	Pratama G.D. (2022)	Indonesia	0.764	0.067	Strong
14	Jurgelaitis M (2019)	Lithuania	0.363	0.015	Medium
15	Gurjanow I. (2019)	Germany	0.160	0.026	Weak
16	Moutsinas G.A. (2023)	Greece	0.123	0.095	Weak
17	Legaki N.-Z. (2020)	Greece	1.478	0.028	Very Strong
18	Sadeghi K. (2022)	Turkey	2.142	0.197	Very Strong
19	Suharno (2023)	Indonesia	0.499	0.098	Medium
20	Kaya O.S. (2023)	Turkey	0.783	0.072	Strong
21	Ali R. (2022)	Saudi Arabia	2.665	0.126	Very Strong
22	Chen C. 1 (2023)	China	0.691	0.071	Strong
23	Chen C. 2 (2023)	China	1.237	0.079	Very Strong
24	Valenzuela-Pascual F (2022)	Spain	3.428	0.082	Very Strong
25	Firas Layth Khaleel (2019)	Malaysia	3.909	0.194	Very Strong
26	del Olmo-Munoz J (2023)	Spain	0.142	0.050	Weak
	Average Effect Size		1.061		Very Strong

A forest plot summarizes the overall effectiveness of gamification on student learning outcomes, based on 26 studies, in comparison with traditional and alternative instructional approaches.

Figure 2. *Forest Plot Effect Size Overall*



The results of data analysis in the figure show an overall effect size of 1.061 (ES>1), including in the very strong category and the observed effect size results have different values with 95% Confident Intervals from 0.745 to 1.378.

The second stage of analysis involved evaluating heterogeneity to determine the appropriate estimation model. Heterogeneity was assessed to identify differences among study effect sizes using the Q-statistic with 25 degrees of freedom (df = 25). The results of the heterogeneity test obtained from OpenMEE software are presented in Table 3.

Table 3. Heterogeneity Test Data Summary

Q	Df	p	I^2
313.509	25	0.001	92.026

The analysis yielded a Q statistic of 313.509 with a p-value of less than 0.001, indicating a high degree of heterogeneity across the included studies. This conclusion is further reinforced by an I^2 value of 92.026, which implies that roughly 92% of the total variance in effect sizes reflects true between-study differences rather than random sampling error. Consequently, the effect size distribution can be characterized as heterogeneous, highlighting the importance of conducting moderator analyses to explore potential sources of this variability. In light of the substantial heterogeneity observed, a random-effects model was employed to estimate the pooled effect size. The findings of the moderator analyses are reported in the following section.

Table 4. Moderator Variable Analysis Results

Variabel	Estimate	Lower bound	Upper bound	Std. error	p-Val
Overall	1.061	0.745	1.378	0.162	< 0.001
Education Level					
Elementary School	0.887	-0.597	2.371	0.757	0.241
Senior High School	1.184	0.791	1.577	0.201	< 0.001
College	0.580	0.139	1.022	0.225	0.010
Sample Size					
≤30	1.254	0.749	1.758	0.257	< 0.001
>30	0.891	0.476	1.306	0.212	< 0.001
Year of Publication					
2020-2024	1.061	0.709	1.413	0.180	< 0.001
2015-2019	1.073	0.318	1.828	0.385	0.005

The moderator analysis based on educational level was categorized into three subgroups: elementary school, senior high school, and higher education. The findings indicate that the largest effect size was observed at the senior high school level, with a value of 1.184, which can be classified as very strong. This result suggests that educational level plays a significant role in moderating the effectiveness of gamification on students' learning motivation when compared with traditional or alternative instructional approaches. While the moderator variable for sample size is divided into two subgroup variables, namely sample size ≤30 and >30. Although the average effect size of research with a sample size ≤30 is higher than ≤30, the difference is not very significant. This indicates that sample size does not really affect the effectiveness of gamification on student learning motivation when compared to traditional or other approaches.The last moderator variable, Year of Publication, is divided into two subgroups, namely publications published in the period 2020-2023 and 2015-2019. Of the two categories analyzed, research published in the 2015-2019 period (ES = 1.073) is more effective when compared to research published in the 2020-2023 period (ES = 1.061).

The third phase of the analysis focused on estimating the pooled effect size derived from the experimental studies. The overall effect size (g) was computed using OpenMEE software. The analysis yielded a combined effect size of g = 1.061 based on 26 studies (k = 26), with a lower bound (LBg) of 0.690 and an upper bound (UBg) of 1.302. This pooled estimate falls within the moderate effect size category. A summary of the combined effect size results is presented in Table 4.

Table 5. Combined Effect Size using Random Effect

Effect Size (g)	Lower Bound	Upper Bound	Std. error	p-Value
1.061	0.745	1.378	0.162	<0,001

Furthermore, a publication bias assessment was performed to evaluate whether the collected data adequately represent the target population. This evaluation was initially based on visual inspection of the funnel plot to determine whether the distribution of studies appeared symmetrical or asymmetrical. The results of the funnel plot analysis are illustrated in the following figure. Although the funnel plot appears visually asymmetrical, this pattern alone is insufficient to draw a definitive conclusion regarding the presence of publication bias. Therefore, an additional statistical approach, namely the Fail-Safe N method, was employed to provide further confirmation.

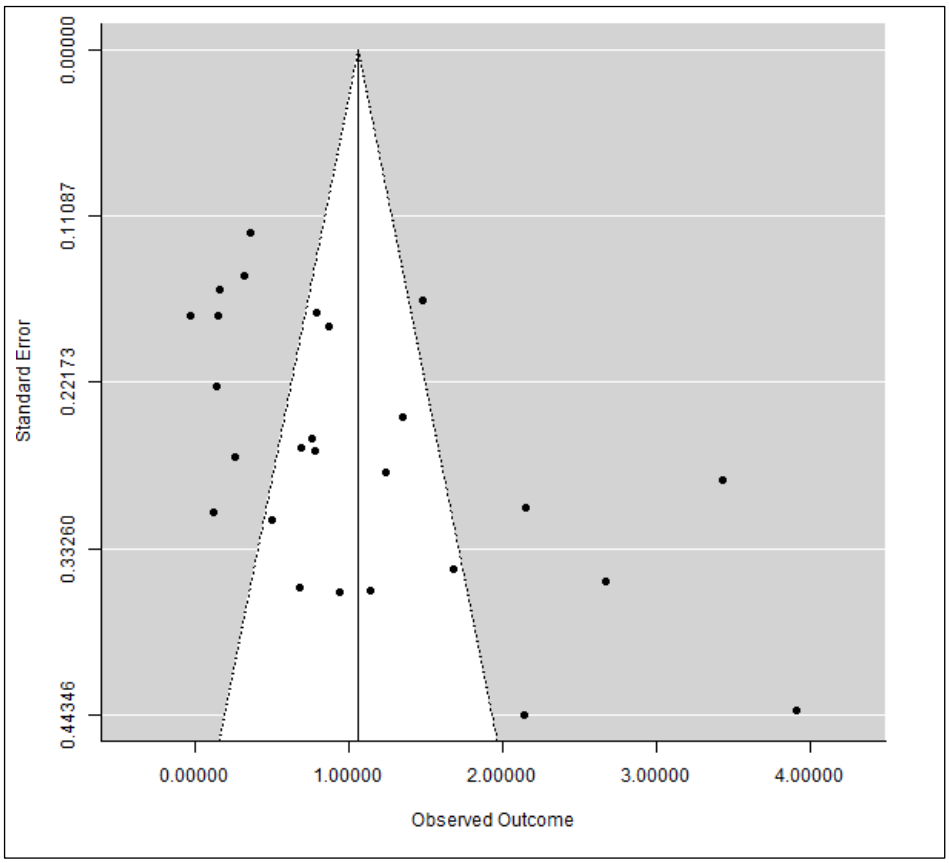


Figure 3. Funnel Plot of Biased Publication Test

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Observed Significance Level: <.0001

Target Significance Level:   0.05


Fail-safe N: 3636
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Figure 4. Fail-safe N Biased Publication Test

The Fail-Safe N analysis yielded a value of 3,636 ($\alpha = 0.05$; $p < 0.001$). Given that the number of included studies was 26 ($k = 26$), the corresponding threshold value calculated using the formula $5k + 10$ was 140. Since the obtained Fail-Safe N substantially exceeds this criterion, the results indicate that the findings of this meta-analysis are not significantly affected by publication bias.

2. Discussion

Based on reports from various studies that were the source of this meta-analysis, gamification has been empirically proven to increase students' motivation to learn. However, there are other studies that report the opposite. This meta-analysis synthesized 25 studies published in Scopus-indexed journals on the impact of gamification on student motivation. The findings of this meta-analysis indicate that gamification exerts a positive effect on learning outcomes, demonstrating a very strong level of effectiveness when compared with non-gamified instructional strategies. This is consistent with the opinion of Romero-Rodriguez et al. (2019) where the group of students (experimental) who applied gamification strategies had higher levels of student engagement and motivation compared to the non-gamification group (control). The findings of the present study are consistent with and further reinforce the results reported in a previous meta-analysis conducted by Mula-Falcón et al. (2022). Their results revealed that gamification can increase student motivation. Similar evidence has been reported in a meta-analysis of 21 empirical studies published over the past decade, which confirmed the positive effects of gamification. The results showed that gamification has the greatest influence on student motivation (Zhan et al., 2022).

The moderator analysis based on educational level was categorized into three subgroups: elementary school, senior high school, and higher education. The results indicate that gamification effectively enhances student motivation across all examined educational levels. However, the strongest effect size was observed at the senior high school level. These findings suggest that educational level moderates the effectiveness of gamification on student learning motivation. Similar conclusions were also reported by Lister (2015) the level of education affects gamification on learning motivation. Similarly, the findings revealed by Bai et al. (2020) show that education level affects gamification on learning motivation, although there are differences in findings that show that the strongest effect is found in higher education. Similar findings also suggest that a stronger impact can be observed in higher education (Bolat & Taş, 2023). Accordingly, this study provides a comprehensive overview of the effectiveness of gamification in enhancing student learning motivation across different educational levels.

While the moderator variable for sample size is divided into two subgroup variables, namely sample size ≤30 and >30. Although the average effect size of research with a sample size ≤30 is higher than ≤30, the difference is not too significant. This suggests that sample size does not play a substantial role in determining the effectiveness of gamification in enhancing student motivation when contrasted with traditional or alternative instructional methods. Similar findings were also reported by Baptista & Oliveira (2019). However, slightly different from the findings of Mula-Falcón et al. (2022) who emphasized the need for further investigations using larger samples to better assess the effects of gamification on student motivation and academic achievement. In contrast, the present discussion highlights the importance of conducting additional empirical studies to examine the potential of gamification in improving students' behavioral outcomes. While the small sample size hinders the ability to provide advice from the research results on the effectiveness of gamification on student motivation (Ritzhaupt et al., 2021). Due to inconsistent results, further meta-analysis research needs to use more studies to reveal the impact of sample size on the effectiveness of gamification on student learning motivation.

The last moderator variable, Year of Publication, is divided into two subgroups, namely publications published in the period 2020-2024 and 2015-2019. Of the two categories analyzed, research published in the 2015-2019 period is slightly stronger when compared to research published in the 2020-2024 period. Both sub groups are in the very strong category.

Although this meta-analysis included 25 publications sourced from the Scopus database, it is possible to miss relevant published articles. In addition, some experimental studies were not part of the articles analyzed because they did not include statistical scores that were required in this study, such as sample size, mean and standard deviation. In addition, the types of publications that we synthesized are those sourced from journal articles only, it does not rule out the possibility that articles sourced from proceedings or grey literature can contribute more in-depth information. The scope of this research is limited to studying the effectiveness of gamification on learning motivation by including moderator variables such as education level, sample size, and publication year.

Further research can reveal the impact of other moderator variables, such as the type of instrument and the country where the research was conducted. Examining the country in which a study is conducted as a moderator variable offers a valuable perspective for understanding the effects of gamification on learning motivation. Such an analysis makes it possible to investigate whether the influence of gamification on

students' learning motivation is consistent across different national contexts or varies from one country to another.

2.1 Implications

The findings of this meta-analysis indicate that gamification demonstrates a substantial positive impact when compared to control conditions employing traditional or non-gamified instructional approaches. The applied implication is that both teachers and educational institutions can take gamification seriously as a methods to enhance student engagement and motivation, particularly in the context of senior high school education level where it shows the greatest effect. Theoretical implications in this study might also provide evidence to further support the relevance of some motivational theories (e.g., Self-Determination Theory, Flow Theory, and Regulatory Focus Theory) as conceptual lenses to design effective gamification-based learning. Curriculum developers and educators should be encouraged to carefully select and design gamification elements that suit the needs and characteristics of learners so that learning objectives can be maximally achieved.

2.2 Research contribution

This research contributes significantly to educational literature and practice by providing a comprehensive synthesis of 26 Scopus-indexed studies from 2015-2024 that address the effectiveness of gamification on student motivation to learn. Through a random effects meta-analysis approach, this study provides strong quantitative evidence of the high effectiveness of gamification across different levels of education and identifies important moderator variables such as education level, sample size and publication year that influence the results. This enriches academic understanding of gamification's influence dynamics and provides a strong scientific basis for educational policy designers and practitioners to implement innovative gamification-based learning strategies.

2.3 Limitations

The limitations of this study include the selection of data sources limited to English-language articles published in Scopus-indexed journals with full statistical reporting, so potentially important literature from proceedings or relevant gray literature may not be accommodated. In addition, the high heterogeneity between studies (I^2 of 92%) suggests a large variation in the design, context and implementation of the gamification studied, which may affect the consistency of the meta-analysis results. The moderator variables analyzed were also limited to the aspects of education level, sample size, and publication year, while other potential factors such as gamification type, evaluation instrument, cultural context, and field of study have not been explored. The last, this study has not examined the long-term impact of gamification on student motivation and learning outcomes due to the lack of longitudinal data.

2.4 Suggestions

On the basis of the findings and limitations of this study, it is recommended that future research examine a greater variety of moderator variables (e.g. type of gamification design, cultural context, field of study, type of evaluation instruments and methods). Longitudinal and experimental studies, are required to substantiate this finding and answer the question of whether gamification could lead to long-lasting effects on student motivation and success. Gamification of the learning process must be contextualized for different systems of education's demands and students' profile to be as effective as possible. Moreover, cross-cultural studies should be carried out to investigate if the effect of gamification is consistent in different countries or there are significant differences, which can be useful for a more precise application of gamification. Learning practitioners are also suggested to integrate continuous evaluation and feedback into their gamification implementation to adapt and enhance it systematically.

D. Conclusion

This meta-analysis study concludes that gamification has a significant and very strong positive effect on students' learning motivation compared to traditional or non-gamified learning approaches. The overall effect size obtained (ES = 1.061) indicates that students who engage in gamified learning environments demonstrate higher levels of motivation. Moderator analysis shows that education level plays a role, with the strongest impact observed at the senior high school level, while sample size and year of publication have less influence on the overall outcomes. These findings highlight that gamification can be effectively implemented across different educational contexts, providing educators and curriculum developers with evidence-based support to integrate game-based elements into teaching strategies. However, due to the high

heterogeneity among studies, future research should further investigate other moderator variables such as cultural context, gamification type, and long-term effects to enrich the understanding of gamification's sustainability and broader applicability in education.

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F. Author Contribution Statement

ME conceived the research idea and coordinated the overall study. AHH provided theoretical and methodological guidance and supervised the research process. RNH contributed to refining the research design, particularly in the selection of variables and meta-analysis framework. GR assisted in interpreting the results and formulating the discussion and implications. ZPS and LS conducted the systematic literature search, article screening, and data extraction. MKG performed the data analysis using OpenMEE software and contributed to preparing figures and tables. ZPS, LS, and MKG collaboratively prepared the initial draft of the manuscript. ME, AHH, RNH, and GR critically revised and finalized the manuscript. All authors reviewed and approved the final version for submission.

References

Ab. Rahman, R., Ahmad, S., & Hashim, U. R. (2018). The effectiveness of gamification technique for higher education students engagement in polytechnic Muadzam Shah Pahang, Malaysia. *International Journal of Educational Technology in Higher Education*, *15*(1), 41. https://doi.org/10.1186/s41239-018-0123-0

Abdul Rahim, Aisyah Saad, Abu Ziden, Azidah, & Yap, Beow Keat. (2020). gamified-online-quizzes-pharmacy-student-perceptions-of-learning-in-an-undergraduate-medicinal-chemistry-course. *Malaysian Journal of Pharmacy*, *6*(1), 6–12. https://doi.org/10.52494/QAWJ8258

Aldalur, I., & Perez, A. (2023). Gamification and discovery learning: Motivating and involving students in the learning process. *Heliyon*, *9*(1), e13135. https://doi.org/10.1016/j.heliyon.2023.e13135

Alharthi. Saleh. (2020). Assessing Kahoot's Impact on EFL Students' Learning Outcomes. *TESOL International Journal*, *15*(5), 31–64. Google Scholar

Alsawaier, R. S. (2018). The effect of gamification on motivation and engagement. *The International Journal of Information and Learning Technology*, *35*(1), 56–79. https://doi.org/10.1108/IJILT-02-2017-0009

Alzahrani, F. K., & Alhalafawy, W. S. (2023). Gamification for Learning Sustainability in the Blackboard System: Motivators and Obstacles from Faculty Members' Perspectives. *Sustainability*, *15*(5), 4613. https://doi.org/10.3390/su15054613

Arlinwibowo, J., Retnawati, H., & Kartowagiran, B. (2022). The impact of ICT utilization to improve the learning outcome: A meta-analysis. *International Journal of Evaluation and Research in Education (IJERE)*, *11*(2), 522. https://doi.org/10.11591/ijere.v11i2.22112

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, *1*(1), 377–386. https://doi.org/10.1162/qss_a_00019

Bai, S., Hew, K. F., & Huang, B. (2020). Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review*, *30*, 100322. https://doi.org/10.1016/j.edurev.2020.100322

Baptista, G., & Oliveira, T. (2019). Gamification and serious games: A literature meta-analysis and integrative model. *Computers in Human Behavior*, *92*, 306–315. https://doi.org/10.1016/j.chb.2018.11.030

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, *68*(3), 255–278. https://doi.org/10.1016/j.jml.2012.11.001

Bolat, Y. I., & Taş, N. (2023). A meta-analysis on the effect of gamified-assessment tools' on academic achievement in formal educational settings. *Education and Information Technologies*, *28*(5), 5011–5039. https://doi.org/10.1007/s10639-022-11411-y

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2010). A basic introduction to fixed-effect and random-effects models for meta-analysis. *Research Synthesis Methods*, *1*(2), 97–111. https://doi.org/10.1002/jrsm.12

Borenstein, M., & Higgins, J. P. T. (2013). Meta-Analysis and Subgroups. *Prevention Science*, *14*(2), 134–143. https://doi.org/10.1007/s11121-013-0377-7

Buckley, P., & Doyle, E. (2016). Gamification and student motivation. *Interactive Learning Environments*, *24*(6), 1162–1175. https://doi.org/10.1080/10494820.2014.964263

Chu, M.-W., & Fowler, T. A. (2020). Gamification of Formative Feedback in Language Arts and Mathematics Classrooms. *International Journal of Game-Based Learning*, *10*(1), 1–18. https://doi.org/10.4018/IJGBL.2020010101

D Cuervo-Cely, K., Restrepo-Calle, F., & J Ramírez-Echeverry, J. (2022). Effect of Gamification on the Motivation of Computer Programming Students. *Journal of Information Technology Education: Research*, *21*, 001–023. https://doi.org/10.28945/4917

de Sousa Borges, S., Durelli, V. H. S., Reis, H. M., & Isotani, S. (2014). A systematic mapping on gamification applied to education. *Proceedings of the 29th Annual ACM Symposium on Applied Computing*, 216–222. https://doi.org/10.1145/2554850.2554956

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness. *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, 9–15. https://doi.org/10.1145/2181037.2181040

Ebrahimi, R., & Alhumairi, A. (2023). Investigating the Impact of Gamification in Education in an InternationalSchool in Oman: An Analysis of Students, Teachers. *Association for the Advancement of Computing in Education (AACE).*, 753–758. Google Scholar

Elshiekh, R., & Butgerit, L. (2017). Using Gamification to Teach Students Programming Concepts. *OALib*, *04*(08), 1–7. https://doi.org/10.4236/oalib.1103803

Ferriz-Valero, A., Østerlie, O., García Martínez, S., & García-Jaén, M. (2020). Gamification in Physical Education: Evaluation of Impact on Motivation and Academic Performance within Higher Education. *International Journal of Environmental Research and Public Health*, *17*(12), 4465. https://doi.org/10.3390/ijerph17124465

Fischer, C., Malycha, C. P., & Schafmann, E. (2019). The Influence of Intrinsic Motivation and Synergistic Extrinsic Motivators on Creativity and Innovation. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.00137

Forssell, M., Hassan, L., Turunen, M., & Aura, I. (2023). Accessibility of Kahoot! And Quizizz. *The 11th International Conference on Communities and Technologies (C&T)*, 75–84. https://doi.org/10.1145/3593743.3593760

Gurjanow, I., Oliveira, M., Zender, J., Santos, P. A., & Ludwig, M. (2019). Mathematics Trails: Shallow and Deep Gamification. *International Journal of Serious Games*, *6*(3), 65–79. https://doi.org/10.17083/ijsg.v6i3.306

Kabilan, M. K., Annamalai, N., & Chuah, K.-M. (2023). Practices, purposes and challenges in integrating gamification using technology: A mixed-methods study on university academics. *Education and Information Technologies*, *28*(11), 14249–14281. https://doi.org/10.1007/s10639-023-11723-7

Kapp, K. M. (2012). *The Gamification of Learning and Instruction: Game-based Methods and Education*. Google Scholar

Kaya, O. S., & Ercag, E. (2023). The impact of applying challenge-based gamification program on students' learning outcomes: Academic achievement, motivation and flow. *Education and Information Technologies*, *28*(8), 10053–10078. https://doi.org/10.1007/s10639-023-11585-z

Lee, J. J., & Hammer, J. (2011). Gamification in Education What, How, Why Bother? *Academic Exchange Quarterly*, 146. Google Scholar

Lipsey, M. W., & Wilson, D. B. (2001). The role of method in treatment effectiveness research: Evidence from meta-analysis. *Psychological Methods*, 413. Google Scholar

Lister, M. (2015). Gamification: The effect on student motivation and performance at the post-secondary level. *Issues and Trends in Educational Technology*, *3*(2). https://doi.org/10.2458/azu_itet_v3i2_lister

Loganathan, P., Talib, C. A., Thoe, N. K., Aliyu, F., & Zawadski, R. (2019). Implementing Technology Infused Gamification in Science Classroom: A Systematic Review and Suggestions for Future Research. *Learning Science and Mathematics*, 60–73. Google Scholar

Lyons, R. M., Fox, G., & Stephens, S. (2023). Gamification to enhance engagement and higher order learning in entrepreneurial education. *Education + Training*, *65*(3), 416–432. https://doi.org/10.1108/ET-05-2022-0204

Manzano-León, A., Camacho-Lazarraga, P., Guerrero, M. A., Guerrero-Puerta, L., Aguilar-Parra, J. M., Trigueros, R., & Alias, A. (2021). Between Level Up and Game Over: A Systematic Literature Review of Gamification in Education. *Sustainability*, *13*(4), 2247. https://doi.org/10.3390/su13042247

Marczewski, A. (2015). Even Ninja Monkeys like to play. In *London: Blurb Inc* (p. 28). Google Scholar

Moliner-Heredia, R., & Abellán-Nebot, J. V. (2023). Evaluation of the impact of gamification on students' performance and engagement in manufacturing engineering courses. *International Journal of Mechanical Engineering Education*, *51*(3), 174–193. https://doi.org/10.1177/03064190231160357

Mula-Falcón, J., Moya-Roselló, I., & Ruiz-Ariza, A. (2022). The Active Methodology of Gamification to Improve Motivation and Academic Performance in Educational Context: A Meta-Analysis. *Review of European Studies*, *14*(2), 32. https://doi.org/10.5539/res.v14n2p32

Nyćkowiak, J., & Kołodziej, T. (2023). Gamification Potential in Traditional Social Research Methods. *Knowledge On The Move. Studies on Mobile Social Education*. Google Scholar

Oliveira, W., Hamari, J., Shi, L., Toda, A. M., Rodrigues, L., Palomino, P. T., & Isotani, S. (2023). Tailored gamification in education: A literature review and future agenda. *Education and Information Technologies*, *28*(1), 373–406. https://doi.org/10.1007/s10639-022-11122-4

Pavlus, J. (2010). The Game of Life. *Scientific American*, *303*(6), 43–44. https://doi.org/10.1038/scientificamerican1210-43

Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The Titans of Bibliographic Information in Today's Academic World. *Publications*, *9*(1), 12. https://doi.org/10.3390/publications9010012

Qiao, S., Yeung, S. S., Zainuddin, Z., Ng, D. T. K., & Chu, S. K. W. (2023). Examining the effects of mixed and non-digital gamification on students' learning performance, cognitive engagement and course satisfaction. *British Journal of Educational Technology*, *54*(1), 394–413. https://doi.org/10.1111/bjet.13249

Ritzhaupt, A. D., Huang, R., Sommer, M., Zhu, J., Stephen, A., Valle, N., Hampton, J., & Li, J. (2021). A meta-analysis on the influence of gamification in formal educational settings on affective and behavioral outcomes. *Educational Technology Research and Development*, *69*(5), 2493–2522. https://doi.org/10.1007/s11423-021-10036-1

Romero-Rodriguez, L. M., Ramirez-Montoya, M. S., & Gonzalez, J. R. V. (2019). Gamification in MOOCs: Engagement Application Test in Energy Sustainability Courses. *IEEE Access*, *7*, 32093–32101. https://doi.org/10.1109/ACCESS.2019.2903230

Ryan, R. M. et D. E. L. (2017). Self-determination theory. Basic psychological needs in motivation, development and wellness. New York, NY : Guilford Press. *Revue Québécoise de Psychologie*, *38*(3), 231. https://doi.org/10.7202/1041847ar

Sadeghi, K., Sağlık, E., Mede, E., Samur, Y., & Comert, Z. (2022). The effects of implementing gamified instruction on vocabulary gain and motivation among language learners. *Heliyon*, *8*(11), e11811. https://doi.org/10.1016/j.heliyon.2022.e11811

Sailer, M., & Sailer, M. (2021). Gamification of in-class activities in flipped classroom lectures. *British Journal of Educational Technology*, *52*(1), 75–90. https://doi.org/10.1111/bjet.12948

Sanmugam, M., Selvarajoo, A., & David, J. A. (2021). Effects of Gamified Learning on Students of Different Player Traits in Malaysia. *Iafor Journal of Education*, *9*(6), 89–111. https://doi.org/10.22492/ije.9.6.05

Saraubon, K. (2021). Development and evaluation of a mobile game as an English learning tool for ESL learners. *International Journal of Advanced And Applied Sciences*, *8*(7), 77–83. https://doi.org/10.21833/ijaas.2021.07.009

Wallace, B. C., Lajeunesse, M. J., Dietz, G., Dahabreh, I. J., Trikalinos, T. A., Schmid, C. H., & Gurevitch, J. (2017). Intuitive, open-source software for meta-analysis in ecology and evolutionary biology. *Methods in Ecology and Evolution*, *8*(8), 941–947. https://doi.org/10.1111/2041-210X.12708

Zhan, Z., He, L., Tong, Y., Liang, X., Guo, S., & Lan, X. (2022). The effectiveness of gamification in programming education: Evidence from a meta-analysis. *Computers and Education: Artificial Intelligence*, *3*, 100096. https://doi.org/10.1016/j.caeai.2022.100096