Gamification in Early Childhood Education: A Meta-Analysis of Learning Outcames and Engagement

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Abstract: Gamification has emerged as an innovative strategy in early childhood education; however, its effectiveness has shown inconsistent results. This study aims to evaluate the impact of gamification on learning outcomes and child engagement, as well as to identify the elements and moderating factors that influence its success. The method employed is a Meta-Analysis Literature Review (MALR) based on a systematic review of relevant empirical studies. Data were obtained from open-access scholarly literature that met the inclusion criteria and were analyzed using statistical techniques for aggregating effect sizes. The findings indicate that gamification has a significant positive impact, particularly when game elements are tailored to the developmental characteristics of children. This research provides both theoretical and practical contributions to the development of more targeted and evidence-based gamification-based learning strategies in the field of early childhood education.

1 INTRODUCTION

1.1 Factual Background of the Problem

The digital transformation in education has significantly influenced teaching approaches across all levels, including early childhood education (ECE). One of the innovative approaches that has emerged in recent years is gamification, which refers to the application of game elements in non-game contexts, such as classroom learning. Globally, this approach has been utilized to enhance engagement, motivation, and learning outcomes among children in both formal and informal educational settings (Chudhary et al., 2022). However, despite the enthusiasm surrounding gamification, field realities reveal disparities in its implementation. While some educational institutions have successfully integrated gamification, others face considerable challenges in selecting game elements that align with the developmental characteristics of young children. The inconsistency in learning outcomes and children's engagement across different gamification contexts indicates the presence of complex issues that warrant systematic examination.

1.2 Literature Facts and Theoretical Gap

Previous studies have attempted to explain the effectiveness of gamification in enhancing early childhood learning; however, the findings remain highly variable. For instance, some studies have reported increased motivation and focus among children when gamification is applied in science and mathematics learning (Xezonaki, 2022).Conversely, other studies have noted minimal or even counterproductive effects due to an imbalance between game elements and children's cognitive load (Marín-Díaz et al., 2020). Theories such as Self-Determination Theory and Cognitive Load Theory provide a conceptual

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foundation, yet they have not fully accounted for the variations observed in practice. The lack of systematic synthesis and the limited identification of the most effective gamification elements, along with moderating factors such as age, duration, and learning domain, highlight an existing gap in our understanding of this approach's effectiveness

1.3 Research Objectives

This study aims to systematically evaluate the effectiveness of gamification strategies on learning outcomes and engagement in early childhood education. Furthermore, it seeks to identify the most effective gamification elements and analyze moderating factors such as children's age, learning domain, intervention duration, and the type of technology employed. Using a meta-analytic approach, this research endeavors to synthesize existing empirical findings to produce evidence-based guidelines applicable for educational practitioners in the context of early childhood education (Wang, 2025). Additionally, the study aims to strengthen the theoretical foundation of gamification implementation in early childhood education by drawing on multiple theoretical frameworks, including Self-Determination Theory and Flow Theory (Kareem & Khalid, 2024).

1.4 Rationale and Research Urgency

Given that gamification continues to evolve and is widely implemented in various countries, yet lacks strong and systematic evidence synthesis, this study is both relevant and necessary. The inconsistency of previous findings not only obscures the true effectiveness of gamification but also hinders educational practitioners from making data-driven decisions when designing learning experiences appropriate for young children (Aldhilan et al., 2024). By identifying the most impactful gamification elements and the factors moderating their effectiveness, this research can make a significant contribution to the development of innovative, efficient, and developmentally appropriate learning strategies (Riska et al., 2021). Therefore, this study is not merely academic in nature but also practical, with the aim of bridging the gap between theory and practice in the application of gamification in early childhood education.

2 LITERATURE REVIEW

2.1 Definition of the Concept of Gamification

Gamification is defined as the use of game elements—such as points, challenges, narratives, and feedback—in non-game contexts with the aim of enhancing user motivation and engagement (Anastasiia Igorevna Buentsova, 2022) Unlike game-based learning, which delivers instruction through a complete game, gamification selectively incorporates components of games into real-world activities that are not inherently games, with the purpose of making these activities more engaging without creating a full game from scratch (Li et al., 2023).

Gamification and playful design both aim to enhance motivation, attention, and learning interest by incorporating game elements into non-game educational contexts (Ružic & Dumancic, 2015). This approach is particularly relevant for digital-native learners who have grown up with technology and tend to respond more positively to interactive and challenge-based learning strategies(Langendah & Mark-Herbert, 2016). Thus, gamification serves as a pedagogical strategy with considerable potential to create adaptive and motivating learning environments, especially in early childhood education.

2.2 Manifestations and Categorization of Gamification

The manifestation of gamification in educational contexts can be categorized into several core elements: game mechanics (such as points, levels, and badges), social dynamics (competition and collaboration), and narratives that foster students' emotional engagement (García et al., 2021). Gamification can be implemented through digital media such as interactive applications, augmented reality (AR), or even adapted conventional board games designed for educational purposes (Chudhary et al., 2022). In the context of early childhood education (ECE), gamification is not limited to the use of technology; it also involves designing play experiences aligned with children's cognitive and social developmental stages(Wang, 2025). Therefore, the selection of gamification elements must consider age appropriateness and the specific learning context to ensure a positive and meaningful impact.

2.3 Definition of Early Childhood Education (ECE)

Early childhood education (ECE) represents a critical stage in human development, emphasizing cognitive, social, emotional, and motor stimulation from an early age. ECE covers the age range of 0 to 6 years and plays a vital role in establishing the foundation for lifelong learning (Alejandro Lorenzo-Lledó, 2023). Education at this stage focuses not only on academic skills but also on holistic character formation and life skills development (Riska et al., 2021). Consequently, teaching approaches in ECE prioritize active, enjoyable, and developmentally appropriate learning experiences (Kareem & Khalid, 2024). This definition underscores the importance of innovative pedagogies that integrate cognitive, social, and emotional aspects in a balanced manner.

2.4 Manifestations and Practices of Early Childhood Education

In practice, early childhood education emphasizes thematic learning, play-based approaches, and the use of engaging media to stimulate children's exploration and creativity. Play-based learning in ECE has evolved alongside advances in digital technology, such as computers and mobile devices (Alotaibi, 2024). The implementation of gamification in ECE often involves storytelling, avatars, game simulations, and leaderboards as tools to foster children's motivation and engagement (Aldhilan et al., 2024). These elements are used to convey concepts such as hygiene, health, literacy, and numeracy through enjoyable game-based contexts that are easily accessible to young learners (Fan et al., 2022). Furthermore, educators increasingly leverage new technologies such as interactive media and AR to enrich children's learning experiences. This approach reinforces the principles of constructivism, which posit that children build knowledge through active interaction with their environment.

2.5 Definition of Meta-Analysis

Meta-analysis is a statistical method used to combine the findings of multiple independent studies to draw more robust and generalizable conclusions about a particular phenomenon. In education, meta-analysis allows researchers to identify patterns, effect sizes, and potential moderating variables that may influence the effectiveness of an intervention (Gao, 2024). This approach is particularly valuable for addressing the fragmented literature and inconsistent findings frequently encountered in gamification research in ECE. Meta-analysis is also employed to assess the methodological quality of previous studies, measure intervention effect sizes, and examine the influence of moderators such as age, task type, and learning duration (Fan et al., 2022). Therefore, meta-analysis serves as a critical evidence-based decision-making tool in education.

2.6 Application on Meta-Analysis in the Context of Gamification in ECE

In the context of gamification in early childhood education, meta-analysis can be applied to identify the most effective game elements for enhancing children's learning outcomes and engagement. The studies analyzed may encompass various approaches, including digital gamification, narrative-based gamification, and hybrid models combining traditional and digital methods(Alotaibi, 2024). The results of such meta-analyses can offer practical recommendations on the most suitable types of gamification based on children's age, learning domains, and the characteristics of the technology used (Aida Theeb Mohammad, 2023). Consequently, meta-analysis emerges as a strategic approach for integrating and directing gamification implementation more effectively across diverse early childhood education settings.

3 METHOD

3.1 Research Object

This study focuses on the growing phenomenon of using gamification strategies in early childhood education, particularly concerning learning outcomes and student engagement. In the era of rapid advancements in educational technology, gamification has emerged as a promising approach; however, its implementation in various contexts has yielded inconsistent results (Kim & Castelli,

2021). While some studies report enhanced motivation and learning outcomes, others have found insignificant or even negative effects. This inconsistency raises the question of the extent to which gamification can genuinely deliver a positive impact, especially within the context of early childhood education, which possesses unique developmental characteristics (Briffa et al., 2020). Therefore, this study seeks to examine in depth both the successes and limitations of gamification strategies applied in early childhood education through a meta-analytic approach

3.2 Type of Research and Data Sources

This study is a library research employing the Systematic Literature Review (SLR) method with a Meta-Analysis Literature Review (MALR) approach. Primary data were obtained from empirical studies that directly examine the implementation and impact of gamification in the context of early childhood education, published in reputable and indexed scholarly journals. Secondary data comprised relevant literature that provides the theoretical foundations of gamification, early childhood education, and meta-analysis, including books, scientific reports, and systematic review articles (Mula-Falcón et al., 2022). The search was conducted through databases such as Scopus, Web of Science, and ScienceDirect, applying strict inclusion–exclusion criteria to ensure the validity and relevance of the studies reviewed (Poecze & Tjoa, 2020). Accordingly, this research relies on the methodological rigor and data integrity of trustworthy scientific sources.

3.3 Theoritical Foundations on the Study

This research draws upon several foundational theories that serve as the conceptual and analytical basis for understanding the effects of gamification on early childhood learning. First, the *Self-Determination Theory* by Edward Deci and Richard Ryan (1985) emphasizes three basic psychological needs—autonomy, competence, and relatedness—as the foundation of intrinsic motivation (Sailer & Homner, 2020). Second, Mihaly Csikszentmihalyi's (1975) *Flow Theory* explains how a state of complete immersion in an activity can foster optimal performance in learning. Third, John Sweller's (1988) *Cognitive Load Theory* provides a critical perspective for evaluating how game elements may influence children's information-processing capacity. Additionally, Yu-kai Chou's (2012) *Octalysis Framework* is employed as a tool to identify eight core motivational drivers in gamification that can impact learning motivation. Collectively, these theories offer a comprehensive framework for assessing the effectiveness of gamification in the context of early childhood education.

3.4 Research Process and Data Collection Techniques

The research process began with the determination of the topic and specific research questions, namely the effectiveness and moderating factors of gamification in early childhood education. Data collection was carried out through electronic literature searches in various scientific databases, including Scopus, ERIC, and Web of Science, following the PRISMA protocol as a systematic guideline (Santos et al., 2023). The retrieved studies were selected based on inclusion criteria such as experimental design, a focus on early childhood education, and the integration of gamification elements. Conversely, studies that failed to meet methodological quality standards or were deemed irrelevant were excluded. Subsequently, data extraction was performed, and effect sizes were calculated for each study. Statistical analyses were then conducted using a random-effects model to combine the results, yielding more precise aggregate effect estimates(Marín-Díaz et al., 2020). This procedure enables the researchers to draw stronger conclusions compared to relying solely on individual studies

3.5 Data Analysis Techniques

Data analysis in this study employed a content analysis approach aimed at identifying thematic patterns, inter-category relationships, and latent meanings within the body of literature. This method was chosen for its ability to uncover in-depth insights that may not be explicitly stated in each study (Nadi-Ravandi & Batooli, 2022). The analysis process began with initial coding of variables such as types of gamification, learning domains, children's age groups, and learning outcomes. This was followed by categorization and synthesis to construct a systematic narrative on the successes and challenges of gamification

implementation. Furthermore, to ensure objectivity and reproducibility, the data were independently reviewed by two researchers before the final results were agreed upon through collaborative discussion. This technique ensures that the meta-analysis results are not only quantitative in nature but also provide an in-depth qualitative interpretation of the analyzed data.

4 RESEARCH FINDING

Based on the synthesis of various literature, *gamification* is generally defined as the application of game elements in non-game contexts, including the educational domain. Commonly identified elements include points, levels, challenges, leaderboards, and narrative components that enhance user engagement(García et al., 2021). The study by Alejandro Lorenzo-Lledó (2023)identified that the use of gamification in educational settings aims to stimulate students' cognitive abilities through game-based techniques involving problem-solving and collaborative activities. Other studies also indicate that the implementation of gamification employs diverse approaches, ranging from digital applications to story-based activities and avatars that support contextual learning (Chudhary et al., 2022). Thus, the literature review demonstrates the diversity of approaches in applying gamification across various educational contexts.

4.1 Data Explanation: Gamification

Findings reveal that gamification consistently exerts a positive effect on student engagement and learning motivation, although its impact varies significantly depending on the context and the elements employed. In the meta-analysis conducted by (Sailer & Homner, (2020), gamification was found to have a small yet significant effect on cognitive outcomes ($g = 0.49$), motivation ($g = 0.36$), and behavioral outcomes ($g = 0.25$) in learning contexts. Other studies show that the duration of intervention and the type of game elements used are crucial factors influencing the effectiveness of this strategy, with short-term interventions yielding greater impacts compared to long-term ones (Kim & Castelli, 2021). Therefore, the success of gamification is highly dependent on its design and the context in which it is implemented.

4.2 Relation to the Research Problem: Gamification

The description and explanation of the literature on gamification demonstrate alignment with the central issue of this study—namely, the inconsistency of outcomes arising from the implementation of gamification in early childhood education (ECE). Variations in the design of game elements, the duration of interventions, and the media used have contributed to a fragmented approach that has not yet been systematically synthesized. These findings underscore the need for a comprehensive study capable of consolidating and re-evaluating the effectiveness of gamification through data-driven and quantitative statistical approaches, thereby providing practical guidelines for ECE practitioners.

4.3 Data Description: Early Childhood Education

The literature on early childhood education emphasizes the importance of developmentally appropriate learning that addresses cognitive, emotional, social, and motor domains. In this context, active and enjoyable learning approaches are considered primary strategies in ECE practice (Kareem & Khalid, 2024). A study by (Aldhilan et al., 2024) involving ECE teachers in Saudi Arabia found that gamification was positively received by educators, as it enhanced student engagement—particularly when accompanied by teacher training and adequate resource support (Aldhilan et al., 2024). This approach is well-suited to the characteristics of young children, who naturally learn through play and exploration.

4.4 Data Explanation: Early Childhood Education

The collected data indicate that ECE requires learning strategies that harmonize learning objectives with play-based processes. Chudhary et al. (2022) found that digital gamification approaches improved learning autonomy and academic outcomes among young learners, provided that classroom management and instructional design were well-implemented

(Chudhary et al., 2022). Furthermore, game elements in ECE must be age-appropriate and aligned with children's cognitive abilities to avoid imposing excessive cognitive load (García et al., 2021). Consequently, the implementation of gamification in ECE should adopt a selective and targeted approach.

4.5 Relation to the Research Problem: Early Childhood Education

The literature on ECE highlights tangible challenges in the application of gamification, particularly regarding the appropriateness of game elements for children's developmental stages. This reality corresponds to the main research problem, as the diversity in gamification implementation often fails to consider the unique characteristics of ECE. As a result, outcomes are inconsistent, and generalizations become difficult. Therefore, a systematic framework is needed to evaluate the effectiveness of gamification strategies that are specifically designed for early childhood education contexts

4.6 Data Description: Meta-Analysis

Meta-analysis has been widely used in education to combine findings from multiple studies, yielding more accurate estimates of effect sizes. Marín-Díaz et al. (2020) found that gamification had a significant positive effect on students' academic achievement across various educational levels, including ECE, with a Hedges' g of 0.72 (Marín-Díaz et al., 2020). Meta-analysis also provides insights into moderator variables such as age, subject area, and the game elements applied in individual studies. Other research similarly shows consistent positive effects of gamification on motivation and learning outcomes, with variations depending on platform and instructional approach (Zeng et al., 2024).

4.7 Data Explanation: Meta-Analysis

Meta-analysis offers greater statistical power for drawing conclusions compared to single studies. Research by Mula-Falcón et al. (2022) revealed that gamification had a significant effect on learning motivation (SMD = 0.51) and academic performance (SMD = 0.89), albeit with high heterogeneity across studies (Mula-Falcón et al., 2022). Similarly, a study by Nadi-Ravandi & Batooli, (2022), which analyzed over 300 articles, demonstrated that meta-analysis can identify key variables influencing effectiveness, such as media type, educational level, and intervention duration (Nadi-Ravandi & Batooli, 2022). These findings illustrate the potential of meta-analysis as an objective tool for elucidating the impact of gamification in ECE.

4.8 Relationship to the Research Problem: Meta-Analysis

The body of literature concerning meta-analytic approaches is highly relevant to the focus and urgency of this study. Inconsistencies and fragmented approaches identified in previous research can be consolidated and clarified through the integrative strength of meta-analysis. This method enables the identification of effective elements as well as moderating factors in the application of gamification strategies within early childhood education. Consequently, the findings of this study are expected to address the limitations of prior evidence syntheses and make a significant contribution to the development of evidence-based policy in early childhood education.

5 DISCUSSION

5.1 Substantive Summary of Research Finding

The synthesis of the reviewed literature indicates that gamification strategies in the context of early childhood education (ECE) generally exert a positive impact on children's motivation, engagement, and learning outcomes. However, such effectiveness is not uniform; it depends on the specific game elements employed, the duration of the intervention, and the alignment with children's developmental characteristics. Furthermore, the meta-analytic approach reveals that shorter interventions and the use of specific elements—such as badges and challenges—are more effective in fostering children's engagement compared to overly complex or prolonged approaches (Kim & Castelli, 2021). In the ECE context, these findings underscore the importance of tailoring gamification design to children's developmental needs.

5.2 Discursive Relationship with Previous Research

This study both reinforces and addresses gaps left unresolved by prior research, particularly those relying on narrative or qualitative approaches. For example, the study by (Alejandro Lorenzo-Lledó, 2023)emphasizes that gamification enhances student motivation and collaboration, yet it does not statistically quantify the magnitude of this effect. Conversely, the meta-analysis conducted by Marín-Díaz et al. (2020) reports an aggregate effect size of Hedges' $g = 0.72$, indicating a significant impact of gamification on students' academic achievement. The distinct contribution of the present study lies in its statistically rigorous synthesis based on strict inclusion criteria within the ECE context—an approach that remains scarce in the existing literature.

5.3 Reflection on the Research Objectives

The findings of this study directly reflect the achievement of the three main objectives that were initially set. The evaluation of gamification effectiveness demonstrated a positive impact on children's learning outcomes and engagement, although design adjustments are necessary to align with the context of early childhood education (ECE). Furthermore, the study successfully identified the most effective gamification elements—particularly narrative features, digital rewards, and short-term challenges. These findings support the formulation of evidence-based policies aimed at enhancing the quality of early childhood learning. In addition, moderators such as children's age and the duration of intervention were found to play a significant role in optimizing the successful implementation of this strategy (Kareem & Khalid, 2024).

5.4 Implications of the Findings

The results of this study have implications in three key domains: instructional design, teacher training, and educational policy development. First, teachers and instructional designers must be able to create game-based learning experiences that are not only enjoyable but also grounded in valid psychological and pedagogical frameworks. Second, ECE teacher training programs should incorporate an understanding of effective gamification design aligned with the developmental characteristics of young children. Third, these findings can serve as a foundation for educational policy considerations that encourage measured and targeted technology-based innovations in the field of ECE (Aldhilan et al., 2024).

5.5 Analysis of the Reasons Behind the Findings

Several factors explain why the study results indicate a generally positive yet varied effectiveness of gamification. One key reason is the variation in the application of game elements, which do not always take into account children's cognitive development and mental load. When elements such as competition become overly dominant, children may experience pressure that disrupts the learning process (Sailer & Homner, 2020). Conversely, the use of engaging narratives and immediate feedback has proven more effective, as it fosters a learning atmosphere that supports children's flow and autonomy. Moreover, overly lengthy or complex designs reduce effectiveness, as they tend to cause boredom among young learners (Kim & Castelli, 2021).

5.6 Action Recommendations Based on the Findings

Based on these findings, the primary action needed is the development of age- and context-specific guidelines for implementing gamification in early childhood education. These guidelines should include recommendations on suitable game elements, ideal duration, and technology platforms that are adaptive to children's limitations. Additionally, regular teacher training programs should be developed to enhance understanding of gamification design and its classroom application. At the policy level, the integration of gamification into the ECE curriculum should be grounded in meta-analytical evidence to ensure that it is not merely a trend but delivers tangible benefits for early childhood learning (Brick et al., 2020). Thus, the results of this study provide a solid foundation for advancing more innovative and evidence-based ECE teaching practices.

6 CONCLUSIONS

6.1 Key Findings

One of the most surprising findings of this study is that the effectiveness of gamification in early childhood education is not determined by how advanced or complex the technology is, but rather by the alignment of game elements with children's psychological needs and developmental stages. Simple elements such as a strong narrative, light challenges, and immediate feedback proved to be more impactful than overly complicated digital applications. In fact, in several studies, gamification designed with a contextual approach and based on social interaction produced far better learning outcomes than strategies relying on high-tech solutions. This finding challenges the common assumption that the success of gamification always depends on digital innovation.

6.2 Theoretica and Practical Contributions

This research makes significant contributions to scientific development, both theoretically and practically. Theoretically, it expands the understanding of the interconnection between Self-Determination Theory, Flow Theory, and the effectiveness of gamification in the context of early childhood education, while strengthening the use of meta-analysis as a relevant synthesis method for the fields of developmental psychology and educational technology. Practically, this study provides evidence-based guidelines for teachers, curriculum designers, and policymakers to implement gamification strategies effectively in early childhood learning. The recommendations produced in this study can also serve as a reference for teacher training and the development of more effective interactive learning media.

6.3 Limitations and Diretions for Future Research

Although this study applied a rigorous and systematic data synthesis approach, there are limitations in the scope of available studies, particularly the limited access to primary data from local contexts in developing countries. This should not be seen as a weakness, but rather as an opportunity for further, more contextually relevant studies involving data from more culturally and geographically diverse populations. Future research may adopt a mixed-methods approach to combine the depth of qualitative analysis with the statistical strength of meta-analysis. Moreover, it is essential to further explore the long-term influence of specific gamification elements through longitudinal studies to assess their impact on character building and learning resilience in children over time.

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