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SCIENCE MAPPING AND PEDAGOGICAL SYNTHESIS: A DUAL-ANALYSIS OF GAMIFICATION'S ROLE IN FOSTERING CREATIVITY AND CREATIVE THINKING

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ABSTRACT

Gamification has emerged as an innovative learning strategy to develop students' creativity and creative thinking. This article aims to synthesize research on gamification for creativity and creative thinking (GCCT) through a multi-method approach that combines bibliometric analysis and systematic literature review. Data were obtained from the Scopus, Web of Science, and PubMed databases with a publication range of 2016–2026. A bibliometric analysis of 97 articles shows an annual growth of 7.18%, dominated by collaborative documents. Science mapping showed that motivation, engagement, and game-based learning were central themes linked to creativity. A systematic review of 19 experimental studies identified that gamification elements such as challenges/missions, point systems, feedback, and collaboration were most often integrated with project-based pedagogical strategies and game-based learning. All studies reported the positive impact of gamification on creativity and creative thinking, with mechanisms through increased motivation and cognitive engagement. However, implementation faces multidimensional challenges, particularly in measuring the impact on creativity (57.89%), technological-pedagogical barriers, ethical-cultural considerations, and increased instructor workload. These findings underscore the need for a holistic approach to gamification design that considers the learning context, infrastructure readiness, educator competencies, and assessment instruments capable of comprehensively capturing the nuances of creativity.

KEYWORDS: Gamification; Creativity; Creative Thinking; Bibliometric Analysis; Systematic Literature Review.

1. INTRODUCTION

Creativity and creative thinking play a crucial role in addressing increasingly complex problems (Kenett, 2025; Molnár & Pásztor, 2025). In the context of education, creativity and creative thinking have become central focuses for educators and researchers as two skills or abilities that are cultivated from an early age. This is evidenced by several bibliometric studies that show an increasing trend in research on creativity and creative thinking over the past few decades (Park & Lee, 2022; Sahin, 2025). Creativity and creative thinking cannot be developed instantly; rather, they require a learning process that demands consistency and time. All levels of education play a role in nurturing these skills. Throughout the learning process, researchers and educators have developed and tested various teaching approaches or strategies.

Gamification has become one of the most widely implemented learning strategies to foster creativity and creative thinking among students (Rivera-valderrama et al., 2024). As attention to this topic increases, research focusing on gamification and creativity or gamification and creative thinking has seen significant growth, with a diverse range of research areas, including different educational levels, disciplines, and methodological approaches. However, the rapid development of research in a particular area can potentially lead to knowledge fragmentation (Aldirdiri, 2024), making it difficult for researchers to gain a comprehensive understanding of the patterns, direction, and primary focus of existing studies. Therefore, bibliometric analysis (BA) is needed to navigate the development of gamification research for creativity and creative thinking (GCCT) through the analysis of scientific publication metadata. On the other hand, a systematic literature review (SLR) plays a crucial role in providing a deeper understanding of the multifaceted impact of gamification on creativity and creative thinking in educational contexts, including variations in outcomes, implementation mechanisms, and learning contexts that affect its effectiveness. Thus, SLR not only complements the findings of BA but also enriches the interpretation of results through substantive analysis of relevant documents.

1.1. Gamification As Learning Innovation

Gamification is not merely about "playing games" in learning; rather, it is an innovative approach/design that transforms students' learning experiences into more meaningful, participatory, and exploratory activities. Gamification is a learning approach that integrates game design elements (such as levels, badges, challenges, etc.) into learning activities, which do not necessarily involve playing games (Limantara et al., 2019; Rodrigues et al., 2019; Wang et al., 2022). Unlike game-based learning, which is designed as learning through complete games, gamification is focused more on innovating the learning experience design rather than simply using games (Khaldi et al., 2023; Moseikina et al., 2022; Saleem et al., 2022; Signori et al., 2018). Several studies have designed learning by integrating various gamification elements, taking into account different aspects. Table 1 presents the gamification elements along with relevant studies.

Table 1: Gamification Elements.

No.	Gamification elements	Examples of related literature
1.	Goals & Rules	(Dicheva et al., 2015; Seaborn & Fels, 2015)
2.	Challenges / Missions / Quests	(de Santana et al., 2016; Moseikina et al., 2022; Toda et al., 2019; Ukgoda, 2025)
3.	Levels & Progression	(Dicheva et al., 2015; Limantara et al., 2019; Moseikina et al., 2022; Toda et al., 2019)
4.	Progress Bars & Tracking	(Agapito & Rodrigo, 2018; Dicheva et al., 2015; Limantara et al., 2019; Moseikina et al., 2022)
5.	Points & Scoring System	(de Santana et al., 2016; Dicheva et al., 2015; Limantara et al., 2019; Moseikina et al., 2022; Sailer et al., 2017; Seaborn & Fels, 2015; Ukgoda, 2025)
6.	Badges / Achievements	(de Santana et al., 2016; Limantara et al., 2019; Sailer et al., 2017; Ukgoda, 2025)
7.	Leaderboards & Social Comparison	(de Santana et al., 2016; Dicheva et al., 2015; Limantara et al., 2019; Moseikina et al., 2022; Sailer et al., 2017; Ukgoda, 2025)
8.	Rewards & Unlockables	(Sieben & Brendel, 2020; Toda et al., 2019)
9.	Feedback Cycles	(Agapito & Rodrigo, 2018; Dicheva et al., 2015; Ukgoda, 2025)
10.	Freedom to Fail	(Agapito & Rodrigo, 2018)
11.	Collaboration / Teammates	(Agapito & Rodrigo, 2018; Sailer et al., 2017)
12.	Competition	(Limantara et al., 2019)
13.	Narrative / Storyline & Role	(Limantara et al., 2019; Toda et al., 2019)
14.	Avatar	(Dicheva et al., 2015; Limantara et al., 2019; Moseikina et al., 2022; Sailer et al., 2017)

(Source: Synthesized by the Authors Based on Various Sources of Literature).

1.2. Creativity And Creative Thinking

The terms creativity and creative thinking are often confusing because they are closely related. Several studies offer clarification on the definitions of creativity and creative thinking (e.g., Hong, 2014), as having informative definitions for each psychological construct is essential for developing quality measurements and serves as a key consideration when designing learning experiences. Creativity encompasses a broader concept related to the process of generating new and useful ideas, whereas creative thinking specifically refers to the cognitive processes involved in generating those ideas (Tschimmel, 2022).

Several researchers define creativity as the ability to produce something (in the form of a product, idea, or solution) that is novel and useful (Kanematsu & Barry, 2016). Furthermore, Harding (2010) states that creativity is not just about generating ideas, but also about evaluating and applying them to bring about change or improvement. Practically, creativity places more emphasis on assessing the quality of the output (product, idea, or solution) produced. Common mechanisms for assessing creativity include the consensual assessment technique (CAT), which uses expert panels to independently evaluate the creativity of products within a specific domain (Cseh & Jeffries, 2019; Cummiskey, 2021; Kaufman et al., 2010), or the creative product semantic scale (CPSS), a multidimensional measure that evaluates various aspects of creative products (O'Quin & Besemer, 2006; Vo, 2022; White et al., 2002).

Unlike creativity, which emphasizes the 'outcome,' creative thinking focuses more on the cognitive processes involved in generating new ideas and making unique connections between various concepts (Good, 2024; Yang & Li, 2018) and the mental activities that transform existing information into new representations and innovative ideas (Kholid et al., 2024). A distinctive characteristic of creative thinking is sensitivity to problems, considering new information, and making unconventional associations to solve problems (H. S. Islam et al., 2022). Assessment of creative thinking is carried out in various ways, but generally, it involves measuring the thinking process. One of the most commonly used assessments is the Torrance Test of Creative Thinking (TTCT), which includes aspects of fluency, flexibility, originality, and elaboration (Alabbasi et al., 2022; Almeida et al., 2008; Yarbrough, 2016).

1.3. Effectiveness Of The Gamification For Creativity And Creative Thinking

The application of gamification has been widely used in educational settings to foster various skills, including creativity and creative thinking. Empirical evidence demonstrates that the integration of game elements in non-game contexts has proven effective in enhancing creativity and creative thinking through various mechanisms and approaches. By implementing gamification, motivation and engagement among participants can be increased, with both factors being critical in the creative process (J. Lee et al., 2023; Xu & Hamari, 2023). Elements such as challenges, rewards, and competition motivate participants to actively engage and think creatively (K.-W. Lee, 2023). The learning environment created through the application of gamification becomes more active, interactive, and dynamic, stimulating curiosity and the desire to learn. This helps participants become more open to new ideas and think outside the box (Ali et al., 2024; Han et al., 2024). Furthermore, gamification elements that encourage collaboration and social interaction can enhance creativity through idea exchange and collective problem-solving. For instance, the use of role-playing games in gamified classroom management has been shown to foster divergent thinking and creative tendencies among students (P. Chen et al., 2020; Rodríguez et al., 2024).

The application of gamification often involves tasks and challenges that require problem-solving, exploration, and risk-taking, which significantly assist participants in developing the creative thinking skills necessary to find innovative solutions (Ikhide et al., 2022; Junruang & Kanjug, 2025). Additionally, some gamification methods integrate creative thinking techniques such as SCAMPER and Mandala Thinking, which directly train participants to think creatively in various situations (Hsu et al., 2025; Perez, 2024). In response to the latest technological advancements, the integration of gamification with artificial intelligence also provides personalized and adaptive learning experiences, helping participants develop creative thinking skills tailored to their needs and abilities (Gómez Niño et al., 2025). Overall, the use of gamification elements and their integration with appropriate pedagogical strategies can enhance creativity and creative thinking.

1.4. Challenges In Implementing Gamification

Although empirical evidence from previous studies suggests that the implementation of gamification is effective in enhancing creativity and creative thinking, its application also faces various multidimensional challenges. One of the main

difficulties is balancing educational objectives with effective game mechanics, where gamification elements such as rewards and competition can divert attention from deeper creative goals (Jun & Lucas, 2025). Furthermore, maintaining participant engagement over the long term remains a significant issue, as gamification often experiences a decline in interest over time (Bakhanova et al., 2023). Technological and pedagogical barriers, such as limited infrastructure and the lack of instructor skills in integrating gamification with appropriate teaching methods, further complicate its implementation in education (Amjad et al., 2025; Oke et al., 2024). Additionally, some studies highlight the challenges in measuring the impact of gamification on creativity, as creativity is multidimensional and difficult to assess using conventional evaluation tools (Pozenel et al., 2022).

From an ethical and cultural dimension, the implementation of gamification must also be carefully considered, as game mechanics may conflict with certain social and cultural values (Kim & Werbach, 2016). The development of effective gamification requires a significant investment of resources, including time, skills, and costs, which are often beyond the capacity of institutions with limited budgets (Al-Rayes et al., 2022; Souza et al., 2020). The burden on instructors to manage gamification and monitor participant progress can also add to the challenges, while issues related to time management and pacing often disrupt the learning flow that has been carefully designed (Alhammad & Moreno, 2020). Therefore, to achieve optimal results, gamification must be designed with a structured approach, taking into account various in-depth pedagogical and technological aspects.

1.5. Current Study

Several review studies on the topic of gamification have been conducted previously, each focusing on various aspects. Some researchers focus on the application of gamification in specific contexts, such as education and training (Dahalan et al., 2024; M. N. Islam et al., 2025; Triantafyllou, Georgiadis, et al., 2025), educational management (da Silva et al., 2019), medical education (Mccoy et al., 2016), nursing education (Angela et al., 2020), and physical education (Ferraz et al., 2024). Other researchers focus on particular disciplines, such as science education (Hashim et al., 2024; Kalogiannakis et al., 2021; Nurfadilah et al., 2025), foreign languages (Shang, 2025), and mathematics (Mayrhofer et al., 2025; Sánchez-arévalo et al., 2025). Regarding the level of education, some studies have successfully provided a comprehensive overview of the development of gamification research through bibliometric analysis in the context of education in general (Swacha, 2021), while others have focused on primary schools (Romero-Rodríguez et al., 2024; Yuan et al., 2024) and higher education (Khatibi et al., 2021).

Various review methods on the topic of gamification have also been conducted with diverse objectives. For instance, bibliometric analyses conducted by Goi (2023), Lopes et al. (2024) , Trinidad et al. (2021), and Yazdi et al. (2024) have provided comprehensive insights into the development of research trends. To address more specific findings, some researchers have conducted Systematic Literature Reviews (SLR) and have uncovered significant discoveries, such as the dimensions of gamification design and the technologies utilized in gamification within heritage contexts (Marques et al., 2023), the powerful effects of gamification elements in e-learning (Saleem et al., 2022), and various ways gamification is used in peer review contexts (Indriasari et al., 2020). Given the flexibility of gamification, which can be integrated with various pedagogical designs, some researchers have focused on how gamification can be used to achieve learning objectives. Several studies have mapped how gamification can be beneficial for critical thinking (Kassenkhan et al., 2025), computational thinking (Triantafyllou, Sapounidis, et al., 2025), and clinical reasoning (C.-Y. Lee et al., 2024).

Although previous research has provided significant insights, there has been no study specifically focused on gamification for creativity and creative thinking. Furthermore, most reviews have used single methods, which may limit a more holistic and comprehensive understanding of the topic. The use of a more diverse approach, such as combining multiple methods, can offer deeper insights and enrich the analysis results. To address the gap in understanding the challenges and potential of implementing gamification comprehensively across various learning contexts and education levels, this study employs a multi-method approach that combines bibliometric analysis and systematic literature review. This approach is used to gain a more comprehensive understanding of gamification for creativity and creative thinking, as well as to identify research trends, literature gaps, and further research that may not have been revealed through a single approach. Additionally, the depth of the findings is enhanced by identifying how gamification is integrated into learning and the challenges faced in implementing

gamification.

To provide clearer direction, this study is based on the following research questions:

- **RQ 1:** What are the characteristics of GCCT publications based on performance analysis?
- **RQ 2:** What are the trends and key research themes in GCCT based on science mapping?
- **RQ 3:** What gamification elements and pedagogical strategies are integrated as learning innovations to enhance creativity and creative thinking?
- **RQ 4:** What is the impact of implementing gamification strategies on creativity and creative thinking?
- **RQ 5:** What are the primary challenges educators face when implementing gamification strategies to enhance creativity and creative thinking in the classroom?

2. RESEARCH METHOD

2.1. Protocol

The protocol for this bibliometric and systematic literature review was preregistered on the Open Science Framework (https://doi.org/10.17605/OSF.IO/UQES2) to enhance methodological transparency and reproducibility and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). All datasets covering (i) search strategies and metadata; (ii) metadata files from Scopus, Web of Science (WoS), and PubMed after the initial screening stage; (iii) metadata files after the eligibility assessment process; and (iv) coding procedures in data extraction are available for public access and can be downloaded through Zenodo. Open access to these resources aims to encourage open science practices and facilitate further research in related fields.

2.2. Eligibility Criteria

This study adapted the SPIDER framework to determine eligibility criteria, following the guidelines outlined by Cooke et al. (2012) and Kurnaz & Koçtürk (2025) as shown in Table 2. These criteria ensure that studies included in the BA and SLR have methodological robustness and minimize bias in the findings. The SPIDER framework was chosen because it has the highest level of specificity in each database compared to the PICO or PICOS frameworks (Methley et al., 2014), which is appropriate for this study that is specific to the GCCT area.

Table 2: Criteria For The SPIDER Framework (Cooke Et Al., 2012; Kurnaz & Koçtürk, 2025).

Aspects	Criteria
(S) Sample	Everything related to the field of education, whether students or educators.
(PI) Phenomenon of Interest	The study focuses on gamification-creativity and/or gamification-creative thinking.
(D) Design	Eligible studies must be empirical studies, with experimental or non-experimental designs (for BA) and experimental designs (for SLR).
(E) Evaluation	For BA, eligible studies must report findings on correlations, effects, or perceptions of gamification approaches on creativity and/or gamification-creative thinking. For SLR, studies are required to evaluate the effects of gamification approach interventions on creativity and/or creative thinking.
(R) Research Type	For BA, eligible studies must be empirical studies reporting quantitative and/or qualitative data. For SLR, the reported data must be at least quantitative.

2.3. Information Sources And Search Strategy

Metadata was searched through three databases, namely Scopus, WoS, and PubMed. The search was completed on February 1, 2026. The combination of search terms was compiled based on the research sub-themes, namely gamification, creativity, critical thinking, and educational context. The query used for gamification was (gamifi*), while for creativity and creative thinking, the query used was (creativ*). To ensure that the metadata that appeared was related to the educational context, we used the query (education OR teach* OR learn* OR student* OR school OR universit* OR college). The search string used in the literature search process was compiled using Boolean operators, wildcards, and field tags, as presented in Appendix A. Although using the SPIDER framework, the initial metadata search in the database focused on the suitability of the (S) Sample and (PI) Phenomenon of Interest aspects. The suitability of the (D) Design, (E) Evaluation, and (R) Research Type aspects was assessed at the eligibility assessment stage. This was done so that the data obtained from each database would be more extensive and relevant to BA and SLR.

2.4. Study Selection And Data Collection Process

The study selection process was conducted in a structured manner to ensure that the metadata included in the BA and the documents included in the SLR were in accordance with the criteria so that

the conclusions obtained were minimally biased. The data collection process began by searching for metadata in three separate databases, followed by initial screening based on the criteria of publication year, document type, language, source type (Scopus specifically), and species (PubMed specifically). In general, the data selection process is shown in Figure 1.

In this study, inclusion and exclusion criteria were established to ensure that the publications analyzed were relevant, of high quality, and aligned with the research objectives. In the BA stage that answered RQ1–RQ2, these criteria served to filter documents that met the database standards, time range, publication type, and relevance to the topic of GCCT (gamification for creativity and creative thinking), so that publication performance analysis and knowledge mapping were carried out on a valid and consistent dataset. Meanwhile, in the SLR stage that answers RQ3–RQ5, inclusion and exclusion criteria are used to select empirical studies that explicitly discuss gamification elements, pedagogical strategies, their impact on creativity and creative thinking, and the challenges of their implementation in the context of learning. The establishment of these criteria aims to increase the transparency of the literature selection process, reduce study selection bias, and ensure that the findings of the BA and SLR are based on relevant, accountable, and replicable sources. All metadata eligible for BA was reselected based on inclusion-exclusion criteria to select documents eligible for the SLR stage. The inclusion-exclusion criteria for the BA and SLR stages are shown in Table 3.

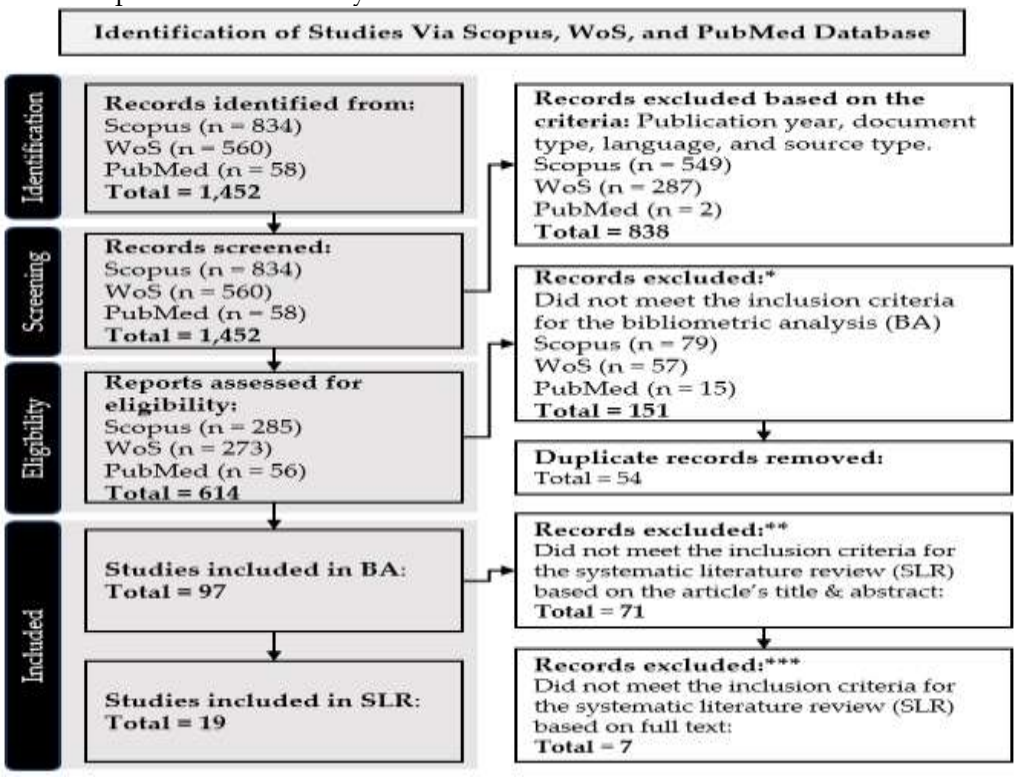

Figure 1: Metadata And Document Selection Process for Analysis.
(Source: Adapted From PRISMA 2020 (Page Et Al., 2021), With Modifications For The Context Of This Study).

Noted: *eligibility assessment for each database was conducted independently by three groups of authors, based on the title and abstract; **eligibility assessment was conducted independently by three groups of authors, based on the title and abstract; ***eligibility assessment was conducted independently by three groups of authors, based on the full text.

Table 3: Inclusion And Exclusion Criteria.

No.	Inclusion Criteria	Exclusion Criteria
General criteria (for BA and SLR):		
1.	Articles published between 2016 and 2026.	Articles published before 2016.
2.	Document type: article.	Document type: book, book chapter, proceedings, lecture notes, editorial, letter, note, erratum, short survey, report, etc.
3.	Document source: journal.	Document source: non-journal.
4.	Language: English.	Language: Non-English.

5.	Has primary data (empirical studies), both quantitative and qualitative.	Does not have primary data (literature studies or studies with secondary data).
Additional criteria for SLR:		
6.	Uses an experimental research design by applying gamification.	Does not use an experimental research design.
7.	There is a measurement of creativity or creative thinking.	There is no measurement of creativity or creative thinking.

(Source: Synthesized by the Authors Based on the Inclusion and Exclusion Criteria for the BA And SLR)

2.5. Data Analysis

2.5.1. Bibliometric Analysis

Data analysis in BA is conducted through two main stages. First, performance analysis will be applied to answer RQ1 by quantifying bibliographic data, including the identification of main information, annual trends in the number of publications and citations, and the most cited documents. This analysis uses the Bibliometrix R-package software. Some of the data presented in the analysis is then re-represented using Microsoft Excel to make it more informative. Second, to answer RQ2, science mapping is conducted to reveal the intellectual structure and research trends through the analysis of trends and key research themes in GCCT. In this section, the Bibliometrix R-package was used to analyze the most frequent words, trend topics, and thematic maps, while VOSviewer was used to analyze the network visualization of terms in GCCT. In an effort to minimize bias in the visualization of term analysis, two or more identical terms were combined. For example, the terms "attitude" and "attitudes" were combined because they represent the same thing.

2.5.2. Systematic Literature Review

The coding guide was developed to extract information from the included studies. The information extracted included (1) general information (such as region or country, subject or discipline, and education level); (2) gamification impact for CCT; (3) gamification elements; (4) pedagogical innovation; and (5) primary challenges of implementing gamification. The coding guide was developed by determining themes, sub-themes, operational definitions, and coding indicators based on the analysis and synthesis of previous studies (see Appendix C).

Data analysis was conducted in four stages to ensure the accuracy of the findings. First, four authors (M.R.A.T., R.A.P., A.S., and S.N.M.R.) jointly reviewed relevant studies to design coding guidelines. Second, based on the coding guidelines that had been compiled; to strengthen reliability, three groups of authors analyzed the documents independently. The first group of authors (M.R.A.T. and R.A.P.), the second group of authors (A.S. and S.N.M.R.), and the third group of authors (M.Z.M. and S.R.) analyzed all documents independently. Scoring is done for each code based on the information that appears in the document, with a score of 0 for information that does not appear and a score of 1 for information that does appear. An exception is made for scoring on the coding of the country where the study was conducted. If all raters list the same country, a score of 1 is given. The overall inter-rater agreement across all studies reached 0.915, which can be interpreted as "near-perfect agreement" because it has a score of $\alpha > 0.8$ (Hughes, 2024). This value represents Krippendorff's Alpha across all coding themes. The Krippendorff's Alpha values for each theme are 0.959 for general information, 1.000 for gamification impact for CCT, 903 for gamification elements, 0.771 for pedagogical innovation, and 0.796 for primary challenges. For this qualitative data analysis, we did not use Krippendorff's Alpha. Krippendorff's Alpha is only used to measure the level of agreement between coders (inter-coder reliability). In this study, data reliability was obtained through consensus discussions. Differences of opinion were resolved through repeated discussions until agreement was reached by re-examining the original text to ensure accuracy and that no important information was overlooked.

3. RESULT

3.1. Gcct Publication Characteristics (Rq1)

3.1.1. Main Information

Table 4 presents an overview of the characteristics of publication data related to research trends, publication intensity, and researcher collaboration patterns on the topic of gamification in the development of creativity and creative thinking during the period 2016–2026. In the last decade, a total of 97 documents from 83 scientific sources were recorded in the Scopus, WoS, and PubMed databases. The annual growth rate of 7.18% indicates a stable upward trend in publications, signaling increased researcher interest in the use of gamification as a learning innovation. The average age of the documents is 3.18 years, indicating that most of the publications are relatively new, so this topic can be categorized as an emerging research

area. This is reinforced by an average citation of 11.48 per document, which indicates that research in this field has considerable relevance and academic influence. In terms of authorship, there are 428 authors consisting of 97 documents, indicating a high level of academic participation. In addition, only 9 (9.28%) documents were written by a single author, and the average number of co-authors per document was 5.1, indicating that research in this field is dominated by collaborative work. Information about the percentage of international co-authorship of 13.4 also shows that cross-country collaboration has begun to form, but is still moderate. This opens up great opportunities for broader international collaborative research, especially in examining the application of gamification in various cultural contexts and different systems.

Table 4: Main Information.

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2016:2026
Sources	83
Documents	97
Annual Growth Rate %	7.18
Document Average Age	3.18
Average citations per doc	11.48
AUTHORS	
Authors	428
Authors of single-authored docs	9
AUTHORS COLLABORATION	
Single-authored docs	9
Co-Authors per Doc	5.1
International co-authorships %	13.4

(Source: Analysis Conducted by the Authors Using the Bibliometrix R-Package)

3.1.2. Annual Producation & Citation

Figure 2 shows the dynamics of publication development and its impact based on citations obtained. In general, the number of articles published has experienced a significant upward trend, especially after 2021. In the early phase (2016-2018), publication productivity was still relatively low, indicating that this topic was not yet a major focus of research. There was an increase in 2019, and it remained consistent until 2021. After that, the number of publications continued to increase, reaching its peak in 2025. The sharp increase in the number of articles indicates growing academic interest in gamification as a learning innovation. Meanwhile, the mean total citation per year (MTCpY) shows a different pattern, with relatively high citation values in the early years and a downward trend in recent years. This pattern indicates that earlier articles had more time to obtain citations, while recent publications, despite their increasing number, do not yet fully reflect a high citation impact. Overall, these findings indicate a shift from an exploratory phase to an expansion phase of research, while confirming that this field still has the potential for long-term academic impact.

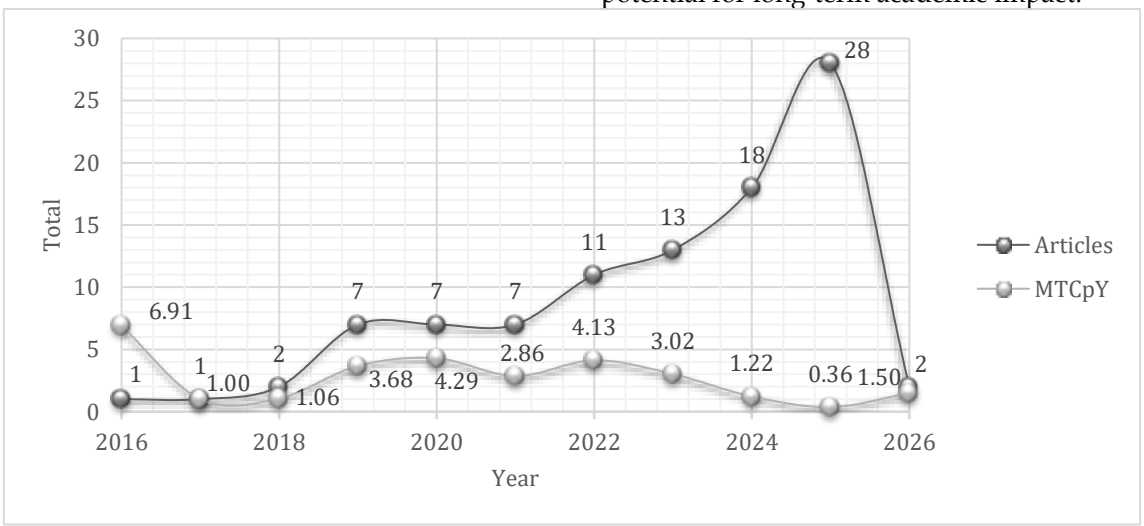

Figure 2: Annual Articles Production and Mean Total Citation Per Year.

(Source: Visualization of Bibliometric Analysis Results Using the Bibliometrix R-Package, Re-Visualized with Microsoft Excel by the Authors).

Table 5 shows the ten documents with the highest global citations. These findings highlight that although dominated by non-open-access documents (*f* = 6), these documents still received high citations because five of them came from major publishers such as Elsevier, Springer, and SAGE. One of the non-open-access documents was published by SLACK Incorporated, a publisher that focuses more on health and medicine. Although it is not a large publisher that publishes multidisciplinary and broad-scope articles, the document may be highly relevant to gamification research in health education, making it a frequent reference. Furthermore, for open-access documents, in addition to the relevance of the topic to current research, the large number of citations obtained is due to the ease of accessing these documents. From a time distribution perspective, the distribution of publication years shows that 90% of articles were published in the period 2019–2022, while only one article was published in 2016.

Table 5: Top 10 Most Global Cited Documents.

Author(s), PY	TC	TCpY	Publisher	Open Access
Chen & Chiu (2016)	76	6.91	Elsevier	No
Wannapiroon & Pimdee (2022)	65	13.00	Springer	No
Arnab et al. (2019)	55	6.88	Academic Conferences & Publishing International	Yes
Mee et al. (2020)	54	7.71	Institute of Advanced Engineering and Science (IAES)	Yes
García-Viola et al. (2019)	50	6.25	SLACK Incorporated	No
Alt & Raichel (2020)	48	6.86	Elsevier	No
Moseikina et al. (2022)	45	9.00	SAGE Publications	No
Parjanen & Hyypiä (2019)	41	5.13	Elsevier	No
Kummanee et al. (2020)	38	5.43	IACSIT Press	Yes
Pozo-sánchez et al. (2022)	36	7.20	Universidad de Alicante	Yes

(Source: Analysis conducted by the authors using the Bibliometrix R-package, with additional information on publisher and access status (open/closed) for each document; PY: publication year; TC: total citation; TcpY: total citation per year)

The fact that relatively new articles have obtained a high number of citations in a short period of time indicates the characteristics of a fast-moving research field. In rapidly developing fields, the cycle of knowledge diffusion becomes shorter due to the high intensity of publications, global collaboration networks, and accelerated dissemination through digital platforms and international indexing. This indicates that scientific impact no longer depends entirely on the accumulation of time, but also on the relevance and urgency of the research topic. Thus, not all articles with high citations originate from older periods. Instead, the data shows that new articles are able to gain academic attention quickly. This condition reinforces the assumption that the relevance of the research topic is the main determinant in the acceleration of citations.

3.2. Tren Dan Tema Key Research In GCCT (RQ2)

3.2.1. Most Frequent Words

Figure 3 shows the most relevant words (terms) on the topic of GCCT, with "gamification" being the most frequently occurring term (*f* = 63). The next most frequently occurring terms are "motivation" (*f* = 19) and "education" (*f* = 18), indicating that gamification research in the context of education is most often associated with increasing student motivation. In relation to the GCCT context, the term "creativity" appears more frequently (*f* = 15) than "creative thinking" (*f* = 9), indicating that research on gamification focuses more on creativity than creative thinking. The findings from this data also highlight the term "higher education" (*f* = 12) as the only term related to education level. This shows that gamification research is mostly applied in the context of higher education compared to lower levels of education.

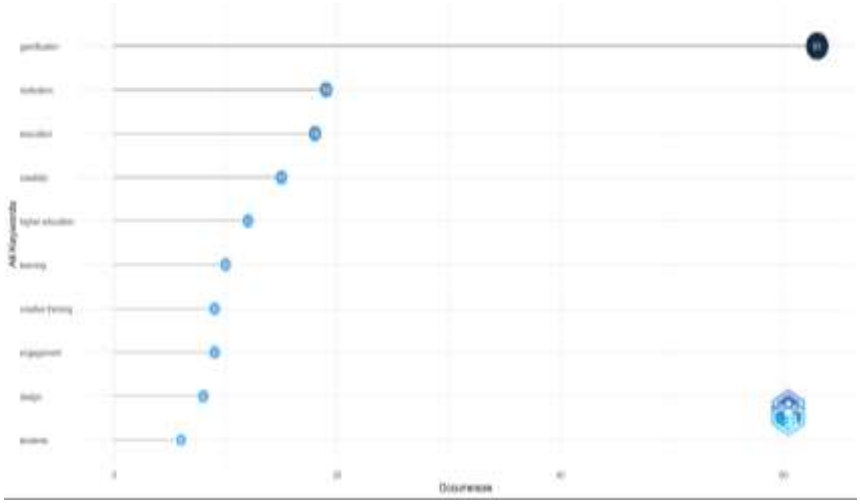

Figure 3: Most Relevant Words In GCCT.
(Source: Analysis Conducted by the Authors Using the Bibliometrix R-Package)

3.2.2. Trend Topics

The circles shown in Figure 4 indicate the frequency of term occurrence, with the horizontal lines representing the range between the first and second quartiles. The circles show the period and extent to which the keywords achieved popularity. The term "gamification" (f = 57) was the most popular topic throughout the research period, followed by 'creativity' (f = 14) and "motivation" (f = 14). Other trending topics also emerged, including creative thinking (9), learning (7), and engagement (6). Finally, active learning (3), educational innovation (3), and serious games (3). Creative thinking dominated the research (2020-2025) and continued throughout the period, indicating that this topic was a focus. Additionally, creativity and gamification (2022-2025) further clarify that this research focuses not only on creative thinking but also on creativity. This explains that gamification is generally aimed at developing creativity and creative thinking. Serious games (2024-2025) and engagement (2024-2025) are the latest trends that show the increasing popularity of entertainment-oriented gamification in serious learning objectives.

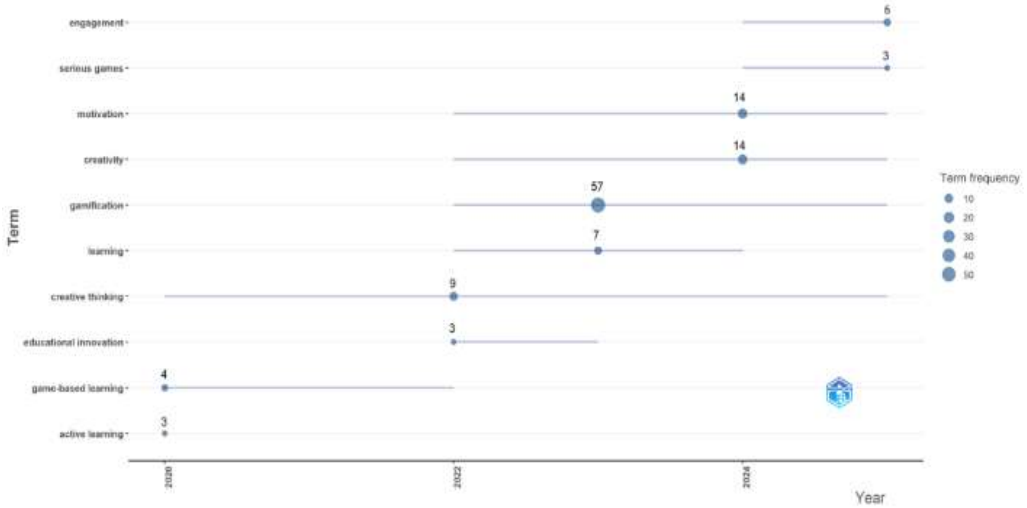

Figure 4: Trend Topics In GCCT.
(Source: Analysis Conducted by the Authors Using the Bibliometrix R-Package).

3.2.3. Co-Occurrence Network

Figure 5 presents a visualization of a bibliometric network based on keyword co-occurrence generated using VOSviewer. This map illustrates the structure of international research on gamification in the context of education. Terms grouped in a cluster indicate that they have a strong relationship in the analyzed literature, which may reflect a similar or interrelated research focus in the studies reviewed. The clustering of dominant terms is shown in Table 6. The first cluster identifies several important terms,

such as "gamification," "creative thinking skill," "STEM," and "higher education." These terms reveal that gamification is not just a tool to attract students' attention, but also an in-depth method for developing creative thinking skills at the higher education level (Mauri-Medrano et al., 2024; Zhu et al., 2025). In this context, active learning and collaboration play an important role in creating a more interactive and participatory learning environment, where students are involved in a learning process that integrates digital literacy and educational innovation (Bal, 2019; Marin-mantilla & Moscoso-barrera, 2025; Wong, 2021). Thus, gamification is considered an important element in facilitating a more comprehensive learning experience and building essential skills for a dynamic professional world.

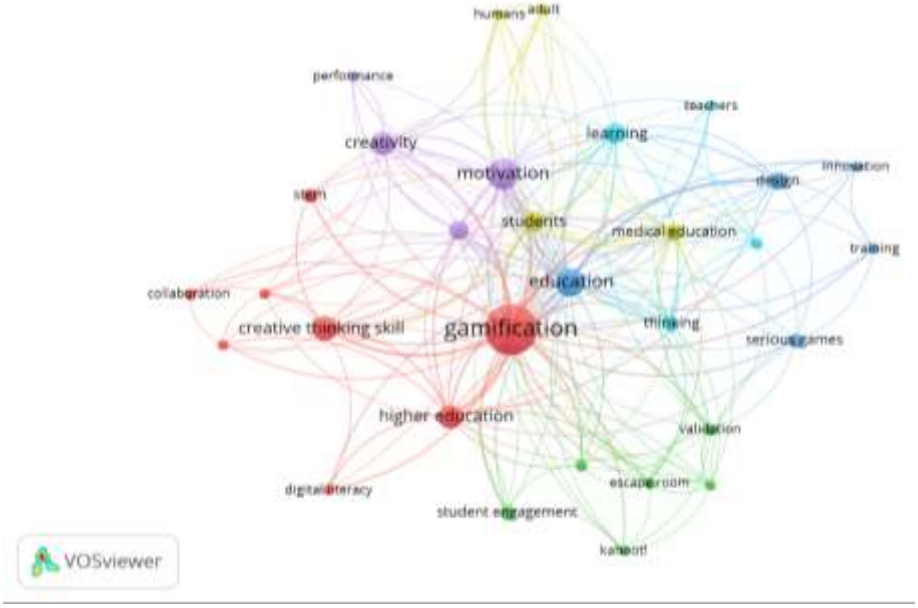

Figure 5: Network Visualization of Terms In GCCT.
(Source: Analysis Conducted by the Authors Using the Vosviewer).

Table 6: Clustering Of Terms In GCCT.

Cluster	Terms
Cluster 1	Active learning; Collaboration; Creative thinking skill; Digital literacy; Educational innovation; Gamification; Higher education; STEM.
Cluster 2	Escape room; Game-based learning; Gameful experience; Kahoot! Student engagement; Validation.
Cluster 3	Education; Innovation; Serious games; Training.
Cluster 4	Adults; Humans; Medical education; Students.
Cluster 5	Creativity; Engagement; Motivation; Performance.
Cluster 6	Impact; Learning; Teachers; Thinking.

(Source: Analysis Conducted by the Authors Using the Vosviewer).

Meanwhile, the second cluster, which highlights the terms "game-based learning," "escape room," and "Kahoot!" illustrates how gamification can enrich the learning experience with a game-based approach. The concept of student engagement is key to increasing student motivation and attention in learning, especially by utilizing fun and challenging game elements (Antón-Solanas et al., 2022; Balaskas et al., 2023). The use of validation in this context shows that gamification is not just about entertainment, but also about evaluating and recognizing student achievement, which further encourages their involvement in the learning process (Srivastava et al., 2025; Stathakarou et al., 2024). This shows that game-based experiences have great potential to create more immersive and interactive learning experiences.

Furthermore, the third cluster emphasizes the importance of educational innovation and serious games in training and education. Here, gamification is considered an effective tool for transforming traditional learning into a more creative and solution-based process (Alarcon et al., 2025; Villarrubia et al., 2024). Training presented in a serious game format can improve students' understanding in a more applicable way, while developing critical thinking and problem-solving strategies relevant to the world of work (Kloeckner et al., 2021; López-Serrano et al., 2025). In this context, gamification not only increases engagement but also

supports the development of practical skills needed by students.

More specific concepts emerge in the fourth cluster, which includes "medical education" and learning for "adults". In this cluster, there are indications that the application of gamification in medical education has great potential to help students understand complex concepts through game-based simulations that provide practical experience (Stathakarou et al., 2024; Zhou et al., 2024). This is even more relevant in the context of medical education, which requires highly specific clinical and theoretical skills. Thus, gamification is not limited to general education, but also to more focused and technical disciplines.

Finally, the fifth and sixth clusters highlight the concepts of "creativity", "motivation", and "performance". This indicates that gamification has a direct impact on the development of students' psychological and cognitive aspects (Dubiaha et al., 2025). Increased creativity and motivation through gamification not only improve academic outcomes but also strengthen students' commitment to the learning process (de la Peña et al., 2021; Kersánszki et al., 2023). Thus, gamification serves as more than just an educational innovation but as an element that changes the way students interact with subject matter, improving their performance in an educational context.

3.2.4. Thematic Map

The thematic map in GCCT shown in Figure 6 provides two pieces of information: the extent to which a theme has developed (vertical axis) and how central or relevant a theme is in the context of GCCT (horizontal axis). The lower left quadrant shows the least relevant and least developed themes, such as "learning motivation," "gamified learning," "21st century skills," etc. These themes are underdeveloped, possibly indicating that they are in the early stages of exploration or that their popularity is declining in the context of gamification research. The lower right quadrant shows relevant but underdeveloped themes, consisting of "games," "environments," "skills," and "digital games." These findings indicate that although these themes are important, their application is less central to gamification research for creativity and creative thinking. They are often explored in relation to broader educational themes but do not dominate the research landscape, reflecting a more fundamental or supplementary role in gamification. On the other hand, the upper left quadrant shows developing but less relevant themes, consisting of "game design," "soft skills," and "teacher training." These themes are less developed and specialized within broader fields, indicating niche areas where gamification may not be prominently discussed or applied. The theme of "game design" is a developing theme, but it is not a central theme because in gamification, game elements are integrated into non-game contexts. Finally, the most developing and relevant themes in GCCT are shown in the upper right quadrant, consisting of several terms, such as "creativity," "creative thinking," "motivation," "collaboration," "medical education," "nursing education," etc. This quadrant represents Motor Themes, indicating significant opportunities for future research development in these themes.

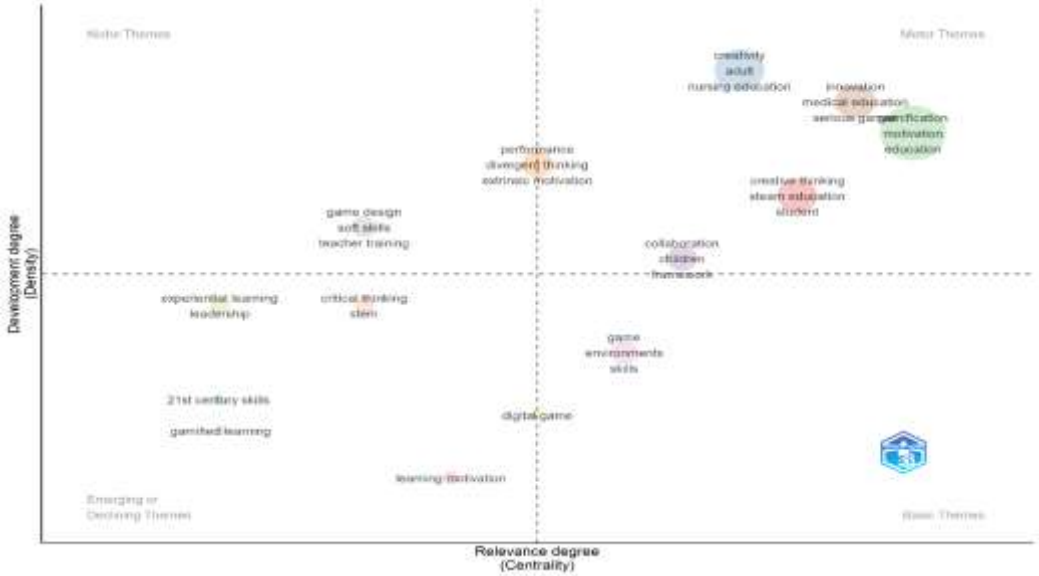

Figure 6: Thematic Maps In GCCT.
(Source: Analysis Conducted by the Authors Using the Bibliometrix R-Package).

3.3. Learning Innovations In GCCT (RQ3)

Based on 19 studies eligible for review (Table 7), the countries where the studies were conducted were dominated by China (*f* = 4; 21.95%), Thailand (*f* = 4; 21.95%), and Taiwan (*f* = 3; 15.79%), indicating serious attention from these countries to game-based learning innovations to stimulate creativity. Other countries were also identified, such as Indonesia, Spain, Colombia, Saudi Arabia, Ukraine, and Jordan. This Asian dominance indicates that countries in the region, with their various challenges and educational reforms, are actively exploring gamification as a potential solution for developing 21st-century skills.

Table 7: Overview Of Included Studies in SLR (N = 19).

Study ID	Author(s) & PY	Region/ Country	Subject/Discipline	Education Level
S01	(Huang et al., 2026)	China	Arts/Design/Creativity Studies	University
S02	(C.-H. Chen & Chiu, 2016)	Taiwan	Mathematics	Primary School
S03	(Zainuddin, 2024)	Indonesia	Business/Economics/ Entrepreneurship	University
S04	(Marin-mantilla & Moscoso-barrera, 2025)	Colombia	Engineering	Senior High School
S05	(Zhu et al., 2025)	China	Health Sciences/ Medicine/Nursing/ Public Health	University
S06	(Dubiaha et al., 2025)	Ukraina	General Education	Primary School & Junior High School
S07	(Aljraiwi, 2019)	Saudia Arabia	Language Learning	Primary School
S08	(Lu, 2025)	China	Arts/Design/Creativity Studies	University
S09	(T. Chen et al., 2023)	Taiwan	Computer Science/Programming/ Informatics	University
S10	(Zhou et al., 2024)	China	Health Sciences/ Medicine/Nursing/ Public Health	University
S11	(Parody et al., 2022)	Spanyol	Engineering	University
S12	(Aibar-Almazán et al., 2024)	Spanyol	Health Sciences/ Medicine/Nursing/ Public Health	University
S13	(Wannapiroon & Pimdee, 2022)	Thailand	Arts/Design/Creativity Studies	University
S14	(Chaiyarat, 2024)	Thailand	Social Sciences	Junior High School
S15	(P. Chen et al., 2020)	Taiwan	General Education	Primary School
S16	(Hasan et al., 2026)	Indonesia	Science	Junior High School
S17	(Ali et al., 2024)	Yordania	Language Learning	Primary School
S18	(Dangprasert, 2023)	Thailand	General Education	University
S19	(Wannapiroon & Petsangsri, 2020)	Thailand	STEM (General)	University

(Source: Analysis Conducted by the Authors).

Based on an analysis of the distribution of disciplines in research on gamification for creativity, it was found that the focus of studies was spread across various fields with varying degrees of concentration. Three main domains dominate the research landscape, namely Health Sciences/Medicine/Nursing/Public Health, Arts/Design/Creativity Studies, and General Education, each of which had the highest frequency of occurrence (3 studies). This indicates an urgent need for innovative solutions to stimulate creative thinking in the health sector (e.g., for patient diagnosis or treatment), the arts and design fields that inherently require creativity, and general education that seeks to integrate more engaging learning methods.

Meanwhile, disciplines such as Engineering and Language Learning are in the middle (2 studies each), which indicates considerable potential for research development in these fields. Interestingly, although research is spread across STEM (Science, Technology, Engineering, and Mathematics) fields as a whole, the concentration in each subfield, such as STEM Education, Mathematics, Science, and Computer Science, is still relatively low (1 study per field). This pattern reveals that although gamification has touched various scientific fields from the social sciences to Business, the main focus remains on fields that directly require innovation in practice (health and arts) and in the broad context of general education, but not yet deeply in pure technical disciplines.

Research information based on education level shows a dominance at the higher education level (*f* =

11; 57.89%) of research focused on universities. Meanwhile, at the primary and secondary education levels, research is more limited. No research has been identified at the early childhood and non-formal education levels, indicating that gamification for creativity and creative thinking development is still more widely applied in higher education, although there are efforts to explore its application at lower levels.

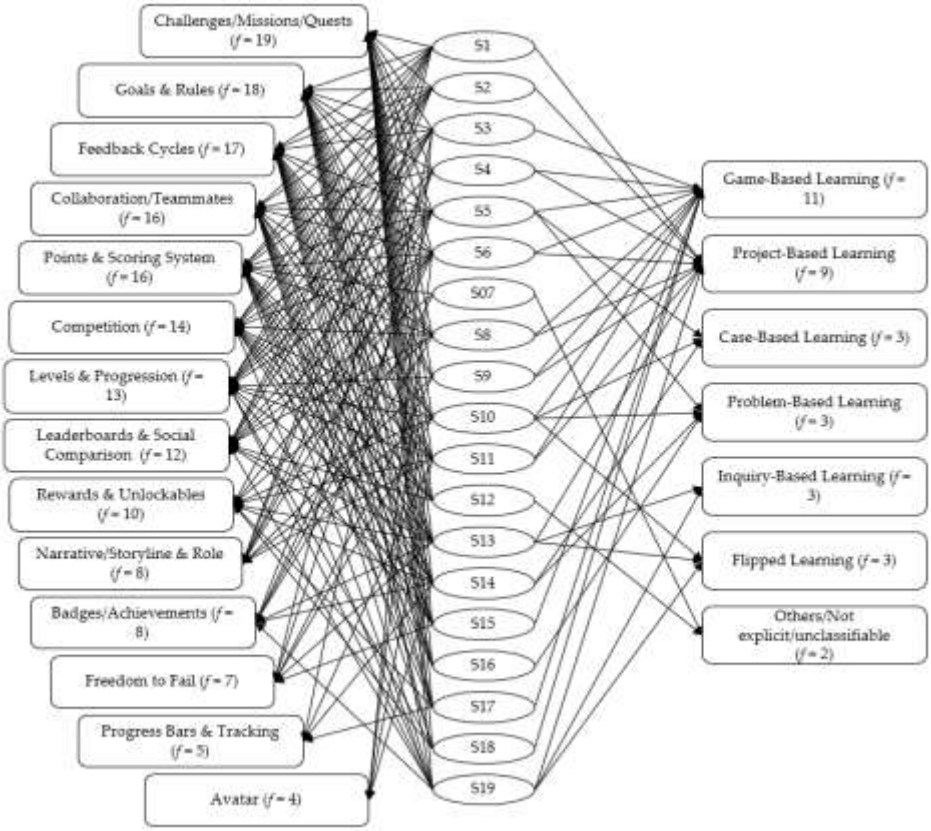

Figure 7: Mapping Learning Innovation Based on the Integration of Gamification Elements and Pedagogical Strategies.

(Source: Analysis Conducted by the Authors).

The analysis of 19 articles confirms that gamification relies on core elements that consistently build creativity and creative thinking. The most universal element is challenges, missions, or quests that appear throughout the studies (Figure 7). This element serves as a structural and contextual framework that transforms abstract learning tasks into authentic and meaningful problem-solving experiences. By providing real-world scenarios and clear objectives, these missions not only direct and focus students' creative efforts within productive boundaries but also significantly increase their intrinsic motivation and engagement through immersive narratives and accompanying competitive elements (C.-H. Chen & Chiu, 2016; Huang et al., 2026; Zhu et al., 2025). These challenges are inherently linked to the goals & rules element (f = 18; 94.74%), which provides clear structure and success criteria. Clear structures, such as explicit project stages (Huang et al., 2026), fixed time allocations (C.-H. Chen & Chiu, 2016), and strict rules (Zhou et al., 2024) are useful for directing students' creativity toward problem solving rather than procedural confusion. Meanwhile, transparent success criteria, such as tiered assessment rubrics (C.-H. Chen & Chiu, 2016) or quantitative point targets (Zhu et al., 2025), provide clear benchmarks for students to evaluate and refine their creative work. Thus, the goals & rules element does not limit creativity, but rather creates productive constraints that trigger innovation and facilitate meaningful feedback. Another key element is the feedback cycle (f = 17; 89.47%). Dubiaha et al. (2025) in their survey of teachers found that "prompt feedback" is a crucial mechanism for recognizing achievement and motivating student learning, which in turn supports the development of creative thinking.

In addition to these fundamental elements, the analysis findings highlight how social and structural elements are increasingly being integrated to enrich

the creative learning experience. Points & scoring system (*f* = 16; 84.21%), collaboration or teammates (*f* = 16; 84.21%), competition (*f* = 14; 73.68%), levels & progression (*f* = 13; 68.42%), and leaderboards (*f* = 12; 63.16%) have been proven effective in encouraging engagement. C.-H. Chen & Chiu's (2016) experiment specifically showed that groups with intergroup competition mechanisms had significantly better creativity scores than groups without competition, with the leaderboard displaying the top three teams and their design and collaboration scores. This is reinforced by Dubiaha et al.'s (2025) finding that 68% of teachers actively use competitive elements to increase motivation and learning outcomes. Uniquely, the freedom to fail element (*f* = 7; 36.84%) reflects an important pedagogical shift. T. Chen et al. (2023), in their study on gamified educational robots, emphasized the importance of creating an environment where students are encouraged when they make mistakes, allowing them to receive inspiration without destroying their emotions, and to try unknown things. This principle is essential for creative experimentation. The narrative/storyline & role element (*f* = 8; 42.11%) is also useful in training CCT, as shown by Huang et al.'s (2026) study, which found that pretending to be a scientist, whether hardworking or brilliant, significantly increases children's persistence in science activities. The avatar element is the least implemented (*f* = 4; 21.05%), which supports student personalization and identity, such as creating preferred avatars in ClassDojo (Chaiyarat, 2024) or using avatars in the Classcraft platform (Parody et al., 2022), where avatars are said to increase learning motivation (Dubiaha et al., 2025). Overall, this evidence confirms that gamification for CCT is a multidimensional approach that combines structured challenges, iterative feedback, social dynamics (competition and collaboration), and a safe space for experimentation within an immersive narrative framework.

Figure 7 also shows how these gamification elements are integrated into pedagogical strategies. In the identified studies, some of them integrate gamification elements into several pedagogical strategies at once. The combination of several pedagogical strategies has the potential to enrich the learning experience of students, as demonstrated in the study by Wannapiroon & Petsangsri (2020), which applied project-based learning, flipped learning, and inquiry-based learning in their teaching. A similar multidimensional approach was also seen in the study by Zhou et al. (2024), which combined problem-based learning, case-based learning, flipped learning, and game-based learning in an educational escape room for nursing students, as well as Zhu et al. (2025), which combined case-based learning, inquiry-based learning, and game-based learning through the game "Gene Detective."

The results of the analysis show that in the context of learning to train creativity and creative thinking, game-based learning (*f* = 11; 57.89%) and project-based learning (*f* = 9; 47.37%) are the two dominant pedagogical strategies. Gamification is effective for creativity and creative thinking because it encourages active engagement, exploration, and problem-solving in a fun and challenging environment. This is evidenced by research using quiz platforms such as "Quizizz" and "Kahoot!" to increase engagement and critical thinking (Zainuddin, 2024), or the use of role-playing games such as Classcraft, which creates an "immersive role-playing culture" to encourage continuous participation (Parody et al., 2022). Other forms, such as educational escape rooms, have also been shown to facilitate critical collaborative problem solving (Zhou et al., 2024), while structured gamification designs with exercise, achievement, and reward system elements are directly targeted at honing students' creative and innovative thinking skills (Dangprasert, 2023).

Meanwhile, project-based learning plays a role in providing opportunities for students to apply their ideas in real projects, which encourages exploration, innovation, and practical solutions. The integration of gamification into PjBL has proven effective in guiding students through clear project phases, as seen in the study by Huang et al. (2026) which used team competitions and point-based rankings in cultural preservation projects, or Lu's (2025) research which organized creative competitions for the creation of interactive art products with a system of points, badges, and leaderboards. Even in complex engineering projects, gamification through educational robots is used to provide challenges and feedback that motivate students during the design and prototyping process (T. Chen et al., 2023). These studies show that gamification is not just a fun addition, but is integrated into project stages, such as to mark milestone achievements (Dubiaha et al., 2025; Wannapiroon & Pimdee, 2022) and encourage effective teamwork (Huang et al., 2026).

Other pedagogical strategies applied in learning include Case-Based Learning, Problem-Based Learning, Inquiry-Based Learning, and Flipped Learning. Case-based learning is implemented by presenting realistic scenarios, such as clinical cases (Zhou et al., 2024; Zhu et al., 2025) or social problems (Chaiyarat, 2024) that students must analyze.

Problem-based learning is seen in the J-PBL (Joyful Problem-Based Learning) model, which integrates traditional games into each phase of problem solving to create meaningful learning (Hasan et al., 2026). Inquiry-based learning is realized through the investigation and discovery phases in the STEAM-ification model (Wannapiroon & Pimdee, 2022), as well as the process of "solving clues" and providing evidence-based reasoning in detective games (Zhu et al., 2025). Finally, flipped learning is implemented by providing pre-class gamified materials and activities through an online platform, so that face-to-face time can be focused on active application and collaboration (Wannapiroon & Petsangsri, 2020; Wannapiroon & Pimdee, 2022; Zhou et al., 2024).

3.4. The Impact Of Gamification On Creativity And Creative Thinking (RQ4)

Based on a synthesis of 19 studies reviewed, all studies showed the positive impact of gamification on increasing creativity and creative thinking in various educational contexts. The findings indicate that certain game mechanics directly target different indicators of creativity. For example, points, timers, and repeated challenges significantly encourage fluency by triggering rapid and abundant idea generation (Aljraiwi, 2019; Dangprasert, 2023). Competitive elements such as badges and leaderboards stimulate flexibility and originality, motivating students to develop unique strategies and unconventional solutions to outperform their peers (Ali et al., 2024; Aljraiwi, 2019). Deeper cognitive processes such as elaboration are facilitated through collaborative tasks and clear feedback mechanisms (Dangprasert, 2023; Hasan et al., 2026). More complex gamification designs, such as role-playing (Parody et al., 2022; Zhou et al., 2024), puzzle-based escape rooms (Zhou et al., 2024), and intergroup competitions (C.-H. Chen & Chiu, 2016), further enhance creative cognition by encouraging divergent thinking, perspective-taking, and adaptive problem-solving under productive constraints such as time pressure.

Beyond individual mechanics, this synthesis highlights critical mediating factors and conditions that amplify gamification's impact on creativity and creative thinking. A key finding is the role of increased motivation and engagement as a psychological bridge between game elements and creative outcomes. Gamification elements such as team competition and role-playing increase intrinsic motivation, leading to higher cognitive and emotional engagement, which in turn fosters a flow state conducive to creative thinking (Chaiyarat, 2024; C.-H. Chen & Chiu, 2016; Huang et al., 2026). The collaborative nature of many gamification approaches is also crucial, as team-based problem solving allows for the synthesis of diverse perspectives, resulting in more innovative outputs (Huang et al., 2026; Zhou et al., 2024). However, the synthesis also reveals that effectiveness depends on design and dosage. Integration with pedagogical models such as STEAM or project-based learning is essential (Wannapiroon & Pimdee, 2022), and the "dosage" of gamification is important, where significant increases in creative intelligence are only observed with adequate exposure duration (Aibar-Almazán et al., 2024). Overall, this research concludes that well-designed gamification, which strategically combines competitive, collaborative, and narrative elements, creates a supportive ecosystem that significantly enhances the cognitive and affective dimensions of student creativity.

3.5. Primary Challenges (Rq5)

Figure 8 shows the mapping of challenges when applying gamification in learning, where studies identify the challenge of measuring the impact on creativity as the most critical issue (f = 11; 57.89%). The complexity of the multidimensional construct of creativity makes the quantification process difficult, while the self-assessment instruments that are often used are not always in line with students' objective performance (Hasan et al., 2026; Zhu et al., 2025). The phenomenon of the recalibration effect further complicates the situation, where a decrease in self-perception scores may actually reflect an increase in metacognition after students experience experiential learning, rather than a decline in creative ability (Marin-mantilla & Moscoso-barrera, 2025). The inability of researchers to isolate the effects of gamification from other pedagogical variables, as well as the focus of measurement that only touches on the process aspect and ignores creative products, further complicates the validity and generalization of the findings (C.-H. Chen & Chiu, 2016; P. Chen et al., 2020).

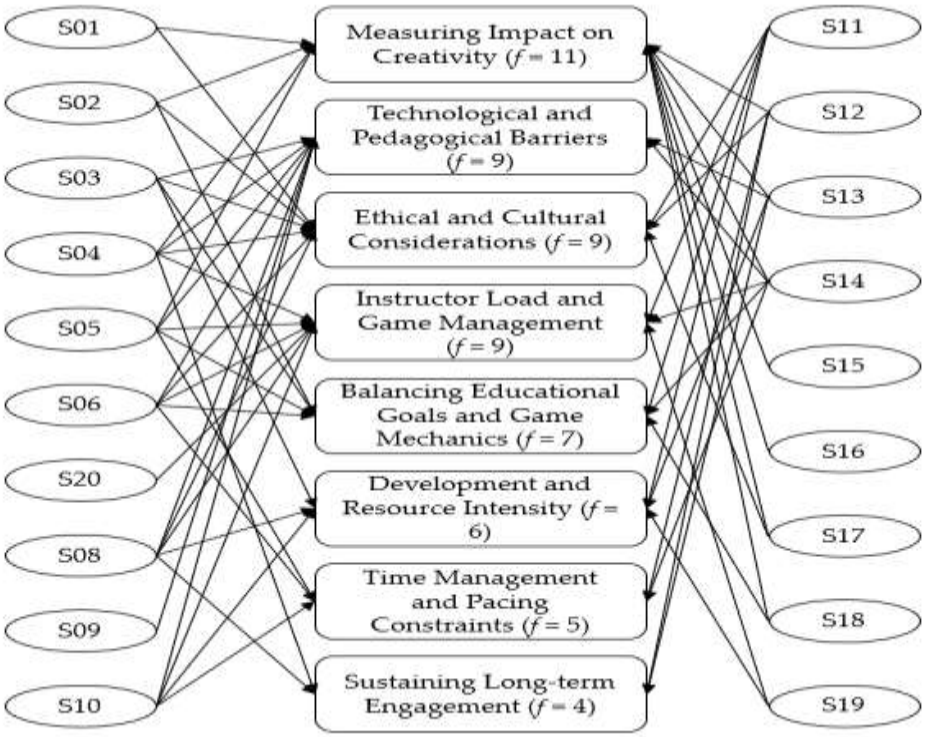

Figure 8. Mapping Primary Challenges in Implementing Gamification For CCT.
(Source: Analysis Conducted by the Authors).

Another equally significant structural challenge is technological and pedagogical barriers (*f* = 9; 47.37%) and ethical & cultural considerations (*f* = 9; 47.37%). In developing countries, infrastructure limitations such as internet access and devices, low digital literacy among teachers, and platforms that are incompatible with learning needs are major obstacles to implementation (Marin-mantilla & Moscoso-barrera, 2025; Zainuddin, 2024). Meanwhile, from an ethical perspective, competitive pressure from elements such as leaderboards has been shown to cause anxiety in some students (Lu, 2025) and risks undermining collaboration if the intensity of competition is not carefully managed (C.-H. Chen & Chiu, 2016). Cultural factors and students' socioeconomic backgrounds also influence the effectiveness of gamification, so approaches that are successful in one context cannot necessarily be replicated in another cultural context (Aibar-Almazán et al., 2024; Dubiaha et al., 2025).

Additionally, the burden on instructors (*f* = 9; 47.37%) indicates that the transformation of the teacher's role is a serious challenge. Educators are not only required to master the material but also to play a dual role as facilitators, game designers, and classroom managers who monitor the game in real time (Lu, 2025; Wannapiroon & Petsangsri, 2020). This condition is exacerbated by the intensity of resources required to design quality gamification, with several studies reporting the need for a multidisciplinary team involving professional game designers and technology engineers (Zhou et al., 2024). The challenges of balancing educational objectives with game mechanics (*f* = 36.84%) and time management and pacing (*f* = 5; 26.32%) add to the complexity of implementation, especially when the novelty effect begins to fade, and student motivation tends to decline over time (Aibar-Almazán et al., 2024; Lu, 2025). Thus, the success of gamification for creativity requires a holistic approach that not only focuses on game mechanics design but also considers infrastructure readiness, educator competence, cultural sensitivity, and the availability of assessment instruments capable of capturing the nuances of creativity in a comprehensive and sustainable manner.

4. DISCUSSION AND CONCLUSION

4.1. Gcct Publication Characteristics (Rq1)

The steady growth in publications confirms that gamification for creativity and creative thinking (GCCT) has transformed from a peripheral study to a mainstream topic in educational technology research. This growth rate reflects the academic community's response to global trends in addressing issues related to developing 21st-century skills, where creativity is positioned as one of the key

competencies in various international education policy frameworks (OECD, 2025; WEF, 2023). When compared to other fields of educational technology research, the growth rate of GCCT is in the moderate category—slower than research on artificial intelligence in education, but faster than studies on conventional e-learning. This indicates that GCCT is in a consolidation phase, with the potential for continued growth in the future.

The dominance of collaborative publications reflects the epistemological complexity of GCCT studies. Creativity as a psychological construct requires measurement expertise from psychometrics, while gamification design requires competence from computer science and instructional design. This multidisciplinary collaboration is not merely a methodological preference, but a substantive necessity. From the perspective of modern science, phenomena such as GCCT occupy the "Pasteur's quadrant" zone—research that pursues both fundamental understanding and practical considerations (C. Chen et al., 2019; Mangel, 2024). Collaboration is a prerequisite for bridging these two orientations.

On the other hand, the low percentage of international collaboration indicates that GCCT research is still concentrated in regional or national networks. In fact, creativity as a cognitive phenomenon is significantly influenced by the sociocultural context (Glăveanu, 2020; Sawyer, 2012). Societies with individualistic orientations tend to define creativity as personal novelty and originality, while those with collectivist orientations place more emphasis on social contribution and adaptation (Erez & Nouri, 2010; Shao et al., 2019). The lack of cross-cultural collaboration has the potential to produce culturally biased and non-generalizable findings.

Future research should systematically build international collaboration networks through joint research schemes and researcher mobility. Strategic questions that can be answered through such collaboration include: Do specific gamification mechanics—for example, competition versus collaboration—have different effects on creativity in different cultural contexts? Cross-cultural studies with identical experimental designs but applied in different countries will provide significant theoretical contributions about the universality versus cultural specificity of gamification design.

4.2. Tren Dan Tema Key Research Pada GCCT (RQ2)

The strong association between gamification and motivation in the GCCT literature confirms the theoretical path that has been assumed, namely that gamification works by activating the motivational system to influence cognitive outcomes. However, these findings also reveal a potential theoretical blind spot—namely, the tendency to reduce creativity as a product of motivation, ignoring that creative thinking involves specific cognitive skills such as divergent thinking, associative thinking, and cognitive flexibility that do not automatically arise from motivation alone (Roskes et al., 2012; Runco, 2014). The implication is that the development of GCCT theory needs to expand its scope from a mere mediation model of motivation to a model that integrates direct cognitive pathways—for example, how certain game mechanics train cognitive flexibility through tasks that require perspective switching.

The temporal trend showing a shift from "creative thinking" (2020-2025) to "serious games" and "engagement" (2024-2025) indicates the maturation of the field of study. In the early phase, researchers concentrated on proving the concept that gamification can influence creative thinking. Entering the maturation phase, attention shifted to how to create sustainable immersive experiences through serious games. This shift parallels the evolution of game design theory from an elementary approach (adding points, badges, leaderboards) to a holistic approach (creating a coherent narrative world) (Deterding, 2016; Warsinsky et al., 2021).

In a broader context, this trend reflects the maturity of a field that is beginning to question the quality of experience, rather than simply the quantity of interventions. Based on the identified thematic clusters, where the STEM/higher education cluster is separate from the medical education and game-based learning clusters, this indicates a fragmentation of the research community that could potentially hinder the accumulation of knowledge.

Researchers in medical education may develop insights into clinical simulation that are unknown to researchers in STEM education, and vice versa. In fact, design principles such as productive failure found in medical education research can enrich designs for engineering education. This fragmentation reflects academic institutional structures that tend to keep research in disciplinary silos.

Future research directions need to explicitly bridge this fragmentation through cross-disciplinary replication studies. For example, studies on the effectiveness of escape rooms for creative thinking in medical education could be replicated in engineering education. Researchers can explore whether the same

mechanisms work or whether there are disciplinary moderators that need to be considered. These issues are crucial and require empirically based answers. Furthermore, bibliometric analysis in the coming period needs to track whether there is convergence or divergence between thematic clusters.

4.3. Learning Innovations In GCCT (RQ3)

The dominance of Asia—particularly China, Thailand, and Taiwan—in the GCCT research landscape reflects an interesting sociological phenomenon. Countries with exam-oriented education systems and high academic pressure have become the main locus of pedagogical innovation aimed at unleashing creativity. This can be interpreted as a form of resistance to the dominant pedagogical culture as well as an effort to adapt to global creative demands. The Chinese government, through its Double Reduction Policy, explicitly encourages a reduction in academic workload and an increase in holistic learning, including through a gamification approach. Implicitly, education policies in other developing countries can learn from Asia's experience in using gamification as a tool for pedagogical transformation, rather than merely as a technological addition.

An important finding that we highlight is that the concentration of research in higher education confirms the assumption that curriculum flexibility and resources at the university level facilitate pedagogical experimentation. Ironically, however, it is at the primary and secondary education levels—where the foundations of creative disposition are formed—that research is still limited. Piaget (1970) has long reminded us that the concrete-operational stage is a critical period for the development of cognitive flexibility. The lack of research at this level leaves a serious knowledge gap about how and when gamification interventions are most effective in shaping long-term creative capacity.

The integration of gamification elements with pedagogical strategies in the studies reviewed shows a shift from an additive approach to an integrative approach. The additive approach—adding game elements to existing learning—tends to produce chocolate-covered broccoli (van Roy & Zaman, 2019), where games are merely a sweet coating that does not change the substance of the learning experience. In contrast, integrative approaches, such as those in the studies by Zhou et al. (2024) and Zhu et al. (2025) place game mechanics as the fundamental structure that shapes the entire learning experience. These findings contribute to the theoretical debate about the essence of gamification: whether it is an instructional method or a paradigm for experience design.

The element of "freedom to fail," which is beginning to gain attention in the literature, reflects a fundamental shift in educational philosophy. Traditional educational culture views mistakes as failures to be avoided; in contrast, contemporary cognitive psychology views mistakes as important information for self-regulation and knowledge development (Kapur, 2015; Kapur & Rummel, 2012). Gamification with respawn, retry, and multiple lives mechanisms implicitly teaches that mistakes are a normal part of the creative exploration process. The pedagogical implication is that teachers need to explicitly reframe mistakes as learning opportunities, not as a disgrace.

Future research should test the moderating effect of education level on the effectiveness of gamification element combinations. Is "freedom to fail" more important in primary education than in higher education? Is narrative complexity more appropriate for college students than for elementary school students? Longitudinal studies that follow cohorts of students from primary to higher education can reveal developmental trajectories of responses to gamification. In addition, research on teacher professional development to design integrative, rather than additive, gamification is a practical priority.

4.4. The Impact Of Gamification On Creativity And Creative Thinking (RQ4)

The consistency of positive findings across all synthesized studies provides strong evidence that gamification, when properly designed, can be an effective catalyst for creativity development. However, behind this consistency lies significant variation in effects that was not revealed in our synthesis. Some studies reported dramatic improvements, while others reported moderate improvements. This variation is likely due to differences in design quality, intervention duration, and participant characteristics. In a recent meta-analysis of gamification and cognitive outcomes, substantial heterogeneity of effects was found to be explained by design moderators (Sailer & Homner, 2020). These findings confirm that the question "Is gamification effective?" is no longer a fundamental one. The relevant question is "under what conditions, for whom, and with what design does gamification become more effective?" The differential mechanisms by which different game elements target different indicators of creativity have important theoretical implications.

Multidimensional creativity theory (Guilford, 1967; Torrance, 1971) has been used more for measurement than for intervention design.

These findings suggest that the principle of "alignment" in instructional design—the alignment between goals, activities, and assessments—also applies to the micro level of game elements. For example, pedagogical design cannot use competitive elements if the target is elaboration, because competition is more effective for originality. The implication is that the development of a taxonomy that maps game elements to specific creativity indicators is an urgent need.

On the other hand, the finding that effectiveness depends on the "dose" and duration of exposure confirms the skill acquisition theory (Masson, 1990), which states that the development of complex skills such as creative thinking requires continuous practice, not short interventions. In many educational implementations, gamification is applied for a limited period—a few weeks or months—and evaluated immediately after the intervention. This approach does not capture the full potential of gamification to develop long-term cognitive structures. Furthermore, the novelty effect can inflate estimates of short-term effectiveness, while the true effects only become apparent after the novelty wears off and students interact with gamification authentically.

In a broader context, the impact of gamification on creativity has economic and social implications. The creative economy contributes an increasing proportion of global Gross Domestic Product (GDP) and requires a workforce with high innovation capacity (UNCTAD, 2024). Gamification offers a scalable approach to training this capacity from an early age. However, its effectiveness depends on integration into the broader educational ecosystem, which includes curriculum, assessment, and school culture. Schools that implement gamification but continue to use rote assessment and hierarchical culture may not reap the full benefits (Sambo et al., 2025).

Future research should shift from questions of effectiveness to questions of mechanisms and moderation. Experimental studies with factorial designs that manipulate the presence or absence of specific elements can reveal the causal contribution of each element. Process measurements—for example, through think-aloud protocols or eye-tracking—can reveal the cognitive mechanisms at work during interaction with games. Longitudinal studies with repeated measurements over at least one academic year are needed to test long-term effects. Finally, the development of predictive models that integrate individual characteristics (e.g., openness to experience, need for cognition), design characteristics, and implementation context will enable the personalization of gamification.

4.5. Primary Challenges (Rq5)

The challenge of measuring the impact on creativity, identified as the most critical issue, reflects a broader measurement crisis in the psychology of creativity and creative thinking. Existing instruments tend to measure creative products in standardized conditions, for example, the Torrance Tests of Creative Thinking, which may not capture creativity manifested in naturalistic gamification contexts. Meanwhile, another problem is that gamification creates a new context in which creativity is expressed through interaction with digital systems, producing digital artifacts, and collaboration in virtual teams. Conventional instruments may not be sensitive to these new forms of creative expression. The implication is that the development of new instruments specific to the digital and gamification contexts is a methodological research priority.

The recalibration effect phenomenon reported by Marin-mantilla & Moscoso-barrera (2025) reveals the complexity of interpreting self-report data. When students experience deep learning, they may revise their internal standards of what creativity is, resulting in lower post-intervention self-report scores even though their objective abilities have improved. This phenomenon, known in the literature as response shift bias (Howard, 1980), may have been overlooked in gamification research. This oversight has the potential to lead to erroneous conclusions about the effectiveness of interventions. In this context, methodological solutions such as retrospective pre-tests or the use of anchoring vignettes need to be adopted.

The ethical and cultural challenges that arise (e.g., the anxiety-inducing effects of competition and incompatibility with collectivist cultural values) serve as a reminder that gamification is not a value-neutral technology. It carries cultural assumptions about motivation, achievement, and social relationships that may conflict with local values. Leaderboards, for example, assume that ranking transparency is motivating, but this assumption may not apply in cultures that emphasize group harmony and avoid confrontation (Kwon & Özpolat, 2021). Implicitly, the adoption of gamification needs to go through a process of cultural localization, with adaptations not only in language but also in design philosophy to suit local values.

Another challenge is the drastic increase in the burden on instructors, reflecting the dilemma in educational innovation, where innovation often burdens teachers before its benefits are realized. Teachers must not only master content and pedagogy, but also technology and game design. In education systems with high teacher-student ratios and limited resources, this burden can be a difficult obstacle to adoption. In such conditions, structural solutions are needed, such as the development of technology support teams, the provision of ready-to-use platforms, and incentives for teaching innovation.

Future research should explore solutions to these challenges. There is a need to develop an ethical framework for gamification that can guide the balance between external and internal motivation, between competition and collaboration, and between transparency and privacy. In addition, participatory research involving teachers, students, and parents in gamification design can produce solutions that are more responsive to the local context. Systematic cross-cultural comparative studies on responses to competitive and collaborative elements are needed to inform cultural adaptation. Finally, the development of effective institutional support models (training, mentoring, incentives) for teachers implementing gamification needs to be tested through field experiments.

5. LIMITATIONS

The limitations of this study mainly stem from the scope of the database and the selection criteria applied. By limiting the data sources to Scopus, Web of Science (WoS), and PubMed, this study automatically excludes relevant publications that may only be indexed in specialized or regional databases, thereby potentially overlooking significant contributions from local or non-mainstream journals. Furthermore, the decision to include only article-type documents from journals and in English, while intended to maintain consistency and quality of analysis, could potentially introduce substantial selection bias. Consequently, important findings published in conference proceedings, book chapters, technical reports, or in languages other than English are not represented. As a result, the generalization of bibliometric findings and the synthesis of this SLR study can only be claimed to be relevant to the corpus of English-language peer-reviewed literature indexed in these three databases, and may not reflect the entire landscape of actual knowledge.

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APPENDIX A. META-DATA SEARCH STRATEGY

This study employs search strings designed to systematically retrieve as many relevant documents as possible, ensuring that the results are both relevant and replicable. Data were collected on February 1, 2026. The following section presents the search strings used and the number of records retrieved from the Scopus (Table A1), WoS (Table A2), and PubMed (Table A3) databases.

Appendix A.1. From Scopus Database

Table A1. Search Strings Used in the Scopus Database and the Number of Records Retrieved. [A)]

#No	Search String	Records Retrieved
#1	TITLE-ABS-KEY (gamifi*)	24,856
#2	TITLE-ABS-KEY (creativ*)	311,312
#3	TITLE-ABS-KEY (education OR teach* OR learn* OR student* OR school OR universit* OR college)	10,141,521
#4 (#1 AND #2 AND #3)	(gamif* OR "game- based" OR "gaming") AND (creativ*) AND (education OR teach* OR learn* OR student* OR school OR universit* OR College)	**834**

[a)] From the initial 834 results, filters were applied using the following criteria: (1) publication year: 2016–2026; (2) document type: article; (3) source type: journal; and (4) language: English, resulting in 285 documents.

Appendix A.2. From Web of Science Database

Table A2: Search Strings Used in the Wos Database and the Number of Records Retrieved.[B)]

#No	Search String	Records Retrieved
#1	gamif* (Topic)	16,509
#2	creativ* (Topic)	347,151
#3	education OR teach* OR learn* OR student* OR school OR universit* OR College (Topic)	5,696,247
#4 (#1 AND #2 AND #3)	gamifi* (Topic) and creativ* (Topic) and education OR teach* OR learn* OR student* OR school OR universit* OR College (Topic)	**560**

[a)] From the initial 560 results, filters were applied using the following criteria: (1) NOT Document Types: Review Article; (2) Publication year: 2016-2026; (3) Document type: Article; and (4) Language: English, resulting in 273 documents.

Appendix A.3. From Pubmed Database

Table A3: Search Strings Used in the Pubmed Database and the Number of Records Retrieved.[C)]

#No	Search String	Records Retrieved
#1	gamif*[Title/Abstract]	3,342
#2	creativ*[Title/Abstract]	30,223
#3	education [Title/Abstract] OR teach*[Title/Abstract] OR learn*[Title/Abstract] OR student*[Title/Abstract] OR school [Title/Abstract] OR universit*[Title/Abstract] OR College [Title/Abstract]	2,522,914
#4 (#1 AND #2 AND #3)	((gamif*[Title/Abstract]) AND (creativ*[Title/Abstract])) AND (education [Title/Abstract] OR teach*[Title/Abstract] OR learn*[Title/Abstract] OR student*[Title/Abstract] OR school [Title/Abstract] OR universit*[Title/Abstract] OR College [Title/Abstract])	**58**

[c)]From the initial 58 results, filters were applied using the following criteria: (1) Publication year: 2016-2026; and (2) Language: English, resulting in 56 documents.

APPENDIX B. MERGED TERMS

Merged terms in VOSviewer and the Bibliometrix package in Rare used to combine different terms with the same meaning, thereby improving the accuracy of bibliometric analysis and reducing term fragmentation. Table B1 presents the merged terms used in the VOSviewer analysis.

Table B1: Merged Terms Used in Vosviewer Analysis.

Label	Replaced by
creative thinking skill	creative thinking
interactive learning environments	interactive learning environment
extrinsic motivation	motivation
motivations	motivation
self-determination theory	self-determination
student	students
teaching/learning strategies	teaching/learning strategy

Merging of terms in the analysis using the Bibliometrix R package was conducted as follows.[d)]

[1] 21st century skills; 21st-century skills; 4c skills
[2] adolescent; adolescents
[3] immersive; and total immersion
[4] artificial intelligence; artificial-intelligence
[5] attitude; attitudes
[6] behavior; behaviors
[7] board game; board games
[8] child; children
[9] classroom; classrooms
[10] competence; competences; competencies
[11] cooperative learning; cooperative/collaborative learning
[12] creative thinking; creative thinking skill; creative thinking skills (crts); creative
[13] creativity; creativity style
[14] critical thinking; critical

[15] digital; di-gital
[16] digital game; digital games; digital game-based language learning
[17] digital learning; digital leaning
[18] digital literacy; digital literacy skills; digital skills
[19] early childhood; early childhood education
[20] educational robot; educational robots
[21] flow theory; flow
[22] game-based learning; game-based; game-based learning (gbl)
[23] gamex; gamex scale
[24] gamification; gamificación; gamification in learning; gamification in stem education; gamification of web-based; gamification platforms; gamification strategies; gamification teaching-learning method
[25] higher education; higher-education; higher; university education; undergraduate students
[26] human; humans
[27] ideas; idea
[28] impact; impacts
[29] innovation skills; innovation; innovations; innovative skills; innovative thinking skill
[30] interactive learning environments; interactive learning
[31] kahoot; kahoot!
[32] literacy; literacy skills
[33] medical education; medical-education; medical
[34] music education; music
[35] nursing education; nursing student; nursing students; nursing-students
[36] online learning; online courses
[37] pandemics; pandemic
[38] patients; patterns
[39] perception; perceptions
[40] problem-based learning; problem-based learning; problem-based learning (pbl); project-based learning (pbl)
[41] problem solving;problem-solving
[42] qualitative research; qualitative study
[43] steamification; steam-ification
[44] steam education; stem curriculum
[45] student; students
[46] teacher; teachers
[47] technology; technologies
[48] video game; video games
[49] writing performance; writing skills

[d)]All terms will be replaced with the leftmost (preferred) term.

APPENDIX C. CODING GUIDELINES

This Coding Guide aims to assist researchers in identifying documents. With a robust guide, each researcher can independently code findings from documents and minimize bias. The coding guide for general information is shown in Table C1, key findings on gamification impact for CCT by Table C2, gamification elements by Table C3, pedagogical innovation by Table C4, and primary challenges of implementing gamification by Table C5.

Table C1: Coding Guidelines for General Information.

No.	General Information Aspect (Code)	Operational definition	Coding Indicators

1.	Region/Country (C)	The geographic context of the study, coded primarily as the study location; if not reported, coded as the first author's affiliation country.	Methods/Setting states where participants were recruited/where the intervention took place (school/university/city/country); If location is missing, the first author affiliation indicates a country; If the study clearly spans multiple countries/sites, code Multi-country/Global and list countries if available; and if unclear or cannot be inferred reliably, code "Not reported".
2.	Subject/ Discipline (S)	The learning domain/discipline in which gamification was implemented, and outcomes were targeted. Subject/Discipline categories include: STEM (General) (code: S1), Mathematics (code: S2), Science (Physics/Chemistry/Biology) (code: S3), Computer Science/Programming/Informatics (code: S4), Engineering (code: S5), Health Sciences/Medicine/Nursing/Public Health (code: S6), Language Learning (EFL/ESL/Arabic, etc.) (code: S7), Social Sciences (code: S8), Arts/Design/Creativity Studies (code: S9), Business/Economics/Entrepreneurship (code: S10), General Education (not subject-specific) (code: S11), and Not reported/Unclear (code: S12).	Explicit course/subject/domain label (e.g., programming, EFL, nursing); If multiple, select primary target domain; optionally list secondary; If domain not specified, General Education; and if absent, code as "Not reported".
3.	Education level (EL)	Education level refers to the educational stage of participants targeted by the intervention and is coded as Preschool/Kindergarten (code EL1), Primary School (code EL2), Junior High School (code EL3), Senior High School (code EL4), University (code EL5), or Non-formal Education (code EL6) based on the participant information reported (e.g., grade/year/school type).	Participant level stated (grade/year/school type); If only age, map cautiously with context support; Multiple levels, Mixed/Multi-level (specify); and if absent, code as "Not reported".

Table C2: Coding Guidelines for Key Findings on Gamification Impact For CCT.

Impact Category	Description	Coding Indicators (Evidence Criteria)
Positive (IC1)	Gamification enhances creativity/creative thinking.	Increased creativity test scores; More original ideas generated; Improved motivation and engagement; and smoother or more fluent creative process.
Negative (IC2)	Gamification reduces or hinders creativity.	Decreased quality of ideas; Pressure or competition disrupts creative thinking; Focus shifts to rewards rather than the creative process; and Side effects such as anxiety or stress.
Neutral/Mixed (IC3)	No significant change, or effects vary.	Results are not statistically significant; Positive effects on some aspects, negative on others; and Effects depend on context or individual differences.

Table C3: Coding Guidelines for Gamification Elements.

No.	Gamification Elements	Operational definition	Coding indicator(s)
1.	Goals & Rules (GE1)	Explicit learning/task objectives are stated, accompanied by governing rules that delimit permissible actions, specify completion/success criteria, and define basic consequences (e.g., feedback, penalties, or rewards).	Explicit goals/targets (e.g., "complete module," "reach mastery," "create X product"); Rules/constraints (allowed actions, required steps, time limits, resource limits); Success/completion criteria (what counts as "done" or "passed"); and consequences (e.g., unlock next stage, repeat task, points deducted, access restricted).
2.	Challenges/Missions/Quests (GE2)	Structured goal-oriented tasks framed as missions/quests that require learners to complete specific actions under given constraints, often with defined difficulty, time/attempt conditions, and associated outcomes (e.g., points, access, feedback).	Named or clearly defined missions/quests/challenges/tasks; A task brief (required actions + expected output); difficulty variation or challenge set (optional but strengthens evidence); and a clear link to problem solving or ideation (especially relevant for creativity).

3.	Levels & Progression (GE3)	A staged advancement system in which learners move through sequential levels based on performance or mastery, typically increasing in complexity and unlocking new content, roles, or privileges as progression milestones are achieved.	Discrete levels/stages/tiers; Progression logic (access to next level depends on completion/performance/mastery); and increasing complexity, content depth, or role responsibility across levels (optional but strong).
4.	Progress Bars & Tracking (GE4)	Visual or analytic indicators that display learners' current status toward predefined goals (e.g., percentage completion, milestones, checkpoints), enabling self-monitoring and supporting regulation of learning progress.	Learner-facing progress visualization (progress bar, checklist, completion %, dashboard); Tracking of activity status (completed modules, tasks done, time-on-task, attempts); and learners can monitor their own progress (teacher-only analytics does not qualify alone).
5.	Points & Scoring System (GE5)	A quantified scoring mechanism that assigns points to learners' actions or performance, serving as immediate performance indicators, reinforcing desired behaviors, and enabling accumulation toward goals or progression.	Points/XP/scores are earned for specified actions; The paper describes how points are awarded (rules or examples); and points serve at least one function (feedback, unlocking, ranking, reward eligibility).
6.	Badges / Achievements (GE6)	Achievements Symbolic digital markers awarded upon attaining predefined milestones, competencies, or accomplishments, functioning as visible evidence of achievement and supporting recognition of mastery.	Badges/achievements are described as collectible or displayable indicators; There are clear triggers (e.g., completion, mastery, creative excellence); and badge criteria are specified or inferable from intervention rules.
7.	Leaderboards & Social Comparison (GE7)	A ranked display that publicly (or semi-publicly) compares learners' performance based on points/criteria, enabling social comparison and signaling relative standing within the learning community.	A leaderboard/ranking/top list is explicitly mentioned or shown; the ranking basis is specified (points, performance, speed, quality); and learners can view relative standings (full, top-n, anonymized, etc.).
8.	Rewards & Unlockables (GE8)	Incentives (tangible or symbolic) granted after meeting criteria, including unlockable content/features, privileges, or access, are designed to reinforce engagement and acknowledge completion or mastery.	Rewards are provided (prizes, privileges, bonus access, special items); Unlockables are described (new content/features/roles unlocked after milestones); and rewards/unlocks are contingent on performance/completion/mastery.
9.	Feedback Cycles (GE9)	Timely, iterative information provided in response to learners' actions (e.g., correctness, progress, hints), enabling adjustment of strategies and supporting continuous improvement toward learning goals.	Feedback is given after actions (correctness, hints, suggestions, rubric feedback); an iterative loop exists (attempt, feedback, revise, reattempt); and feedback is frequent (system, teacher, peer, or mixed).
10.	Freedom to Fail (GE10)	A design principle that permits low-stakes errors through retries, multiple attempts, or penalty-light conditions, framing failure as informative and supporting experimentation without undue consequences.	Multiple attempts/retry/resubmission allowed; Low or no penalty for failure (or practice/sandbox mode); and explicit emphasis on experimentation and learning from mistakes.
11.	Collaboration / Teammates (GE11)	Structured opportunities for learners to work interdependently (e.g., group tasks, shared goals, peer support), emphasizing coordination and collective problem solving to achieve learning outcomes.	Learners work in teams/groups with a shared outcome; Team coordination structures exist (roles, division of labor, team missions); and assessment includes team output or interdependent contributions.

12.	Competition (GE12)	Mechanisms that create performance-based rivalry (individual or team) through comparative goals, limited resources, or rank-based outcomes, motivating effort via contest-like conditions.	Competitive structures exist (contest, tournament, battle, winner criteria); There is an explicit winning condition and comparative performance; And stakes are defined (prize/status/recognition/graded competition).
13.	Narrative / Storyline & Role (GE13)	A contextual story framework that situates tasks within a coherent plot and assigns roles/identities to learners, enhancing meaning-making, immersion, and coherence across learning activities.	A storyline/scenario is described (chapters, episodes, mission story); Learners assume roles (e.g., designer, scientist, entrepreneur, detective); And narrative/role is integrated into tasks (not just decorative theme).
14.	Avatar (GE14)	A customizable visual or symbolic representation of the learner in the learning system, used to support identity expression, presence, and engagement within the gamified environment.	An avatar/character profile exists for the learner; Learners can select and/or customize the avatar (strong evidence); And the avatar is used to display status/progress or for interaction.

Note: To Address Potential Overlap, The Authors Agree to the Following Restrictions:

1. Points vs Rewards: Points = numeric accumulation; Rewards/Unlockables = access/privilege/item granted after conditions.
2. Levels vs Progress Tracking: Levels = discrete stages; Progress bars/tracking = continuous indicators/monitoring.
3. Goals vs Challenges: Goals = targets + success rules; Challenges = specific tasks to accomplish goals.
4. Competition vs Leaderboards: Competition = contest structure; Leaderboard = ranking display feature.
5. Narrative/Role vs Avatar: Narrative/Role = story context + role identity; Avatar = visual/character representation.

Table C4: Coding Guidelines for Pedagogical Innovation.

No.	Pedagogical Design	Coding indicator(s)
1.	Project-Based Learning (PI1)	Learning is organized around an extended project (multi-session); Presence of a driving question/problem guiding the project; Students create a tangible artifact/product (prototype, report, presentation, creative product); Clear project phases (planning, developing, presenting, reflecting); And use of milestones/checkpoints and product-oriented assessment/rubric.
2.	Case-Based Learning (PI2)	Learning centered on one or more cases/scenarios (realistic narrative); Students analyze case information, discuss alternatives, and make decisions/recommendations; Emphasis on application of concepts to the case; Structured prompts (e.g., guiding questions); And outcome is typically a case solution/argument, not a long-term project artifact.
3.	Problem-Based Learning (PI3)	Starts with an ill-structured problem as the trigger for learning; Students identify knowledge gaps/learning issues (what we know vs need to know); Self-directed research to fill gaps; Small-group collaborative problem-solving (often with facilitator/tutor); And iterative cycle: problem analysis, inquiry, solution justification/reflection.
4.	Inquiry-Based Learning (PI4)	Learners formulate questions/hypotheses; Engage in investigation (collecting evidence/data, exploration, experimentation); Emphasize evidence-based reasoning and explanation building; Inquiry cycle present (e.g., ask–investigate–analyze–explain–evaluate); And output includes findings/claims supported by evidence, not only "answers".
5.	Flipped Learning (PI5)	Pre-class content delivery (videos/readings/micro-lectures) is explicitly assigned before class; In-class time is used for active learning (problem solving, discussion, practice, projects); Often includes pre-class checks (quizzes, reflections); Clear split: instruction at home, application in class; And gamification may reward preparation/participation.
6.	Game-Based Learning (PI6)	Learning occurs through playing a game (digital/board/simulation) as the primary learning activity; The game has rules, objectives, and gameplay loops that drive learning; Educational content is embedded via game mechanics/ story/ challenges; Evidence of game sessions/levels/missions aligned to learning outcomes; And typically includes reflection/debriefing to connect gameplay with learning.

7.	Others/Not explicit/unclassifiable (PI7)	Paper states "gamified" but does not specify the underlying instructional model (no clear PjBL/CBL/PBL/IBL/Flipped/GBL indicators); The instructional sequence is too vague to classify; Mixed/hybrid pedagogy is mentioned without enough detail to map to one category; And describes only gamification features (points/badges/etc.) without explaining the learning design structure.

Table C5: Coding Guidelines for Primary Challenges of Implementing Gamification.

No.	Challenge theme (Code)	Operational definition	Coding indicators (evidence criteria)
1.	Balancing Educational Goals and Game Mechanics (PC1)	Tension/misalignment between learning objectives and game elements (points, competition, narrative), where game design risks overshadowing pedagogy or distorting learning priorities.	Authors explicitly mention "game elements distracting from learning" or "misalignment with curriculum/learning outcomes"; Concern about extrinsic rewards replacing deep learning/intrinsic motivation; Game mechanics encourage surface strategies (chasing points, speed over quality); And need to redesign mechanics to better reflect learning/creativity criteria.
2.	Sustaining Long-term Engagement (PC2)	Difficulty maintaining learner motivation/ participation over extended periods; novelty effects fade; engagement drops after initial excitement.	Reported decline in participation/engagement over weeks/modules; Discussion of novelty effect or "short-lived motivation"; Need for varied content, progression, and meaningful rewards to prevent boredom; And dropout/attrition linked to gamification fatigue.
3.	Technological and Pedagogical Barriers (PC3)	Barriers caused by technology access/usability and/or lack of pedagogical readiness (training, integration, instructional design).	Access issues (devices, internet, platform constraints); Technical problems (bugs, login issues, LMS integration); Low digital literacy among teachers/students; And lack of pedagogical framework or difficulty integrating into lesson plans.
4.	Measuring Impact on Creativity (PC4)	Challenges in defining, operationalizing, and validly measuring creativity/creative thinking outcomes attributable to gamification.	Author's note: creativity is "hard to measure," or instruments are limited; Reliance on proxies (engagement) rather than creativity outcomes; Inconsistent instruments/rubrics; lack of validity/reliability reporting; And difficulty isolating gamification effects from pedagogy/context.
5.	Ethical and Cultural Considerations (PC5)	Risks related to fairness, well-being, privacy, and cultural appropriateness (e.g., competition pressure, stigmatization, data ethics).	Concerns about anxiety/stress due to competition/leaderboard; Equity issues (different access, disadvantaging certain students); Privacy/data concerns (tracking, analytics); And cultural mismatch (norms against public ranking; values conflict)
6.	Development and Resource Intensity (PC6)	High time/ cost/ resource needs to design, develop, test, and maintain gamified systems/materials (especially custom platforms).	Paper reports high development cost/time; Need for interdisciplinary team (designers, developers, educators); Maintenance/update burdens (content refresh, bug fixing); And limited budget/tools cited as constraints.
7.	Instructor Load and Game Management (PC7)	Increased instructor workload for planning, monitoring progress, managing game rules, moderating interactions, and administering rewards.	Additional teacher time for setup and ongoing management; Need to monitor dashboards, verify points/badges, and handle disputes; Managing teams/ competition/ behavior issues; And the teacher's role becomes "game master" requiring continuous oversight.
8.	Time Management and Pacing Constraints (PC8)	Constraints due to limited class time, curriculum pacing demands, and difficulty fitting gamified activities into schedules.	Authors mention limited time for gameplay + debriefing; Curriculum coverage pressure conflicts with gamified tasks; Pacing issues: too slow (students lag) or too fast (no reflection); And implementation requires more sessions than available.

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