



Review Article

Evolution of teacher training in gamification: a bibliometric analysis of global trends and collaborations

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ABSTRACT

Gamification has emerged as a pivotal technique for reinventing teacher education, fulfilling the necessity to cultivate digital and pedagogical competencies in swiftly changing educational environments. Nevertheless, an integrated perspective that synthesizes its scientific evolution, collaboration networks, and global trends is still lacking. This study conducts a bibliometric analysis of the academic production on gamification in teacher education to identify growth trajectories, international collaborations, and emerging themes. A total of 405 documents indexed in Scopus and Web of Science between 2014 and 2025 were analyzed using the Bibliometrix package in R. The findings indicate an annual growth rate of 20.95%, with Spain leading the field (140 publications), followed by the United States and Turkey. Network analysis highlights a central core of highly connected authors and an increasingly consolidated international collaboration network. Themes such as teacher training and intrinsic motivation emerge as conceptual hubs, evidencing a convergence between initial teacher education and ongoing professional development. A transition is noted from employing gamification as a motivating instrument to its incorporation as a systematic educational technique associated with active learning, self-regulation, and formative evaluation. This paper offers an extensive overview of the conceptual maturity within the subject and suggests future research avenues centered on the personalization of teacher learning using artificial intelligence and adaptive gamified settings.

1. Introduction

Teacher and professional development is a crucial pillar for the development of high-quality education systems. It is a constantly evolving field with major improvements in the incorporation of educational technologies (Román Aguilar et al., 2023; Trujillo Losada et al., 2023) and pedagogical competences (Schleicher, 2018). However, it also faces chronic issues, such as the digital gap (Arango-Lopera, 2022) and inequalities in teacher and professional development (OECD, 2020), which directly effect teaching and learning processes and, consequently, educational practice. The global COVID-19 pandemic intensified these challenges and, simultaneously, accelerated the adoption of technologies in education worldwide (García-Peñalvo et al., 2020), highlighting the urgent need to strengthen teacher training in the pedagogical use of digital tools to respond to a dynamic and constantly evolving educational environment.

In this context, it is imperative that teachers undergo continuous training to remain informed about the most effective methods and tools (Sims et al., 2023). This is achieved by incorporating digital skills (Cavalcante et al., 2020; Piontkewicz et al., 2024) and innovative methodologies (Candel et al., 2021; Cózar-Gutiérrez & Sáez-López, 2016) and promoting active participation (Silva Quiroz & Maturana Castillo, 2017). Gamification has emerged as a promising strategy for enhancing teacher training among these methodologies (Carrión Candel & Colmenero, 2022), providing tools that increase motivation, engagement, and teaching effectiveness (Belova & Zowada, 2020; Flores-Aguilar et al., 2023).

Teacher training is a dynamic and adaptive process focused on developing pedagogical competences and reinforcing values and ethical principles (Gümüş, 2022; Rahimi & Oh, 2024). This approach includes initial training and continuous professional development, allowing educators to effectively integrate new methodologies and address the

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issues posed by increasingly digital educational environments (Veintemilla et al., 2022). Effective teacher training necessitates cohesive programs that correspond to the requirements of the educational environment (Curiel, 2020), fostering active learning, ongoing feedback, and the establishment of professional communities grounded in interaction, inclusion, and equity (Condo Machuca et al., 2023; Desimone & Garet, 2015).

The advancement of teacher training has integrated personalized and adaptive methodologies, consistent with andragogical concepts that highlight self-direction, content relevance, prior experience, and intrinsic motivation in adults (Bendeck Soto, 2019; Malcolm S. Knowles et al., 2020). From this viewpoint, teacher training must account for the diversity of personal, social, cultural, and educational backgrounds of educators (Avalos Dávila et al., 2021; Da Trindade Prestes & Santos Diniz, 2015), presenting the challenge of identifying effective and contextualized training strategies for adult education.

In this context, gamification is defined as the deliberate incorporation of game design features into non-game settings (Deterding et al., 2011), utilizing game principles to enhance motivation, engagement, and involvement in educational processes (Lestuny & Soumokil, 2023). Numerous studies indicate that gamification provides a dynamic and tailored method for teacher training, promoting self-regulated learning and advancement based on individual requirements, while enhancing the engagement and dedication of both pre-service and in-service educators (Calle-Carracedo et al., 2022; Cózar-Gutiérrez & Sáez-López, 2016; Hossein-Mohand et al., 2021; Manzano-León et al., 2022; Navarro-Mateos & Perez-Lopez, 2023).

The principles of gamification involve the integration of game mechanics and dynamics, including points, levels, challenges, feedback, and badges, which foster active engagement, a sense of achievement, and collaboration among participants (Klock et al., 2015; Koivisto & Hamari, 2019; Seaborn & Fels, 2015; Smith & Abrams, 2019; Vera-Saavedra et al., 2024). These dynamics can enhance essential teaching competencies, including classroom management, the design of learning experiences, and the augmentation of digital skills, so directly increasing educational quality (Pozzi et al., 2023).

Teacher training in game-based methodologies has undergone significant expansion in recent years. Foster and Shah (2020) delineate essential principles for incorporating game-based learning (GBL) into teacher training, emphasizing the teacher's function as a pedagogical mediator, the necessity of game literacy, the relevance of the school context, and the significance of ongoing practice opportunities. Game-based pedagogy (GBP), which encompasses gamification, game-based learning, and game creation, necessitates that educators cultivate pedagogical, technological, collaborative, and creative skills (Nousiainen et al., 2018).

Serious games are defined as games that are explicitly designed with an educational, formative, or social purpose, in addition to their entertainment value, and are closely associated with game-based learning (Damaševičius et al., 2023; Schrader, 2022). These strategies have been particularly effective in the training of teachers who work with vulnerable populations, as they provide safe environments for practice, simulation, and continuous feedback (Connolly et al., 2020; Subhash & Cudney, 2018; Vuorio, 2024).

Collectively, gamification, game-based learning, and serious games constitute an integrated pedagogical framework that enhances teacher training by improving engagement, learning, and professional growth (Plass et al., 2015; Sailer & Homner, 2020). Nonetheless, despite the increasing body of research, the literature exhibits thematic and methodological fragmentation that obstructs a thorough comprehension of the field's progression.

This study seeks to investigate, drawing on international scientific literature, the progression of teacher training in the setting of gamification. It also analyzes the growth trajectory and spatial dispersion of gamification in the published literature. A bibliometric review is performed utilizing the Scopus and Web of Science databases,

concentrating on research pertaining to pre-service teachers, beginning teacher training, and professional development.

The bibliometrix software (R-package) was employed for the bibliometric analysis of the scientific literature. This software offers quantitative analysis tools in bibliometrics and scientometrics (Aria & Cuccurullo, 2017). It enables the identification of trends, the measurement of the impact of scientific production, and the analysis of collaboration networks between authors and institutions (González-Zamar & Abad-Segura, 2020).

2. Method

To develop the present study on the evolution of teacher training in the framework of gamification, a bibliometric analysis was applied, a research methodology that uses quantitative, descriptive techniques to analyze scientific production (Moreno, 2019; Ruiz et al., 2023), providing indicators covering journals, prominent authors, institutions involved, main constructs, and most relevant topics (Limaymanta et al., 2020).

2.1. Systematic mapping: search strategy and screening (PRISMA)

To perform the bibliometric review, scientific production between 2014 and 2025 was analyzed following different methodological steps. First, A thorough search was performed in the primary academic databases, Scopus and Web of Science (WoS), focusing on high-impact scientific and research publications recognized for their global prominence, reach, and leadership (Zhu & Liu, 2020). This methodological selection ensures the scientific rigor of the sample via peer review processes and guarantees the availability of standardized and traceable metadata, which are crucial technical prerequisites for performing network analyses, thematic clustering, and scientific mapping with the Bibliometrix package in R— fundamental components of the methodological framework. The search was performed in English and Spanish to identify the most pertinent influential nodes in this domain, initially recognized by their substantial publication volume. These platforms provide a representative and high-quality perspective on global trends and contemporary international cooperation (Donthu et al., 2021). The searches were conducted on October 1, 2025, ensuring the currency and relevance of the records retrieved. During this phase, the methodological focus was solely on the identification and selection of research, without the implementation of data cleaning techniques or bibliometric analysis.

The search fields and filters that are implemented in each database are explicitly specified to guarantee the replicability of the review process. The final search query was executed in the Title, Abstract, and Keywords fields (TITLE-ABS-KEY function) of Scopus. These fields contain the title, abstract, and authors' keywords. The Topic (TS) field in the Web of Science Core Collection was utilized to apply the same conceptual string, which encompasses the Title, Abstract, Author Keywords, and Keywords Plus.

The corpus was exclusively restricted to articles published in scientific journals, including records indexed as Early Access, with respect to document type filters. Furthermore, restrictions by subject category were implemented in both databases: Education & Educational Research in Web of Science and Social Sciences in Scopus, to guarantee that the corpus was pertinent to the educational sector and, in particular, to teacher training. The search and selection strategy is entirely replicable in both indexes as a result of these specifications.

2.2. Identification of sources

To synthesize the evidence on teacher training and gamification, a structured criterion was used, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021), a detailed guide that ensures transparency,

reproducibility, and quality in the presentation of the results. Studies excluded were those that did not directly address teacher training in the context of gamification, articles that did not focus on education or the implementation of gamification in educational settings, and publications that were literature reviews, commentaries, or editorials without empirical data (Liberati et al., 2009).

For a study to be considered, it had to meet certain inclusion criteria. First, the selected articles had to focus on teacher education and research that mentioned gamification, including the concepts of game-based learning and serious games, which were specifically sought for inclusion in this literature review. Research must also yield original empirical data regarding the implementation or outcomes of gamification in teacher education. Studies in English and Spanish were accepted, contingent upon their full accessibility.

To guarantee conceptual clarity and replicability of the selection process, precise operational definitions were created for the study's fundamental concepts. The phrase "teacher education" denotes study concerning pre-service teachers, in-service teachers, and/or teacher professional development, provided that the studies pertain directly to teaching, learning, assessment, or pedagogical innovation processes associated with teaching practice.

The concept of gamification is defined as the deliberate incorporation of game design elements (such as points, levels, badges, narratives, or feedback systems) into non-game educational activities in teacher education settings. As the search technique expanded to encompass game-based learning and serious games, specific differentiating criteria were devised. Research in which learning is predominantly facilitated through the utilization of complete games as the primary instructional medium was classified as game-based learning, whereas those utilizing games specifically crafted for educational or training objectives were categorized as serious games.

The screening procedure was conducted in two consecutive stages: full-text evaluation and title and abstract review. The records were independently evaluated by at least two of the three study authors in both phases, based on the predefined inclusion and exclusion criteria. The authors engaged in a discussion and ultimately reached a consensus to resolve any disagreements that were identified during the selection process. This process guaranteed the final data selection's consistency, transparency, and traceability.

This study, being a bibliometric analysis and scientific mapping activity, did not include a risk-of-bias or methodological quality assessment for individual papers. This decision aligns with the objective of the bibliometric approach, which emphasizes the analysis of metadata and structural relationships within the field (production, collaboration, and thematic evolution), rather than the synthesis of effects or the critical evaluation of experimental designs. As a result, assessment instruments characteristic of systematic reviews designed to evaluate impacts were not utilized. To maintain the quality and traceability of the corpus, eligibility criteria were defined, the sample was limited to articles in indexed journals, and the search, cleaning, and selection processes were documented in a replicable fashion.

The selection of articles was carried out using a specific search string as described in Table 1, a method that facilitates the inclusion of a wide variety of journals and thematic categories, using keywords such as "teacher training", "teacher education", "teacher formation", "teacher

professional development", "teacher improvement", "pre-service teacher", "preservice teacher", "in-service teacher", "inservice teacher", "formación docente" and "formación del profesorado". These were combined with terms related to gamification and game-based learning, such as "gamif", "game-based learning" and "ludific", which enabled the collection of a comprehensive and relevant corpus of scientific literature.

The literature search and study selection were conducted through a series of steps, as illustrated in Fig. 1. A total of 570 articles were identified in Scopus and 309 in Web of Science for the period from 2014 to 2025. The studies were assessed based on eligibility criteria, leading to the exclusion of 305 records, which included the removal of 169 duplicate records that could potentially bias the results (Lefebvre et al., 2019). A total of 405 full articles were available for review. A systematic and rigorous review of the existing literature on gamification in teacher training establishes a robust foundation for bibliometric analysis. The bibliometric analysis phase was initiated after the systematic search and filter process had defined the final corpus.

2.3. Bibliometric analysis procedures: data extraction, deduplication and analysis

A total of 405 studies that met the reference criteria for analyzing gamification in teacher education were discovered. The records were processed in RStudio with the Bibliometrix program to produce bibliometric mapping. The process involved independently converting Scopus and Web of Science (WoS) files exported in BibTeX format into data frames (scopus_data and wos_data), which were then integrated using the mergeDbSources function with duplicate elimination. The data were visualized and explored using the interactive Biblioshiny application, resulting in the data that would be evaluated in the study's findings and discussion. As a preliminary stage to network analysis and the calculation of bibliometric indicators, the data was cleaned and purified during this phase, which included the elimination of duplicate records.

A bibliometric network analysis was performed to discern relational patterns and intellectual structures within the area, excluding meta-analysis or inferential statistics. A weighted, undirected co-authorship network was established using full counting, incorporating only authors with a minimum of two published documents in the final corpus. Centrality metrics, such as PageRank and proximity, were computed on the largest linked component. The conceptual structure was analyzed by an author keyword co-occurrence network, incorporating phrases that appeared in at least five texts, which were normalized to standardize orthographic and semantic variants. The networks were standardized utilizing the strength of association metric, and theme clusters were delineated employing the Louvain algorithm, with the application of Biblioshiny's established settings. Table 2 provides a description of the criteria for network formation, inclusion thresholds, normalization methods, centrality measures, and clustering algorithms utilized.

The primary bibliometric indicators of academic production on education and gamification from 2014 to 2025 indicate a total of 405 documents published in 239 academic sources, with an annual growth rate of 20.95%. The average age of the documents is 2.87 years, and each publication has an average of 9.08 citations. In terms of thematic structure, 1221 author keywords and 445 Keywords Plus were recorded. The contribution consisted of 1153 authors, with an average of 3.15 co-authors per document and 54 single-authored documents. Lastly, the overview of academic productivity during the analyzed period is complemented by 7.41% of international co-authorships.

The software Tableau 2024.1.3 was utilized to generate a heat map for visualizing the geographical spread of gamification in the published literature. The study employed bibliometric scientific mapping as a method to analyze trends and discern potential in the development of teacher training within the context of Gamification.

Table 1
Structure of search string for systematic mapping.

Data Base	Search String
Scopus	(("teacher training" OR "teacher education" OR "teacher formation" OR "teacher professional development" OR "teacher improvement" OR "pre-service teacher*" OR "preservice teacher*" OR "in-service teacher*" OR "inservice teacher*" OR "formación docente" OR "formación del profesorado") AND (gamif* OR "game-based learning" OR ludific*)
WoS	

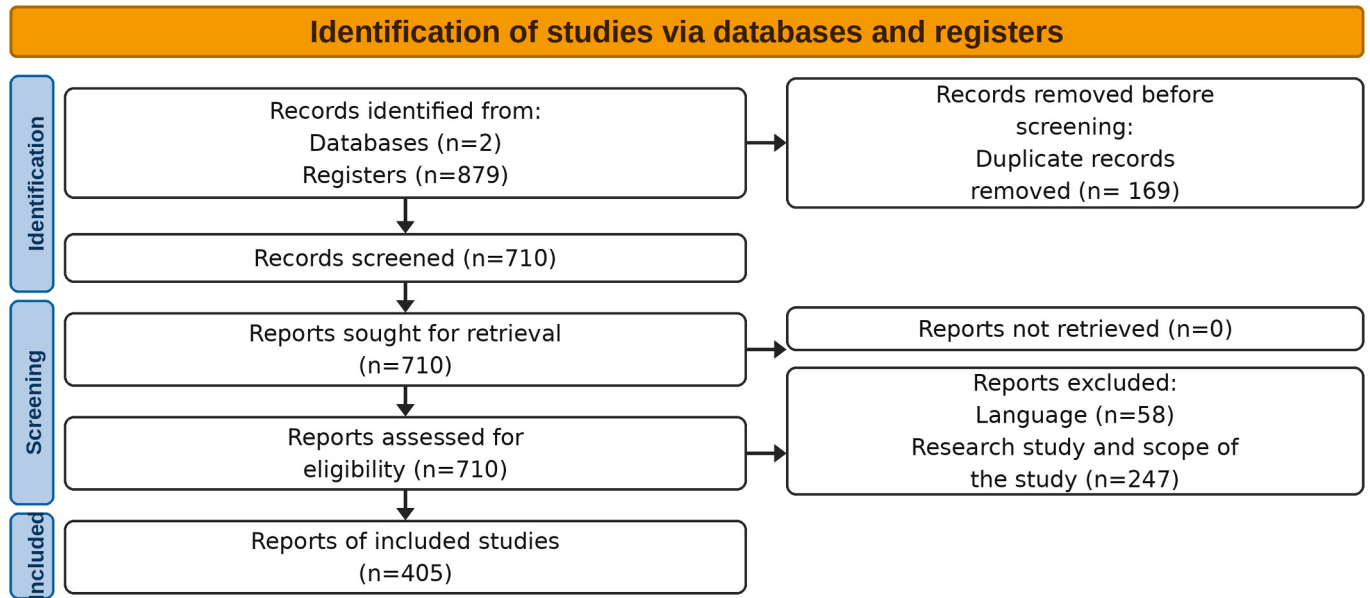


Fig. 1. Literature selection process flowchart.

Table 2

Parameters utilized for the construction and analysis of bibliometric networks.

Element	Co-authorship Network	Keyword
Type of network	Undirected, weighted	Undirected, weighted
Nodes	Authors	Author keywords (DE)
Links	Co-authored publications	Co-occurrence within the same document
Link weighting	Full counting	Co-occurrence frequency
Inclusion threshold	≥2 documents per author	≥5 documents per keyword
Normalization	Association strength	Association strength
Centrality metrics	PageRank, closeness centrality	Frequency, structural position
Component analyzed	Largest connected component	Full network after thresholding
Clustering algorithm	Louvain	Louvain
Clustering parameters	Default values	Default values

3. Results

The results of the study are given in relation to the geographical distribution of gamification and the evolution of the training of teachers within the framework of gamification. This is done after the content of the 405 publications that make up the sample topic of the study has been analyzed.

3.1. Growth trajectory and geographical distribution of gamification

The growth trajectory of annual scientific production in the field of gamification and teaching training during the period 2014–2025, a dynamic and steadily ascending process, can be observed over the past decade, as indicated in Fig. 2. In 2014, ten articles were published; however, by 2017, production had declined to six publications, marking the lowest point of the analyzed period. Beginning in 2018, a gradual recovery emerged, consolidating in 2019 and 2020 with 25 articles each year, and continuing with a consistent increase, reaching 49 in 2022 and 53 in 2023. The most significant change occurred in 2024, when production peaked at 91 articles, more than double the average number of publications recorded throughout the decade. In 2025, output reached 81 articles; however, it is important to note that the data reflect records

up to October 1, 2025, meaning the final figure could be higher by the end of the year.

The analysis of the geographical distribution of literature on gamification in teacher education, as illustrated in Fig. 3, reveals studies spanning more than 60 countries. This demonstrates that gamification has generated growing interest across diverse educational contexts and is consolidating as a research field with truly global reach. Within this body of work, Spain stands out as the clear leader, contributing 140 articles and positioning itself at the forefront of research on gamification applied to teacher education. Following Spain are the United States (38 articles) and Turkey (25 articles), both of which have also developed active scholarly communities in this area. Australia and Germany follow with 12 articles each, along with Portugal (11), and three Asian countries: Indonesia, China, and Malaysia with nine each, reflecting how Europe and Asia have assumed leading roles in advancing knowledge in this field. Other countries, such as Italy and Chile (7 articles each), the Netherlands (6), and Taiwan, Brazil, Greece, Mexico, and Ecuador (5 each), also display a sustained commitment to research in this domain. Likewise, nations including Canada, Russia, Hungary, the Philippines, Peru, Sweden, Thailand, Israel, Norway, and South Africa, each with between four and five publications, complement this academic network.

Several countries from Latin America, Africa, and the Middle East, such as Colombia, Argentina, Saudi Arabia, Ghana, Nigeria, and Palestine, along with several smaller European nations, have contributed at least one or two publications, albeit to a lesser extent. This diversity underscores that gamification is not confined to central or traditionally dominant regions but has begun to gain ground in emerging contexts, adapting to a wide range of educational realities and systems. Collectively, the data confirm two key trends: first, Spain's consolidated leadership in academic production on gamification and teacher education; and second, the progressive internationalization of research, which fosters broader collaboration and enables comparative analyses across different educational settings.

3.2. Evolution of teacher training within the framework of gamification

The analysis of the author collaboration network, represented in Fig. 4 and Table 3, indicates a structure in which a small core of researchers concentrates the highest level of connectivity, while the majority of authors maintain more limited relationships. The cumulative degree distribution shows that only a few nodes account for a significant

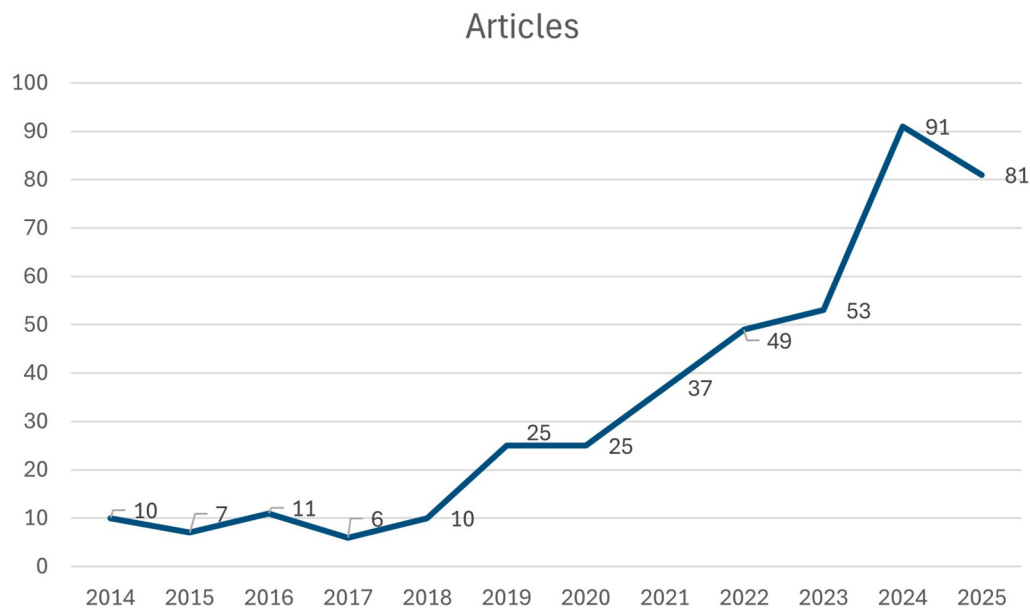


Fig. 2. Annual scientific production.



Fig. 3. Geographic distribution of the literature on gamification in teacher education.

number of connections, whereas most collaborations are localized, an expected pattern in scientific communities where certain authors become key reference points within the network. Elena Carrión Candel is one of the most important authors. She has the highest pagerank value (0.0486), which means she is in the middle of the network. Similarly, Donatella Persico and Francesca Pozzi achieve notable values that place them as significant nodes within their respective clusters. In addition, several authors with a closeness value of 0.5 demonstrate a strategic position within their groups, facilitating faster and more effective interactions. Taken together, the integration of visual and metric results confirms two key aspects: the presence of a small group of highly central authors who drive collaboration in the field of gamification and teacher education, and the contribution of a broader group of researchers with more limited connections who nonetheless play an essential role in sustaining the diversity and breadth of the academic network.

The analysis of the author collaboration network gave helpful information about how research clusters drive the collective production of

knowledge, a perspective that is complemented by the analysis of the emerging themes in gamification and teacher education, based on the data provided by the thematic map. This map, shown in Fig. 5, highlights “education,” “gamification,” and “students” as the basic pillars of the field, while “teacher training” and “language teaching” emerge as motor themes that actively shape pedagogical innovation. Psychological constructs such as “intrinsic motivation” and “self-determination” show a growing interest in the internal mechanisms that sustain engagement, while the inclusion of “augmented reality,” “children,” and “school students” reflects the expansion of gamification into broader educational contexts. At the same time, topics such as “computational thinking,” “taxonomy,” and “usability” indicate emerging areas that connect gamification with the development of digital competencies, and niche themes like “occupational socialization” and “delivery” provide more specialized perspectives. Taken together, these findings show that gamification in teacher education is simultaneously undergoing processes of consolidation and diversification, linking collaborative

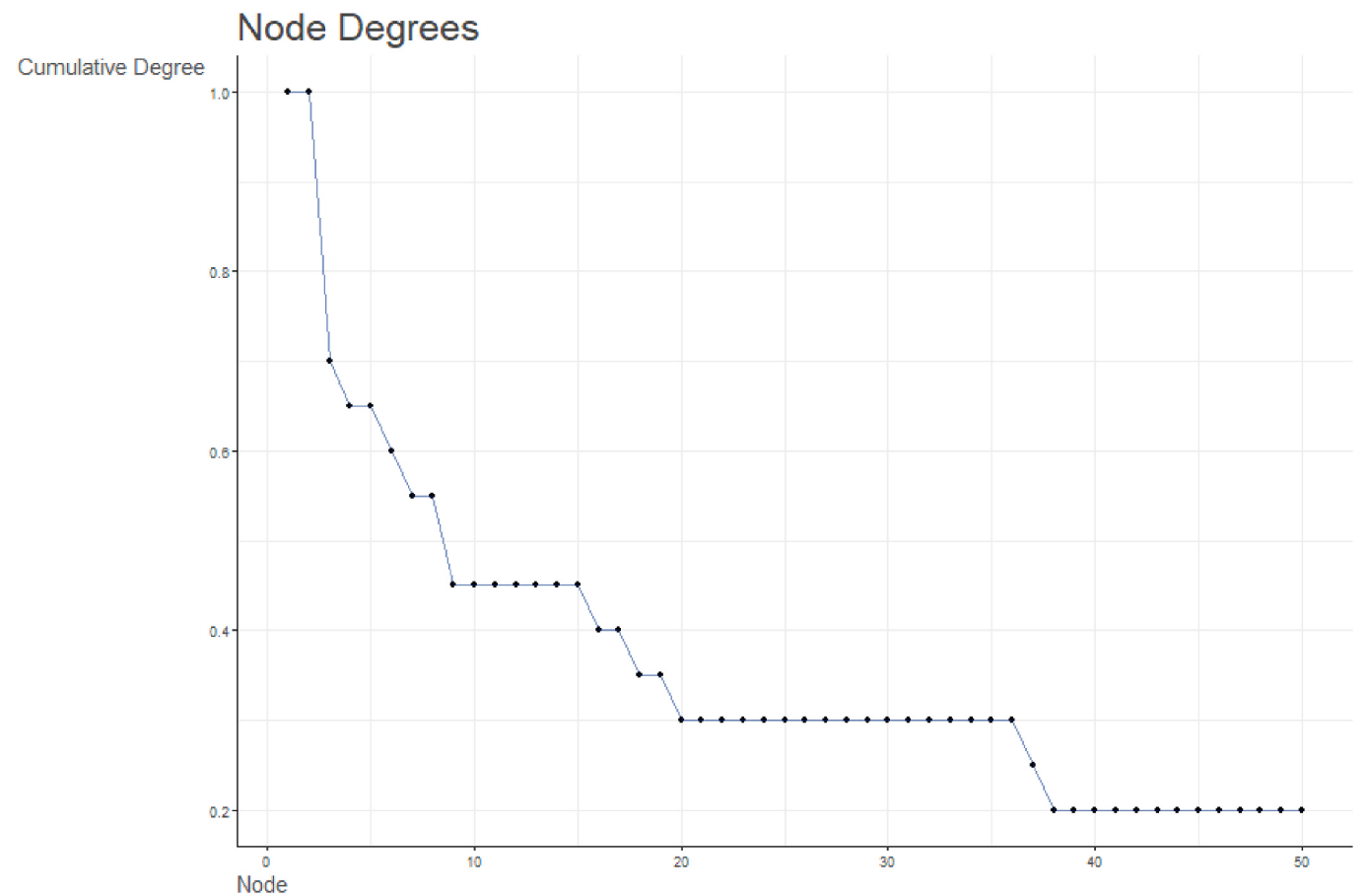


Fig. 4. Author collaboration network (cumulative degree).

Table 3
Influential authors by Closeness and PageRank.

Node	Cluster	Closeness	PageRank
Candel et al. (2024)	1	0,5	0,049
Yllana-Prieto et al. (2021)	7	0,5	0,037
Pozzi and Persico (2024)	8	0,333	0,041
Del Moral Pérez et al. (2022)	9	0,5	0,037
Miralles-Martínez et al. (2019)	10	0,5	0,037
Jiménez-Valverde et al. (2025)	11	0,333	0,039

structures with thematic evolution and positioning the field as both mature and forward-looking.

The co-occurrence network in Fig. 6 complements the author collaboration analysis by visualizing the conceptual evolution of research on gamification within teacher education. Two main thematic clusters emerge, revealing the intellectual structure and progressive diversification of the field. The first cluster (in red) centers on teacher training, game-based learning, and teacher education, indicating a consolidated research focus on how playful learning environments enhance pedagogical practices and pre-service teacher preparation. Terms such as "learning outcomes," "educational contexts," and "teaching practices" demonstrate an ongoing interest in linking gamification with evidence-based improvements in instructional performance and student engagement. The second cluster (in blue) highlights the intersection between professional development, digital games, and pedagogical content knowledge, emphasizing the application of gamified strategies in continuous teacher education and in-service training. This cluster underscores a shift from theoretical exploration toward practical and technological integration, where digital tools and games are used to strengthen professional competencies and instructional design.

Together, these clusters illustrate the evolving nature of teacher education within the gamification framework, transitioning from isolated studies on learning motivation and classroom practice toward a more cohesive and collaborative research landscape. The strong linkages between clusters suggest an increasing dialogue between pre-service and in-service teacher development, reinforcing the collaborative trends already observed in the author network. Ultimately, this network reflects a maturing field that integrates pedagogical innovation, digital fluency, and professional growth to reimagine how educators are trained in the 21st century.

Potential research areas can be projected directly from the observed bibliometric patterns, given the conceptual structure identified through the thematic map and the co-occurrence network. These areas do not represent an exhaustive pedagogical interpretation; rather, they represent a prospective synthesis that is predicated on the thematic organization, the centrality of the concepts, and the relationships between clusters. Table 4 illustrates these potential areas as orientations that are derived from the bibliometric analysis.

4. Discussion

The evolution of teacher education in gamification, as identified through bibliometric mapping, reveals a transition from isolated experiences to a more stable architecture of teaching competencies. In this shift, gamification ceases to function merely as a motivational resource and instead operates as an instructional design framework aligned with goals of professional development, self-regulation, and formative assessment. This interpretation is consistent with recent evidence that situates gamification at the intersection of hybrid didactic ecosystems, game-based learning, and teacher professional development, resulting

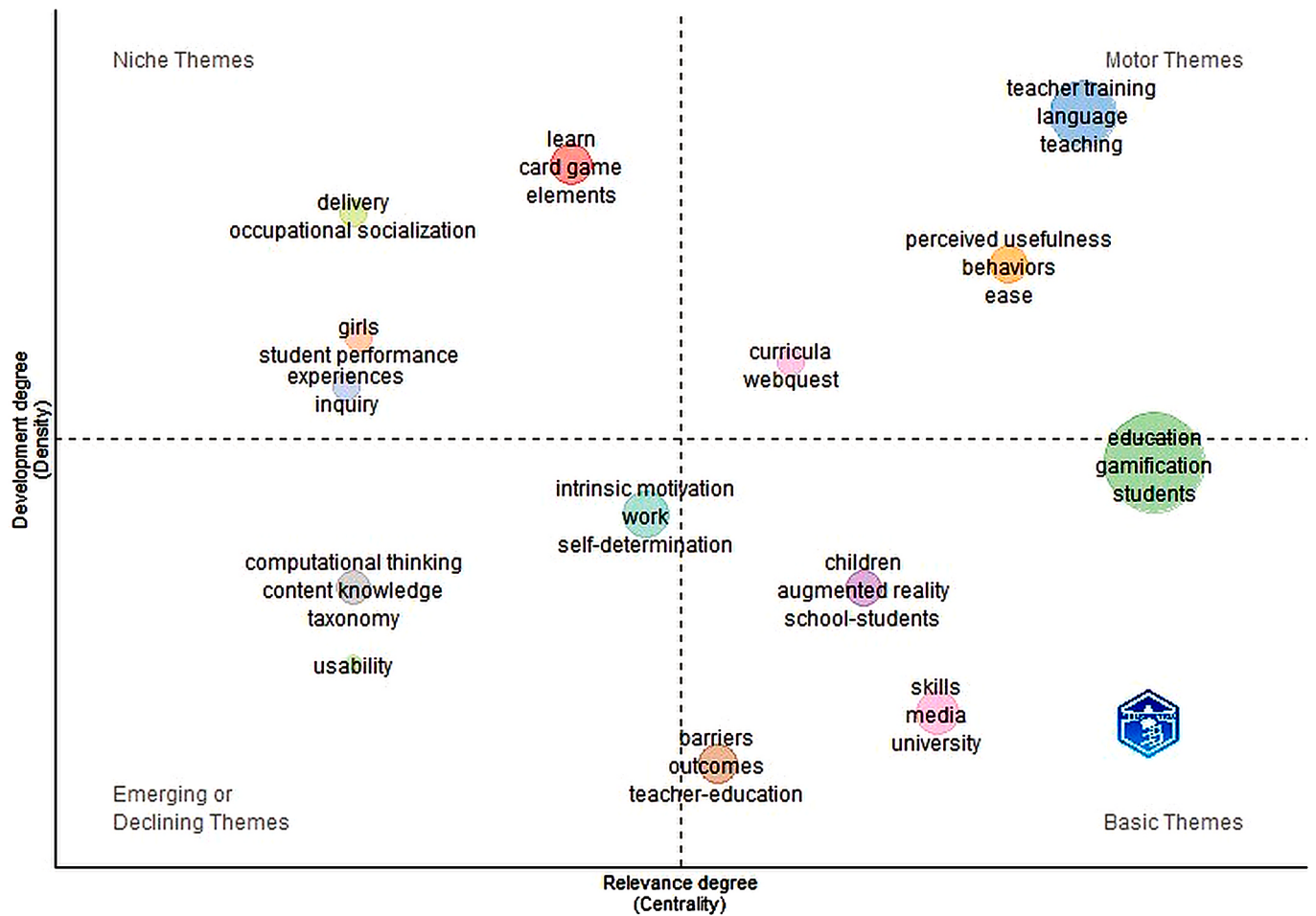


Fig. 5. Core and emerging themes in gamification and teacher education.

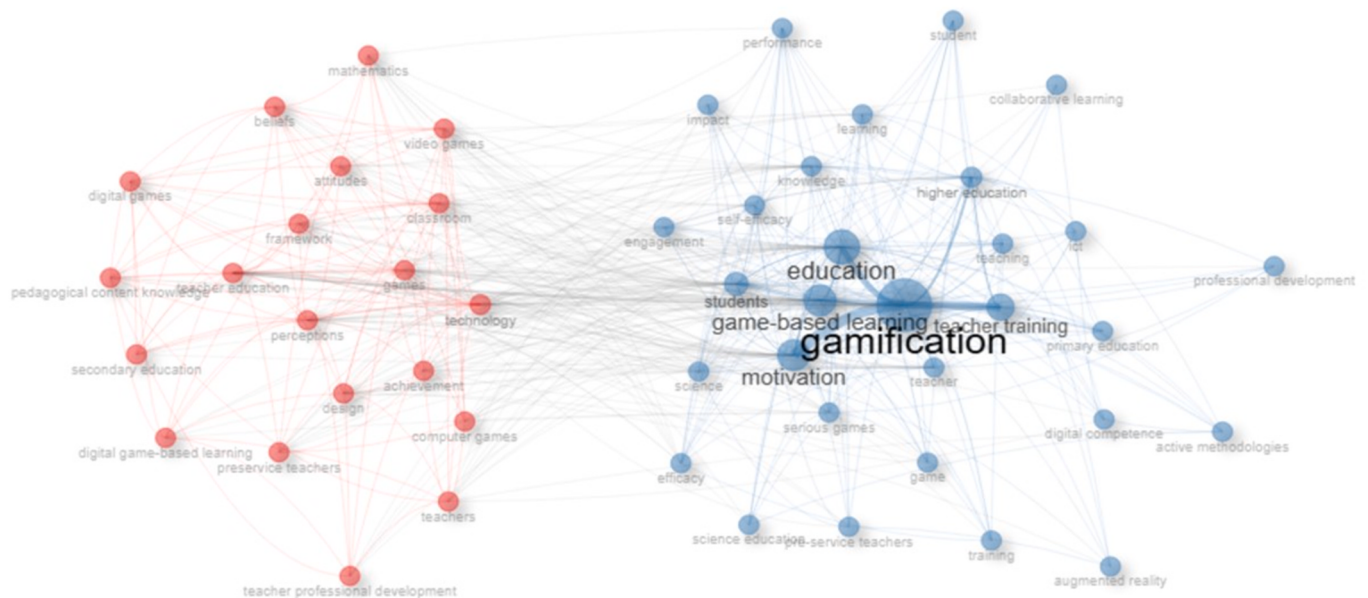


Fig. 6. Co-occurrence network mapping the conceptual structure of gamification and teacher education research.

in positive outcomes in both student and teacher engagement and performance (Marques & Pombo, 2021; Pozzi et al., 2024).

Over the past decade, the number of publications has increased

steadily, with an annual growth rate of approximately 21%, confirming the field's maturity and its progressive integration into educational innovation agendas. This phenomenon can be understood as a global

Table 4
Potential research areas derived from bibliometric analysis.

Prospective research domain	Bibliographic evidence	Prospective orientation
Gamification as a systematic method for educator development	Prominent significance of teacher training and gamification (Figs. 5 and 6)	Creation of reproducible gamified design frameworks in training initiatives
Gamified educator training within professional development frameworks	Cluster associated with professional advancement and digital gaming	A review of the long-term influence on the professional development of educators
Motivational underpinnings of gamified educator development	Development of intrinsic motivation and self-determination	Examination of psychological processes that facilitate teacher learning
Digital teaching abilities and gamification	Co-occurrence of usability, computational reasoning, and technology	Incorporation with established frameworks of digital pedagogical proficiency
Formative assessment and gamification	Convergence between learning outcomes, assessment, and teaching practices	Development of evaluation strategies that are consistent with gamified environments
Innovative technology in gamified educator training	Increasing prevalence of augmented reality and digital gaming	Investigation of hybrid and adaptive training methodologies

response to the challenges arising from the digitalization of learning and the transformation of teaching roles in the post-pandemic era—contexts that have demanded new ways of teaching and learning mediated by digital technologies and learner-centered strategies (Gordillo et al., 2021; Ramírez et al., 2021). Within this context, gamification has evolved from being a complementary motivational tool to becoming a structural pedagogical approach that integrates active learning, self-regulation, and the development of teaching competencies (Pozzi & Persico, 2024).

The bibliometric technique primarily aims to identify structural patterns in scientific production, collaboration, and thematic evolution; nevertheless, its analytical usefulness increases when these patterns are evaluated alongside the substantive advancements reported by primary investigations. This discussion delineates the primary clusters and trends identified in the bibliometric analysis alongside recent empirical evidence, aiming to convert the field mapping into pertinent conceptual, methodological, and pedagogical implications for teacher training.

Initially, the findings verify a gradual reevaluation of the role of gamification in teacher training. The most recent literature demonstrates a transition from extrinsic motivation-focused approaches to more comprehensive conceptions, in which gamification functions as a structural pedagogical framework that facilitates engagement, persistence, and the development of meaningful learning. In initial teacher training contexts, it has been documented that these proposals promote inclusive practices and greater pedagogical involvement when they are linked to explicit learning objectives and clear assessment criteria, thereby consolidating gamification as a component of instructional design and not merely as an accessory resource (Manzano et al., 2022).

Moreover, empirical research substantiates the efficacy of gamification in continuing education and professional development for educators, especially when combined with digital technologies. Recent research indicates that gamified training programs can enhance teacher satisfaction, perceived utility, and willingness to engage, particularly in primary and secondary school. The observed effects seem to be influenced by factors including formative feedback, structured content organization, and individualized learning, thereby supporting the notion of gamification as a promoter of continuous professional development, contingent upon its alignment with the genuine needs and expectations of educators (Liu et al., 2023).

Additionally, the results underscore a branch of research that

concentrates on the conditions that facilitate the adoption of gamification by instructors, thereby offering a more sophisticated comprehension of the factors that contribute to its successful implementation. Research that is substantiated by frameworks such as the theory of planned behavior suggests that the intention to implement gamification is linked to positive attitudes and sufficient levels of teacher self-efficacy. Nevertheless, its successful implementation in training programs is contingent upon institutional, cultural, and organizational mediations that facilitate its sustainable integration (Leiss et al., 2025).

An emergent tendency is solidifying, expanding the scope of gamification to encompass curricular and evaluative dimensions, connecting it to competency assessment, narrative design, and curricular innovation in initial teacher training. In this context, gamified narratives and their corresponding feedback mechanisms have shown potential to enhance formative assessment processes and reflective engagement among prospective educators, thereby fostering a more profound comprehension of professional development and teaching methodologies (Villalustre, 2024).

The consistent increase in scientific output from 2019 to 2025 indicates a conceptual shift in the understanding of gamification within teacher education. Initially, studies tended to focus on its capacity to generate interest or energize classes; however, more recent works reveal a shift toward sophisticated approaches that conceive gamification as a scaffold for promoting self-reflection, autonomy, and formative assessment (Passarelli et al., 2022; Saavedra et al., 2024). In this new stage, the emphasis lies not merely on the use of game mechanics but on the intentional design of learning experiences grounded in psychological principles of intrinsic motivation and self-determination. These advancements have strengthened the methodological rigor of the field and fostered the creation of replicable theoretical models linking the design of gamified experiences with the improvement of pedagogical practice and teacher professional development (Czok et al., 2023). The field's maturity is evident in the quantitative rise in publications, the qualitative diversification of interpretative frameworks, and researchers' enhanced ability to accurately evaluate the impact of gamified strategies in authentic teacher education settings.

The increase in scientific production in 2024, when more than 90 articles were published, coincides with the expansion of emerging technologies such as augmented reality and artificial intelligence applied to learning. These innovations have opened new possibilities for designing interactive gamified environments that promote reflective practice, situated learning, and pedagogical experimentation (Jiménez et al., 2025). Currently, gamification is experiencing a phase of technological convergence that enables its integration with adaptive systems, mobile platforms, and learning analytics, elements that enhance its capacity to personalize teaching and strengthen teachers' digital competence. Regarding the geographical dimension, the study confirms Spain's leadership as the country with the highest number of publications, followed by the United States and Turkey. However, the fact that more than 60 countries have contributed to the analyzed literature demonstrates that gamification has transcended borders, establishing itself as a truly global trend. Emerging regions such as Latin America and Asia show increasing participation, with studies addressing the role of gamification in educational equity, inclusion, and the cultural contextualization of training processes (Vera et al., 2024). This internationalization shows that gamification is not a phenomenon confined to the Global North but rather a flexible practice adaptable to diverse educational settings, capable of responding to the specific challenges of each context.

The investigated co-authorship networks support the concept of collaborative expansion. A core group of highly connected authors can be identified as significant articulators of the discipline, encouraging the dissemination of design models and theoretical frameworks (Pozzi & Persico, 2024). Surrounding this center is a network of researchers with more localized ties, which maintains the area's epistemic diversity and dynamism. This core-periphery arrangement is typical of scientifically

consolidated societies, in which very central groups propose research goals while peripheral nodes adapt and relate these recommendations to local reality. Thematic analysis conducted using co-occurrence mapping reveals the consolidation of three primary conceptual pillars: education, gamification, and students, as well as two driving themes: teacher training and language teaching.

The findings indicate that gamification has been comprehensively integrated into teacher education, especially in language, science, and technology instruction (Leiss et al., 2025). Simultaneously, developing themes such as computational thinking, usability, and augmented reality indicate a shift towards more technical fields and the development of teachers' digital abilities (MacCallum, 2025). Thematic diversity signifies disciplinary maturity, as the field consolidates its conceptual foundations while expanding into new realms of knowledge. Gamification has transitioned from a singular method to an extensive learning environment that amalgamates technology, pedagogy, and professional development, elucidating the cognitive, affective, and social facets of the educational process (Coelho et al., 2025; Gómez et al., 2025).

A particularly significant aspect is the convergence between initial teacher education and continuous professional development. The thematic clusters and co-authorship networks reveal that both formative stages are closely interconnected and mutually reinforcing. Pre-service teachers who participate in gamified environments tend to replicate and adapt these strategies in their professional practice, enabling the effective transfer of pedagogical knowledge (Guerrero, 2024; Triantafyllou et al., 2025). At the same time, professional development programs are increasingly incorporating playful and narrative components to enhance critical reflection, collaboration, and teacher creativity (Mc Kevitt et al., 2025). This link between initial training and professional practice underscores the existence of continuous learning, where gamification serves as a unifying mechanism between theoretical knowledge and educational practice, fostering the development of reflective and collaborative teacher profiles.

4.1. Limitations

It is essential to recognize specific methodological constraints. This analysis, like every research, has inherent limitations. The selection of Scopus and Web of Science prioritized the quality and technical precision of the data, despite the acknowledgment that this decision omits significant contributions from regional repositories and grey literature. While English and Spanish were preferred due to their prominence in this discipline, this selection acknowledges a bias that may neglect emerging discoveries in other languages. Moreover, the data analyzed extend only up to October 2025; therefore, emerging trends may shift as new studies are published in the following months. Despite these limitations, the combined use of the Bibliometrix R-package and Tableau ensured analytical precision, duplicate removal, and interactive data visualization, thereby strengthening the reliability and reproducibility of the process. Finally, the generalization of the study's results may be limited, as the effectiveness and implementation of gamification in teacher education can vary significantly across different educational and cultural contexts. These limitations indicate that, while the investigation offers an informative overview of trends and collaborations in gamified teacher education, further comprehensive and diversified research is required to address these areas for improvement.

5. Conclusions

The bibliometric study of 405 articles published from 2014 to 2025 indicates a stable and steady growth of gamification in teacher education over the past decade. This advancement, characterized by an annual growth rate of roughly 21%, signifies not only an enhancement in academic research and practical applications within the subject but also the solidification of a discipline that has attained notable conceptual and methodological sophistication. Spain ranks first in scientific output,

succeeded by the United States and Turkey, forming collaborative networks that illustrate the increasing internationalization of knowledge. The findings underscore the integration of initial teacher education and ongoing professional development, wherein gamification has transitioned from a standalone motivational instrument to a systematic pedagogical strategy focused on active learning and formative evaluation. This study's primary contribution is the provision of a validated intellectual map that identifies prominent writers and delineates emerging topic boundaries, including the use of augmented reality and the integration of gamification to enhance teacher self-regulation. This mapping is essential for institutions and curriculum designers to base their training programs on evidence of significant impact and global relevance. The primary challenge identified is the methodological and contextual disparity between central research and peripheral studies, which restricts the practical application of gamified models in various educational settings. The establishment of international alliances for applied research is suggested to facilitate the co-creation of adaptable and culturally responsive gamified designs. Integrating artificial intelligence tools and learning analytics can improve the personalization of teacher training and the evaluation of gamified strategies' effectiveness. The future of gamification in teacher education is anticipated to evolve into an adaptive ecosystem, influenced by personalization trends and the growing complexity of instructional designs. Training will transition from a static event to a dynamic environment for ongoing professional development, wherein the teacher's learning process is gamified, providing immediate feedback and personalized pathways informed by actual classroom performance.

CRedit authorship contribution statement

Miguel Alberto Rincón Pinzón: Writing – original draft, Supervision, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ana Dolores Vargas Sánchez:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Funding acquisition, Conceptualization. **Paloma Valdivia Vizarreta:** Writing – review & editing, Validation, Supervision, Investigation.

Data availability statement

Rincón Pinzón, M. A., Valdivia Vizarreta, P., & Vargas Sánchez, A. D. (2025). Evolution of Teacher Training in Gamification [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.17399518>. Haga clic o pulse si confía en este vínculo."><https://doi.org/10.5281/zenodo.17399518>.

Declaration of the use of AI

During the preparation of this work, the authors utilized AI techniques, such as ChatGPT 5, to enhance the article's readability, and Grammarly to guarantee grammatical precision. Also, Tableau 2024.1.3 software IA was used to create a heat map that allows visualization of the geographical distribution of gamification in the published literature. After using these tools, we carefully reviewed, edited, and validated the final version of the manuscript and take full responsibility for the content of the published article.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Given her role as research, had no involvement in the peer review of this article and had no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to another journal editor. ADVS. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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