Contemporary Educational Technology, 2026, **18**(1), ep632
ISSN: 1309-517X (Online)

OPEN ACCESS

Review Article

Game On: A bibliometric analysis of gamification and game-based learning in teacher training and education

Amani Khalaf Hamdan Alghamdi [1*]
0000-0002-8500-0266

Shakil Ahmed [1]
0000-0001-5511-0598

Safiqur Rahaman [2]
0000-0003-1367-2618

[1] Imam Abdulrahman Bin Faisal University, Dammam, SAUDI ARABIA
[2] University of North Bengal, Siliguri, INDIA
[*] Corresponding author: akhalghamdi@iau.edu.sa

Citation: Alghamdi, A. K. H., Ahmed, S., & Rahaman, S. (2026). Game On: A bibliometric analysis of gamification and game-based learning in teacher training and education. *Contemporary Educational Technology, 18*(1), ep632. https://doi.org/10.30935/cedtech/17953

ARTICLE INFO

Received: 5 Oct 2025

Accepted: 1 Jan 2026

ABSTRACT

A comprehensive bibliometric analysis was used to discern the impact and trends of gamification and game-based learning (GBL) in teacher training and education. Examining scholarly output from 2005 to 2024 (610 papers, 1,821 authors, and 4,461 citations) revealed key trends, prolific authors, influential publications and venues, and emerging research areas. The study assessed the growth of publications, frequency of keywords, and geographical distribution of research. Results reveal significant growth in gamification and GBL research with a notable increase in 2024, marked by 68 publications (a 3,300% increase from 2005), and a focus on gamification, GBL, motivation, and engagement as keywords. Most research originated from Spain, the USA, and Italy. Four universities generated most (40%) of the scholarship. Two authors stand out with 82 citations each and a remarkable average of 20.50 citations per publication. Francesca Pozzi was the most prolific author with five publications. *Education Sciences* was the most relevant journal with 21 papers. Integrating gamification and GBL into educational practices, supported by appropriate resources and teacher training, enhances learner outcomes and improves student motivation, engagement, and academic performance. However, challenges and barriers exist, especially inadequate teacher training, change resistance, and unclear distinctions between gamification and GBL. The research landscape to date inspires future research about factors conducive to effective and sustained impact of teacher preparation for gamified learning environments.

Keywords: gamification, game-based learning, teacher training, educational technology, learning outcomes

INTRODUCTION

Recently, gamification and game-based learning (GBL) have garnered significant attention in educational research, particularly in teacher training and education. Gamification uses game elements in nongame contexts (including classrooms) such as points, reward systems, levels, badges, and leaderboards (score boards) (Dahalan et al., 2024). In contrast, GBL applies actual games to *educational* settings. This difference emphasizes their distinct but complementary roles (Al Fatta et al., 2018). GBL uses games to teach complex subjects and achieve educational objectives by providing immersive, experiential, and interactive learning opportunities. Games can be in the form of board games, videos, simulations, puzzles, scenarios, online role playing, and apps (Fernando & Premadasa, 2024; Pineda-Martínez et al., 2023).

Copyright © 2026 by authors; licensee CEDTECH by Bastas. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/).

This paper explores gamification and GBL in teacher education programs that have traditionally relied heavily on lecture-based instruction and the transfer of theoretical knowledge. Although effective to some extent, these methods often fail to engage trainee teachers fully or equip them with the practical skills needed in diverse classroom environments. Traditional teacher training programs usually fall short of preparing teachers for the complexities of the modern classroom. Concurrently, the global education landscape faces several pressing challenges, including teacher shortages, low retention rates, and varying levels of teacher preparedness. Teachers entering the profession in many parts of the world often require additional practical experience or skills to manage modern, dynamic classrooms. This inadequacy often leads to high-stress levels, burnout, and attrition. Gamification and GBL offer potential solutions to these issues by providing more engaging and effective training experience leading to more satisfying and rewarding formal teaching experiences.

Both teaching strategies represent a paradigm shift in educational methodologies. They innovatively leverage the principles and mechanics of games to enhance learning experiences, increase engagement, and improve academic outcomes. The integration of gamification and GBL into teacher education training is not merely a trend but a response to evolving educational paradigms that prioritize active learning, motivation, and the development of 21st century skills. Research indicates that gamified learning environments can significantly improve student motivation and performance (Lester et al., 2023; Zhang & Yu, 2022a). Both have also shown promise in vocational training (Chen et al., 2023), language learning (Kogan, 2023) and special education (Rodríguez-Ferrer et al., 2023). Gamification and GBL in teacher training can also address issues related to inclusivity and differentiated instruction. Adl-Amini et al. (2024) explored a simulation game designed to foster reflection and belief change about inclusion and highlighted the potential of gamification to promote inclusive teaching practices. This is particularly relevant in today's diverse classrooms, where teachers must be equipped to meet all students' educational needs. Moon et al.'s (2024) scoping review of GBL for mathematics teacher education demonstrated how these innovative approaches enhanced preservice teachers' content knowledge and pedagogical skills.

Several factors have contributed to the growing prominence of gamification and GBL in teacher training. Foremost is the rapid advancement of educational technology, which makes it easier to integrate sophisticated game elements into educational programs. The proliferation of digital devices and educational software has further provided educators with tools to design and implement gamified learning experiences. For example, Rocha and Doyle (2024) described BlendMaster as a collaborative board game for training teachers in blended learning, showcasing how technology and creativity can combine to produce practical educational tools. Secondly, the increasing body of research supporting the effectiveness of gamification and GBL in education has spurred its adoption in the classroom. Studies have consistently shown that gamified learning experiences can lead to higher levels of learner engagement, motivation, and knowledge retention (Boysen et al., 2023). Thirdly, the shift toward competency-based education and the emphasis on developing practical, real-world skills have also driven the adoption of gamification and GBL. With their focus on experiential learning and immediate feedback, gamification and GBL align well with the goals of competency-based education. Huang (2023) highlighted the use of gamification and multi-agent simulation for training teachers in preventing bullying. These approaches can equip teachers with critical skills in a controlled, risk-free environment.

Despite growing interest and implementation in education, gamification and GBL are challenging to implement. Common barriers include technological limitations, lack of educator training, and resistance to change (Lester et al., 2023). Moreover, the effectiveness of these approaches can vary depending on the context and specific design of the gamified activities or games (Geisthardt et al., 2023). When implemented effectively, GBL has improved literacy skills among secondary school students (Manzano-León et al., 2022) and enhanced mathematics learning in high school settings (Ortiz et al., 2022). Gamification and GBL were also used in medical education to teach complex medical concepts effectively (Hamdi et al., 2022; Zohari et al., 2022). Integrating gamification and GBL into sustainability education and physical education promoted environmental awareness and physical fitness, respectively (Camacho-Sánchez et al., 2023; Pineda-Martínez et al., 2023).

The effectiveness of gamification and GBL can also be seen in the development of future teachers, who utilize these methods to enhance their pedagogical skills and technological competencies (Vankúš, 2023). The

comparison of gamification, GBL, and serious games (i.e., interactive applications designed with a specific educational purpose beyond pure entertainment) in various educational settings provides insights into their unique benefits and challenges (Farreras et al., 2022). For example, gamification has effectively been used to develop practical, real-world skills for modern classrooms, such as managing student behavior and creating inclusive learning environments (Rocha & Doyle, 2024).

The bibliometric analysis herein aims to explore the gamification and GBL landscape in teacher education and training, shed light on their significance, identify the global challenges they address, and comment on the contributing factors to their growing prominence. By analyzing publication trends, citation patterns, and thematic clusters, we sought to identify key research areas, influential studies and researchers, and emerging trends. Results will contribute to a deeper understanding of how gamification and GBL can be integrated into teacher education programs, highlighting areas for future research and development.

LITERATURE REVIEW

The literature review synthesizes both recent studies on gamification and GBL's implementation in education in general and teacher education in particular with the former intended to provide tangential evidence of the benefits to teaching and learning if teacher educators are exposed to gamification and GBL in their preservice training.

Teachers' Gamification and GBL Attitudes and Competence

Teachers' positive attitudes and competence in using gamified tools and GBL are crucial for successful implementation. Sáez-López et al. (2022) found that Spanish primary education teachers largely supported gamification with a high level of familiarity with tools such as Genially, Kahoot, and Google Classroom, intimating their readiness to incorporate gamified learning into their practices. They concluded that a positive reception among teachers is key because their enthusiasm and expertise significantly impact on the effectiveness of gamification in classrooms. Successful gamification and GBL integration require that teacher education programs teach several competencies. Nousiainen et al. (2018) identified pedagogical, technological, collaborative, and creative skills as essential for teachers to design and facilitate engaging gamified experiences, so they can maximize the benefits of gamification and GBL by creating immersive, motivational, and adaptive learning environments. Krath et al. (2021) emphasized the need for a solid theoretical foundation to understand the influence of gamification and GBL on learning processes especially educational theories such as constructivism and self-determination theory.

Impact of Gamification and GBL on Learning Outcomes

Al-Hafdi and Alhalafawy's (2024) bibliometric study revealed the substantial impact of these approaches on educational outcomes, particularly in terms of motivation and engagement, despite geographical research gaps, notably in African contexts (Guerrero-Alcedo et al., 2022). Research has documented the positive effects of gamification and GBL on learning in various subject areas. For instance, Parra-González et al. (2020) found that gamified experiences in physical education fostered creativity, mitigated negative effects, and enhanced collaboration, indicating benefits in both cognitive and social learning outcomes. Given the positive influence on students' learning outcomes, teacher education programs are encouraged to incorporate gamification and GBL into novice teacher training.

Applications in Teacher Training

Indeed, gamification in teacher training is gaining traction, especially in the social sciences and vocational education. For example, Cózar-Gutiérrez and Sáez-López (2016) examined the use of MinecraftEdu in initial teacher training and demonstrated its potential to heighten engagement and learning outcomes. Dahalan et al. (2024) reviewed gamification and GBL in vocational settings, highlighting their role in improving learning motivation and skill acquisition. These approaches also extend to medical as well as science, technology, engineering, and mathematics education, where studies have shown that gamification makes complex subjects more approachable and engaging (Pesare et al., 2016; Zabala-Vargas et al., 2021). Teacher education programs should heed this research and incorporate GBL pedagogy and technology into their curricula.

Inclusivity and Lifelong Learning through Gamification and GBL

Gamification has also been used in teacher education programs to promote inclusivity and lifelong learning. Adl-Amini et al. (2024) developed a simulation game to encourage inclusive teaching practices. They underscored GBL's potential to prepare teachers for diverse classroom settings. Zhang and Yu's (2022b) meta-analysis confirmed the positive impact of gamification and GBL on students' learning achievement and motivation. Júnior et al. (2019) highlighted the benefits of gamified, problem-based learning. These studies illustrate the potential long-term learning benefits of gamification and GBL, especially inclusivity, academic achievement, learner motivation, and problem solving.

Challenges in Implementing Gamification and GBL

Despite its potential, gamification and GBL usage faces challenges beyond educator teacher scenarios including technological limitations, resistance to change, and adaptation issues (Nolan & McBride, 2014). Jayasinghe and Dharmaratne's (2013) examination of these challenges from the perspective of higher education students emphasized the importance of context-specific implementation strategies, particularly tailoring teaching methods to institutional resources and goals. Teacher education programs should sensitize preservice teachers to the many challenges associated with implementing gamification and GBL.

Research Problem and Question

The primary research problem is the limited understanding of gamification and GBL, specifically within teacher education. Traditional teacher education programs often rely heavily on theoretical instruction, meaning they may not adequately engage teacher trainees in or equip them with practical, adaptive skills suited to today's diverse, contemporary classrooms. Gamification and GBL offer promising strategies to address these limitations by fostering higher trainee engagement, motivation, and practical skill acquisition in teacher education. However, there is a lack of empirical and bibliometric clarity regarding the extent, effectiveness, and geographic distribution of research focused on integrating gamification and GBL into teacher training programs, particularly in terms of the competencies required for effective implementation in their future practice.

The research questions guiding this study were "*How have gamification and GBL been utilized in teacher education to improve trainee engagement, motivation, and skill acquisition and what emerging trends define its current research landscape?*" These questions focused the study on the unique impact and evolving trends of gamification and GBL, specifically in teacher education, which distinguishes it from broader educational applications. By examining these elements, the study aims to identify specific areas where gamification and GBL may enhance teacher preparation and highlight gaps that warrant further exploration.

METHOD

Biblio is a word-forming element meaning 'book.' *Metry* is a word-forming element meaning 'the process of measuring.' Bibliometrics, thus, involves the statistical measurement and analysis of bibliometric data and information contained in books, journal articles, and other written publications to

(a) track author or researcher output and impact and

(b) identify nuances, trends, and evolution patterns in disciplines and research areas (Ahamer & Kumpfmüller, 2014; Aria & Cuccurullo, 2017; Donthu et al., 2021; van Eck & Waltman, 2024).

Statistical and mathematical procedures generate indicators (indices) profiling the basic features of bibliometric data. Results can be absolute (actual numbers), relative (compared to others), and process-based (determined using a formula) (e.g., the *h-index*) (Rousseau & Rousseau, 2021). When interpreting results, we heeded van Raan's (2019) advice to "never use bibliometric analysis, regardless of how advanced it may be, as a standalone tool for research evaluation" (p. 257).

Bibliometrics serves as a complementary approach to the literature review by systematically mapping out key trends, influential works and authors, and geographic distribution patterns in gamification and GBL research within teacher education. Although previous studies have conducted bibliometric analyses in broader educational contexts, few have narrowed their scope to teacher education, leaving a gap in

understanding the research's specific focus on preparing future educators. Via a bibliometric analysis, this study not only identified existing research patterns but also highlighted underexplored areas such as regional disparities and specific competency needs, thus providing a more comprehensive view than a traditional literature review alone could achieve. Results are expected to contribute to a deeper understanding of how gamification and GBL can be integrated into teacher education programs, highlighting areas for future research and development.

Database and Search Strategy

The Web of Science (WoS) was selected as a database for its rigorous indexing standards, extensive multidisciplinary scope, and inclusion of high-impact journals, which ensure data's legitimacy and authenticity. The WoS offers extensive bibliometric data, including citations and metadata, which are crucial for examining trends in gamification and GBL research within the context of teacher training and education.

The search strategy was meticulously crafted to encompass a broad spectrum of relevant studies. Keywords included TI = ("gamif*" OR "game*" OR "gamification*" OR "dgbl" OR "Education* Game*" OR "Video Game*" OR "Serious Game*" OR "Game Design*" OR "computer* game*" OR "Game-Based Learning*" OR "game* play*" OR "game* mechanic*" OR "gameful*" OR "game* element*" OR "game* dynamic*" OR "game* component*" OR "Game* Theory*") AND TI = ("Teacher* train*" OR "teacher* educat*" OR "train* for teacher*" OR "train* of teacher*" OR "train* teacher*") OR AB = ("gamif*" OR "game*" OR "gamification*" OR "dibl" OR "Education* Game*" OR "Video Game*" OR "Serious Game*" OR "Game Design*" OR "computer* game*" OR "Game-Based Learning*" OR "game* play*" OR "game* mechanic*" OR "gameful*" OR "game* element*" OR "game* dynamic*" OR "game* component*" OR "Game* Theory*") AND AB = ("Teacher* train*" OR "teacher* educat*" OR "train* for teacher*" OR "train* of teacher*" OR "train* teacher*") OR AK = ("gamif*" OR "game*" OR "gamification*" OR "dibl" OR "Education* Game*" OR "Video Game*" OR "Serious Game*" OR "Game Design*" OR "computer* game*" OR "Game-Based Learning*" OR "game* play*" OR "game* mechanic*" OR "gameful*" OR "game* element*" OR "game* dynamic*" OR "game* component*" OR "Game* Theory*") AND AK = ("Teacher* train*" OR "teacher* educat*" OR "train* for teacher*" OR "train* of teacher*" OR "train* teacher*")

Data Extraction and Filtration Process

Rigorous inclusion and exclusion criteria were applied. Publications from 2005 to 2024 were considered to ensure contemporary relevance. Acceptable document types included articles, conference papers, and reviews. The search was restricted to English-language publications to avoid translation biases. Titles and abstracts were reviewed to exclude irrelevant studies, focusing solely on those pertinent to gamification and GBL in teacher education. The data extraction and filtration process was conducted using a systematic four-phase approach that ensured meticulous screening and selection of relevant studies (Page et al., 2021; Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA], 2024).

Figure 1 represents the systematic process undertaken to refine the dataset from an initial pool of publications to a relevant set of documents. Each phase of the filtration process was clearly delineated, demonstrating the rigorous application of inclusion and exclusion criteria as well as the critical assessment of remaining records. This thorough approach underscores the authors' commitment to precision and accuracy in their bibliometric analysis. The initial search identified 773 records. In the second phase, 625 records were screened based on predefined inclusion and exclusion criteria, which involved filtering by publication year, document type, and language. The third phase involved a detailed review of titles and abstracts resulting in discarding 15 irrelevant records. This strategy yielded N = 610 relevant documents. Finally, a thorough assessment of the full texts of the remaining records was conducted to confirm their relevance and ensure the highest quality of data for bibliometric analysis.

Data Analysis

The final sample frame of 610 studies was subjected to a detailed bibliometric analysis using Biblioshiny (Aria & Cuccurullo, 2017), VOSviewer (van Eck & Waltman, 2024) and Microsoft Excel. Biblioshiny offers functionalities for comprehensive data visualization and mapping of scientific literature. VOSviewer was utilized to construct and visualize bibliometric networks, which are particularly useful for analyzing citation,

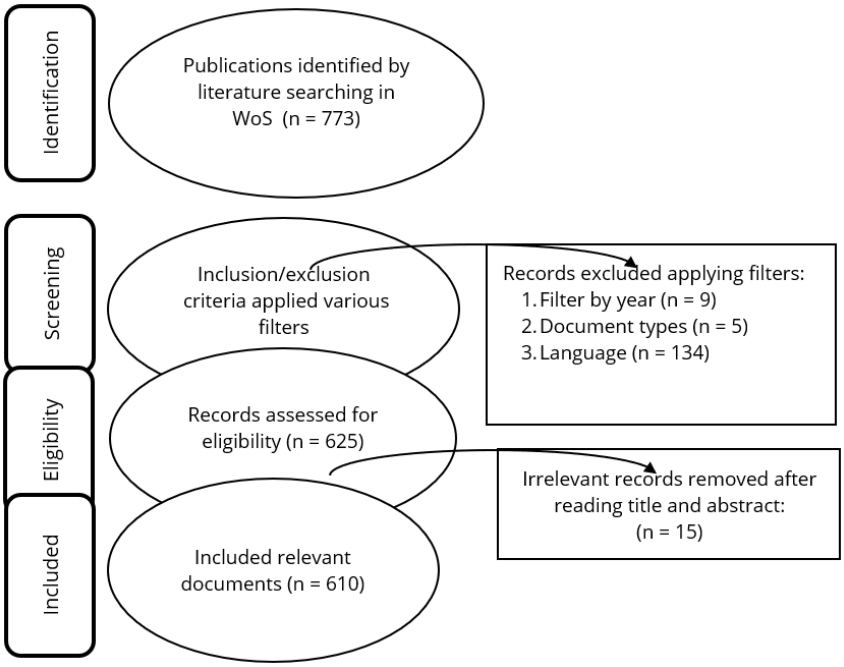

Figure 1. Four-phase flow diagram of data extraction and filtration process [Figure created by the authors based on Page et al. (2021)]

Table 1. Main information about gamification and GBL in teacher education data set

Main information	Data
Publication years	2005-2024
Total publications	610
Citable year	708.45
Number of contributing authors	1821
Number of cited papers	11.07
Total citations	4,461
Citation per paper	7.31
Citation per cited paper	11.07
Citation per Year	234.79
Citation per Author	1,951.68
Author per Paper	2.99
Citation sum within h-core	3,523
h-index	31
g-index	48
m-index	0.044

cocitation, and coauthorship patterns. Microsoft Excel was used for data management, statistical analysis and creating additional visualizations to support Biblioshiny and VOSviewer results.

Methodological Rigor

The use of multiple analytical tools provided a detailed and multifaceted understanding of the research landscape surrounding gamification and GBL in teacher education. The systematic approach ensured a comprehensive and unbiased selection of relevant literature. The four-phase data extraction and filtration process (see **Figure 1**) provided a robust foundation for the bibliometric analysis, enhancing the results' reliability and validity.

RESULTS

Table 1 provides a comprehensive overview of the dataset related to gamification and GBL in teacher training and education. Data spanned 2005 to 2024 and encompassed a total of 610 publications and 4,461 citations. This resulted in an average of 7.31 citations per publication with a median citation year of 2008. The

Table 2. Most influential authors in gamification and GBL research (generated using biblioMagika® (Ahmi, 2024)

Full name	Current affiliation	Country	TP	NCP	TC	C/P	C/CP	h	g	m
Francesca Pozzi	CNR	Italy	5	4	9	1.80	2.25	2	3	0.33
Antonio Sanchez-Mena	Univ Europea Valencia	Spain	4	4	82	20.50	20.50	3	4	0.33
Jose Marti-Parreno	Univ Europea Canarias	Spain	4	4	82	20.50	20.50	3	4	0.33
Nathalie Charlier	Katholieke Univ Leuven	Belgium	4	3	42	10.50	14.00	2	4	0.12
Kelly Samara Samara Silva	Univ Fed Santa Catarina	Brazil	4	4	46	11.50	11.50	3	4	0.30
Thorkild Hanghoj	Aarhus Univ	Denmark	4	4	15	3.75	3.75	2	3	0.17
Wim Westera	Open Univ	Netherlands	4	3	21	5.25	7.00	2	4	0.14
Lucia Pombo	Univ Aveiro	Portugal	4	4	33	8.25	8.25	3	4	0.50
Donatella Persico	Inst Educ Technol CNR	Italy	4	3	7	1.75	2.33	2	2	0.33

Note: TP: Total number of publications; NCP: Number of cited publications; TC: Total citations; C/P: Average citations per publication; C/CP: Average citations per cited publication; h: h-index; g: g-index; m: m-index

Table 3. Most relevant journals in gamification and GBL research

Source title	TP	NCA	NCP	TC	C/P	C/CP	h	g	m
Education Sciences	21	65	17	158	7.52	9.29	7	12	1.167
Sustainability	12	36	11	82	6.83	7.45	6	8	1.000
Physical Education and Sport Pedagogy	12	35	12	422	35.17	35.17	8	12	0.533
European Physical Education Review	8	19	5	87	10.88	17.40	5	8	0.263
EDULEARN19: 11th International Conference on Education and New Learning Technologies	7	20	3	3	0.43	1.00	1	1	0.167
International Journal of Game-Based Learning	6	11	6	41	6.83	6.83	4	6	0.308
11th International Conference of Education, Research and Innovation	6	15	3	6	1.00	2.00	1	2	0.143
British Journal of Educational Technology	6	18	6	183	30.50	30.50	6	6	0.375
Journal of Teaching in Physical Education	6	20	6	58	9.67	9.67	4	6	0.211

Note: TP: Total number of publications; NCA: Number of contributing authors; NCP: Number of cited publications; TC: Total citations; C/P: Average citations per publication; C/CP: Average citations per cited publication; h: h-index; g: g-index; m: m-index

selected publications involved 1,821 contributing authors, demonstrating significant collaborative efforts, with an average of three (2.99) authors per publication. The data set also revealed 11 citations per cited paper, and the citation-to-author ratio was 1951.68, with an annual citation average of 234.79. Moreover, an *h-index* of 31 and g-index of 48 highlight scholarly influence with a cumulative 3,523 citations within its h-core. An m-index of 0.044 indicates the impact per year since being published. These metrics highlight a substantial citation density and a sustained academic relevance in its field. They showcase the foundational role that this collective research has played in advancing gamification and GBL in teacher education.

Table 2 (complete citation information available on request) profiles the most influential authors in the field based on their TP = total number of publications; NCP = number of cited publications; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = *h-index*; g = g-index, and m = m-index. Francesca Pozzi topped the list with five publications and nine citations followed by Antonio Sanchez-Mena, Jose Marti-Parreno, Nathalie Charlier, Kelly Samara Samara Silva, Thorkild Hanghoj, Wim Westera, Lucia Pombo, and Donatella Persico with four publications each and 82, 82, 42, 46, 15, 21, 33, and seven citations, respectively. Their work has garnered significant citations affirming their pivotal role in advancing gamification and GBL research in teacher education.

Antonio Sanchez-Mena and Jose Marti-Parreno stand out with 82 citations each and a remarkable average of 20.50 citations per publication. This high citation count reflects the substantial impact and recognition of their work. Their *h-index* values ranged from 2 to 3, indicating sustained contributions to the field over time. Their g-index and m-index further emphasize their influence and productivity. In summary, **Table 2** highlights the leading voices and foundational research shaping the discourse on gamification and GBL in teacher education. It underscores the importance of how just a few key researchers can be instrumental in driving the understanding and application of these pedagogical strategies.

Table 3 presents the most relevant journals in the context of gamification and GBL. *Education Sciences* had 21 publications and 158 citations. It was followed by two journals, *Sustainability,* and *Physical Education and Sport Pedagogy,* with 12 publications each but differing significantly in total citations (n = 82 and n = 422, respectively). The *European Physical Education Review* followed with eight publications and 87 citations.

Table 4. Leading country contributions in gamification and GBL research (generated using biblioMagika® (Ahmi, 2024)

Country	TP	NCA	NCP	TC	C/P	C/CP	h	g	m
Spain	262	0	173	2,066	7.89	11.94	25	45	1.563
USA	211	0	179	2,620	12.42	14.64	24	51	1.263
Italy	88	0	72	322	3.66	4.47	8	17	0.615
Brazil	86	0	48	573	6.66	11.94	15	23	1.000
Australia	79	0	69	639	8.09	9.26	15	25	0.789
England	72	0	48	1,186	16.47	24.71	17	34	0.850
Germany	66	0	43	421	6.38	9.79	9	20	0.692
Portugal	62	0	34	336	5.42	9.88	10	18	0.769
China	51	0	27	137	2.69	5.07	6	11	0.429
Greece	50	0	32	539	10.78	16.84	17	23	1.000

Note: TP: Total number of publications; NCA: Number of contributing authors; NCP: Number of cited publications; TC: Total citations; C/P: Average citations per publication; C/CP: Average citations per cited publication; h: h-index; g: g-index; m: m-index

Edulearn19: 11th International Conference on Education and New Learning Technologies had seven publications and three citations. The *International Journal of Game-Based Learning*, the *11th International Conference of Education, Research and Innovation,* the *British Journal of Educational Technology,* the *Journal of Teaching in Physical Education,* and the *Proceedings of the 10th European Conference on Games-Based Learning* were the least productive, with six publications each.

Physical Education and Sport Pedagogy, the *British Journal of Educational Technology,* and *Education Sciences* were the top three cited sources with 422, 183, and 158 citations, respectively (see **Table 3**). Their high citation counts underscore their reputation and influence in disseminating high-impact research. The various journals in **Table 3** demonstrate that gamification and GBL research were not confined to education-specific publications but spanned multiple disciplines, reflecting their interdisciplinary appeal and relevance. These citation metrics underscore the significant academic engagement and impact that these journals have had in promoting and advancing research in the gaming aspect of teacher education.

Table 4 ranks countries based on their contributions to research on gamification and GBL in teacher education. Spain led with 262 documents and 2066 citations, reflecting its dominant role in the research landscape. The USA followed with 211 papers and 2620 citations, showing America's solid engagement. Other notable contributors included Italy, Brazil, Australia, England, Germany, Portugal, China, and Greece with varying degrees of output (averaging 70 documents each) and citation impact (averaging 519 citations ranging from 137 to 1186). This geographical distribution of research highlights a concentration in European countries with significant contributions in the field. **Table 4** illustrates the global nature of research in gamification and GBL, albeit with a noticeable underrepresentation from developing regions, particularly Africa. These data suggest a need for broader international collaboration and inclusivity to enrich the research landscape with diverse perspectives and contexts.

Table 5 lists the 10 most frequently cited articles in gamification and GBL-based research (full citation information available on request). Harvey and Jarrett (2014) topped the list with 202 citations, highlighting the game-centered approach to teaching and coaching. They were followed by Repenning et al. (2010) who garnered 135 citations, highlighting the significant impact of their work on scalable game design and computational thinking in public schools. Aldemir et al. (2018) had 112 citations focused on *Student perceptions of game elements in a gamified course*. Trowler and Bamber (2015) *(Higher education teacher training*) received 106 citations. Huizenga et al. (2017) was the 5th most cited paper. It addressed *Teacher perceptions of the value of game-based learning in secondary education* (TC = 100). Ní Chróinín et al. (2018) was the least cited paper with 64 citations, highlighting *Pedagogical principles of learning to teach meaningful physical education*.

Table 5 highlights the foundational and diverse contributions that have shaped the field, providing critical insights into the theoretical and practical aspects of gamification and GBL. The high citation counts reflect the broad recognition and influence of these studies in shaping current understanding and future research directions. The most frequently cited papers, spanning 2005 to 2018, suggest that earlier papers have remained valuable contributors to practice. The entire collection focused on both teacher education and teaching in practice.

Table 5. Ten most-frequently cited gamification and GBL articles

Rank	Reference	Title	Source Title	TC	C/Y
1	Harvey and Jarrett (2014)	A review of the game-centred approaches to teaching and coaching literature since 2006	Physical Education and Sport Pedagogy	202	18.36
2	Repenning et al. (2010)	Scalable game design and the development of checklist for getting computational thinking into public schools	Proceedings of the 41st ACM Technical Symposium on Computer Science Education	135	9.00
3	Aldemir et al. (2018)	A qualitative investigation of student perceptions of game elements in a gamified course	Computers in Human Behavior	112	16.00
4	Trowler and Bamber (2005)	Compulsory higher education teacher training: Joined-up policies, institutional architectures and enhancement cultures	International Journal for Academic Development	106	5.30
5	Huizenga et al. (2017)	Teacher perceptions of the value of game-based learning in secondary education	Computers & Education	100	12.50
6	Kenny and McDaniel (2011)	The role of teachers' expectations and value assessments of video games play in their adopting and integrating them into their classrooms	British Journal of Educational Technology	82	5.86
7	Copland (2010)	Causes of tension in post-observation feedback in preservice teacher training: An alternative view	Teaching and Teacher Education	76	5.07
7	Cózar-Gutiérrez and Sáez-López (2016)	Game-based learning and gamification in initial teacher training in the social sciences: An experiment with MinecraftEdu	International Journal of Educational Technology in Higher Education	76	8.44
9	Nousiainen et al. (2018)	Teacher competencies in game-based pedagogy	Teaching and Teacher Education	65	9.29
10	Ní Chróinín et al. (2018)	Pedagogical principles of learning to teach meaningful physical education	Physical Education and Sport Pedagogy	64	9.14

Table 6. Leading institution contributions to gamification and GBL research (generated using biblioMagika® (Ahmi, 2024)

Institution name	Country	TP	NCA	NCP	TC	C/P	C/CP	h	g	m
University of Granada	Spain	19	0	9	48	2.53	5.33	5	6	0.625
Federal University of Santa Catarina	Brazil	18	0	15	138	7.67	9.20	8	11	0.800
University of Jaume 1	Spain	16	0	6	160	10.00	26.67	6	12	0.545
University of Castilla-La Mancha	Spain	15	0	2	83	5.53	41.50	2	9	0.200
University of Porto	Portugal	15	0	15	193	12.87	12.87	6	13	0.600
University of Aveiro	Portugal	15	0	8	66	4.40	8.25	4	8	0.500
University of Athens	Greece	14	0	4	22	1.57	5.50	4	4	0.235
University of Murcia	Spain	13	0	13	424	32.62	32.62	10	13	1.667
University of Central Florida	USA	13	0	13	425	32.69	32.69	9	13	0.563

Note: TP: Total number of publications; NCP: Number of cited publications; TC: Total citations; C/P: Average citations per publication; C/CP: Average citations per cited publication; h: h-index; g: g-index; m: m-index

Table 6 profiles the 10 leading institutions from which gamification and GBL research arose. The University of Granada (Spain) was the most productive with 19 publications and 48 citations followed by the Federal University of Santa Catarina (Brazil) with 18 publications and 138 citations, Jaume I University (Spain) with 16 publications and 160 citations, and the University of Castilla-La Mancha (Spain) with 15 publications. These four institutions accounted for 40% of all scholarships.

The National Research Council (Italy) was the least productive with 12 publications and 39 citations but still within the top 10. Other leading institutions were Univ Porto, Univ Aveiro, Univ Athens, Univ Murcia, and Univ Cent Florida. The University of Central Florida (USA) was the most cited institution with 425 TC for 13 publications. It achieved a remarkable average citation per article of 32.69 C/P. This was followed by the University of Murcia (Spain) with 424 citations and an average of 32.62 C/P. The University of Athens (Greece) received the fewest citations–22 citations for 14 publications–and had the lowest average citation per publication (1.57 C/P).

Figure 2 presents a detailed visualization of publication (blue bar) and citation (orange line) trends from 2005 to 2024. The data reveal a clear upward trajectory in publications with significant growth from 2013 onward. The publications peaked in 2024 with 68 documents (a 3,300% increase from 2005) indicating heightened research activity and interest in recent years. Other high publication years included 2019, with 61

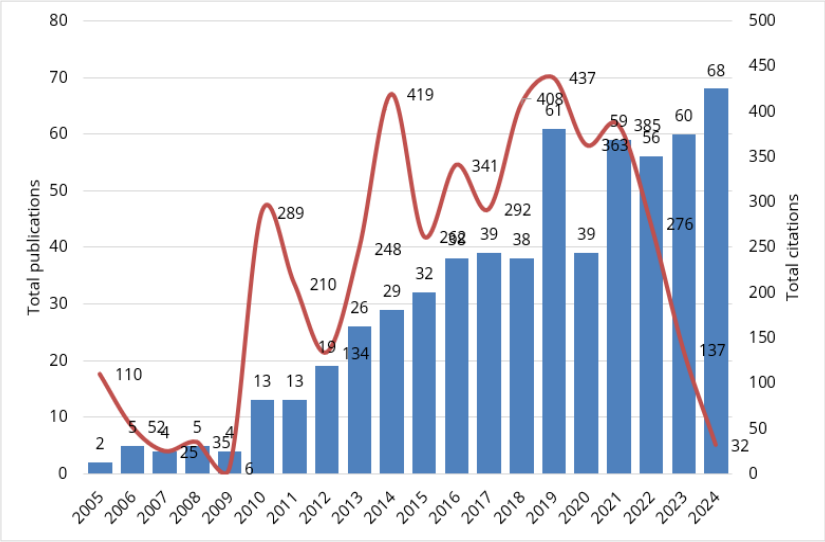

Figure 2. Publications and citation trends in gamification and GBL research (Figure created by the authors using biblioMagika)

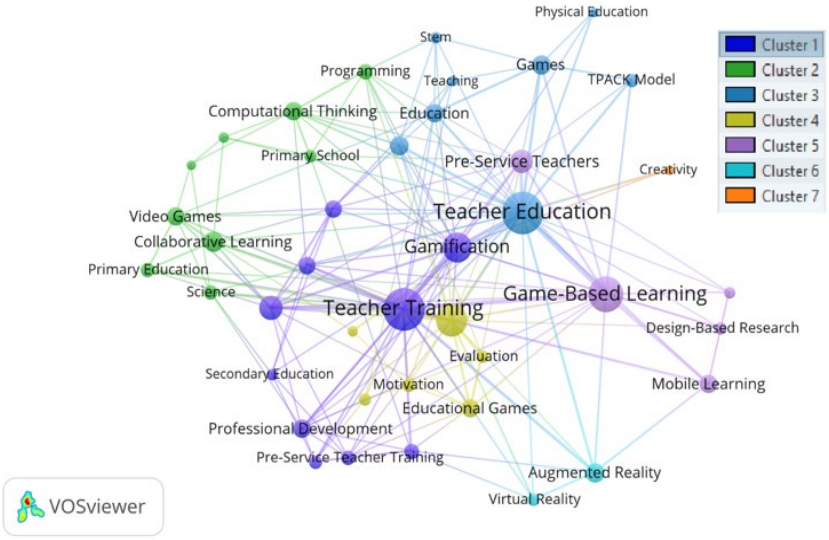

Figure 3. Keyword co-occurrences in gamification and GBL research (Figure created by the authors using VOSviewer)

publications; 2023, with 60 publications; 2021, with 59 publications; and 2022, with 56 publications. The highest number of citations was received in 2019 (437) followed by 2014 (419) and 2018 (408).

This trend aligns with the increasing recognition of the importance and effectiveness of gamification and GLB in educational contexts. The citation trends in **Figure 2** also show a corresponding rise that reflects both growing impact and scholarly engagement. These data underscore the dynamic and expanding nature of the field, highlighting both study proliferation and cumulative academic influence. These trends suggest that gamification and GBL have become increasingly prominent topics within the educational research community, likely driven by technological advancements and a deeper understanding of their pedagogical benefits.

Figure 3 presents a co-occurrence network of author keywords, providing insights into the thematic structure of the research landscape. Keywords such as “gamification,” “game-based learning,” “motivation” and “engagement” were prominent, indicating their centrality to the discourse. The network reveals clusters of related terms suggesting specific focus areas within the broader field.

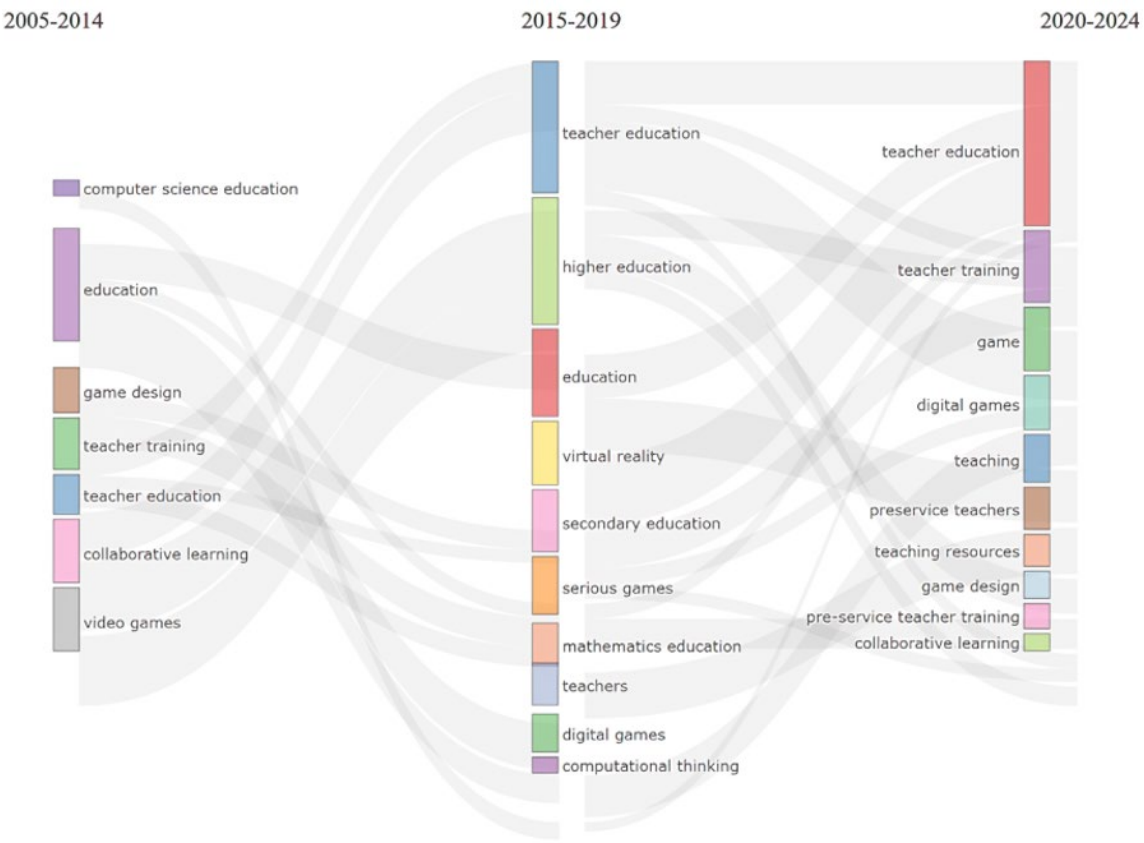

Figure 4. Thematic evolution in gamification and GBL research (Figure created by the authors using bibliometrix)

For instance, clusters around "motivation" and "engagement" highlight research interests in the psychological and behavioral impacts of gamification, while terms like "teacher training" and "education technology" point to practical and pedagogical applications. This visualization maps key topics and shows the interconnectedness of various research themes, thus reflecting the multidisciplinary nature of gamification and GBL studies. The dense interlinking of keywords underscores researchers' integrated approach, combining insights from education, psychology, technology, and game design to enrich the field's understanding and application.

Figure 4 illustrates thematic evolution within the field, depicting how research topics have developed and transformed over time. It shows the progression and shifts in focus areas from initial explorations of gamification concepts to more nuanced investigations into specific educational applications and outcomes. Early research (2005-2014) predominantly concentrated on computer science education, education, game design, teacher training, teacher education, collaborating learning, and video games. More recent studies (2020-2024) have delved into teacher education, teacher training, game, digital games, teaching, preservice teachers, teaching resources, game design, preservice teacher training, and collaborative learning. Themes during 2015-2019 included teacher education, higher education, virtual reality, secondary education, serious games, mathematics education, teachers, digital games, and computational thinking.

The evolution evident in **Figure 4** reflects the maturation of the field with an increasing emphasis on evidence-based practices and practical integration in educational settings. Thematic evolution highlights how research has responded to emerging challenges and opportunities and adapted to new technological advancements and academic needs. This adaptability and growth demonstrate the field's resilience and relevance in addressing contemporary educational issues.

Figure 5 demonstrates authorship patterns in gamification and GBL research (2005-2024). The bottom axis is the number of authors. The pattern of authorship varied from a single to 19 authors. The two-authorship pattern contributed to the highest number of research papers in the field (n = 183), followed by those with three authors (n = 131 publications). There were 107 papers with a single author, 104 with four

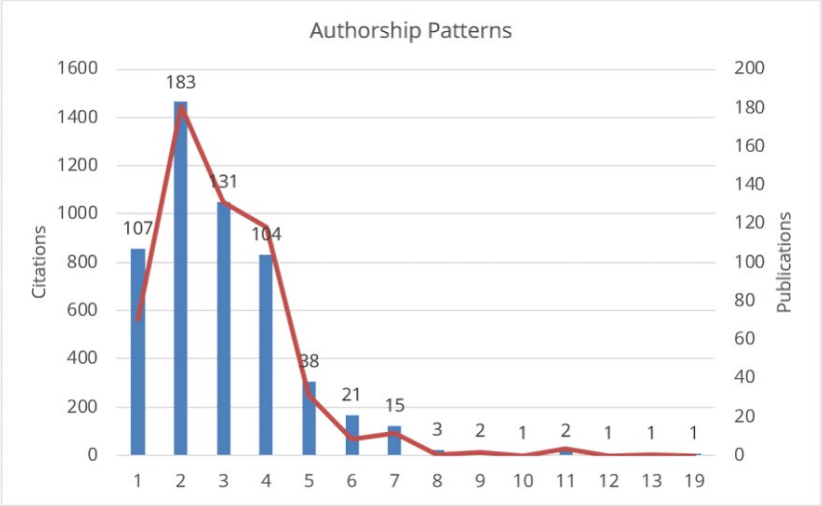

Figure 5. Authorship patterns in gamification and GBL research (Figure created by authors using MS Office)

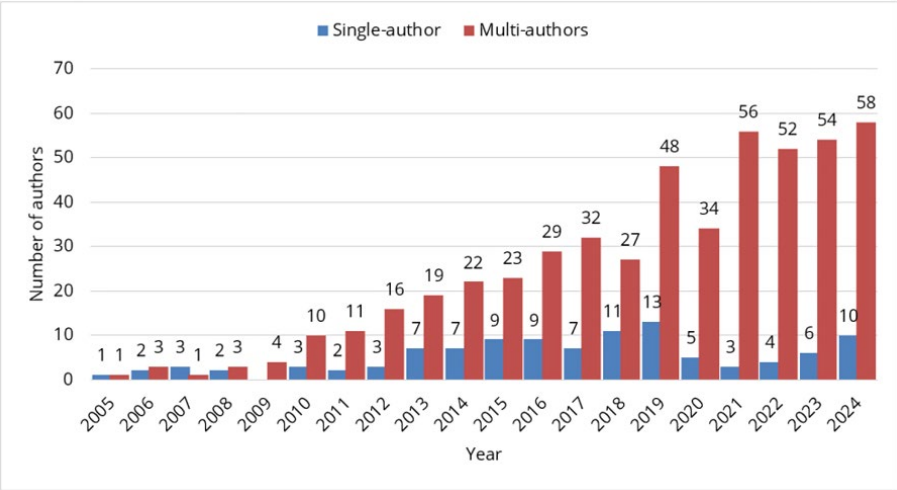

Figure 6. Year-wise authorship trends in gamification and GBL research (Figure created by the authors using biblioMagika)

authors, and 38 with five authors. Papers with 10, 12, 13, and 19 authors contributed the least in the field, with a single publication each. The highest number of citations and publications was observed in the two- and three-authorship patterns. Beyond five authors, both the number of joint publications and citations dropped sharply. Smaller teams may foster more focused discussions and innovative ideas that resonate better with both peers and practitioners. These authorship patterns highlight the collaborative nature of research in gamification and GBL, suggesting that multiple authors (within limits) may lead to more impactful studies and greater visibility within the academic community. This finding underscores the importance of collaboration in enhancing research quality and dissemination.

Figure 6 demonstrates the year-wise authorship trends for the gamification and GBL research field. An upward trend in both single and multiple authorship manifested from 2005 to 2024, particularly in the collaborative trend. There were a few collaborative works (red bar) in the early years (i.e., from 2005 to 2010). There was steady growth in collaborative work between 2011 and 2017, reaching 29 and 32 in 2016 and 2017, respectively. Then, in 2019, collaborative work spiked to 48 papers and continued an upward trend (except for 2020, coincidentally COVID-19). At the same time, single-paper publications declined sharply, ranging from 3 to 10 and averaging seven per year. The dominant trend in collaborative work suggests a growth in interdisciplinary teamwork accompanied by increased funding support. In contrast, the single-author trend shows a sustained independent approach in the field during 2023 and 2024 with 6 and 10 papers, respectively.

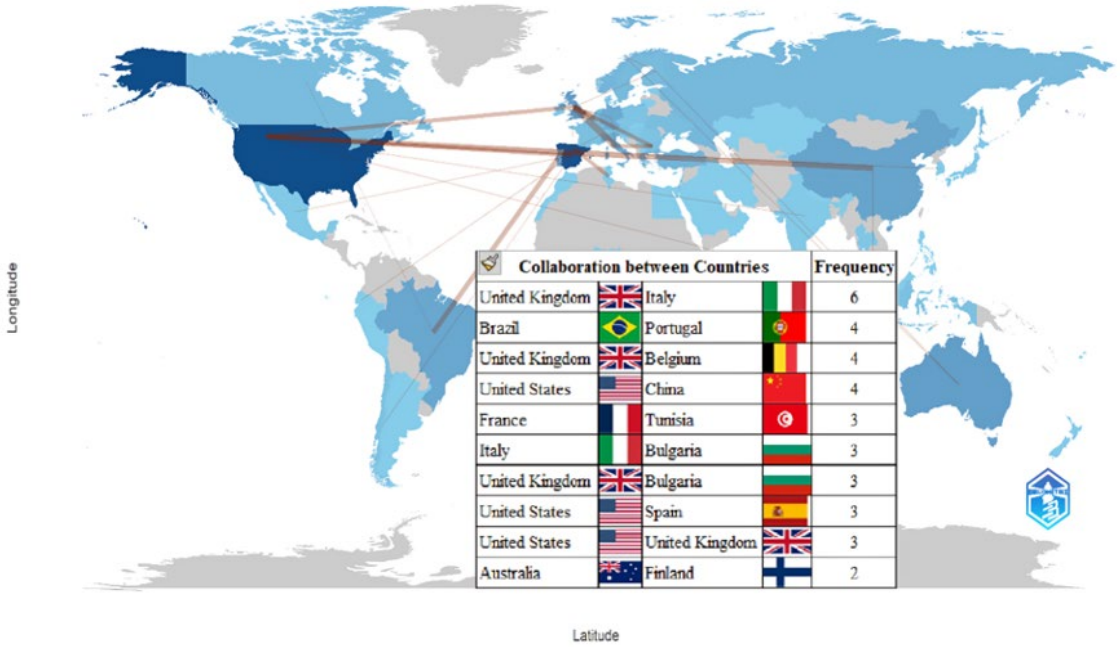

Figure 7. Collaborating countries map in gamification and GBL research (Figure created by the authors using bibliometrix)

Figure 7 maps the collaborating countries (N = 13) in gamification and GBL research, highlighting the geographical distribution of scholarly contributions. Collaborative research was concentrated in North America and Europe with the USA, Spain, Germany, and the UK being prominent contributors. The UK and Italy collaborated most often, with six publications, followed by Brazil and Portugal, the UK and Belgium, and the USA and China with four publications each. This geographical distribution underscores the significant involvement of these regions in advancing gamification and GBL studies. The map also shows collaborations extending to other parts of the world, including Australia, Turkey, and Canada, which indicates a global interest and network in this field. However, the underrepresentation of African, South American and most Asian countries highlights a geographical gap that needs to be addressed. Expanding research collaborations to these regions could provide valuable insights and diversify the perspectives in gamification research, thus making attendant scholarship more universally applicable and inclusive.

Finally, **Figure 8** represents a reference publication year spectroscopy (RPYS), which provides a chronological assessment of significant references in gamification and GBL research. The data indicate a steady rise of cited references (black line) from the 1970s, with a notable spike from around 2000, peaking in 2018 (> 1,200). This tendency correlates with the widespread integration of digital technologies in education and the increasing acceptance of gamification concepts. The red line, denoting deviations from the 5-year median, highlights years with a remarkable number of crucial publications, emphasizing critical times in the field's evolution. The peak periods, especially from 2000 to 2018, are likely to align with the publication of foundational studies and reviews that established the theoretical foundations and practical implementations of gamification and GBL. The decrease in citations after 2019 illustrates a usual delay in citation accumulation for newer publications, highlighting the long-term impact of earlier foundational literature. These insights demonstrate the ongoing advancement of the subject and the significance of seminal publications in shaping current research directions. RPYS data serve as a critical tool for understanding the dynamics of citation and scholarly influence within a field.

DISCUSSION

The adoption of gamification and GBL in teacher training and education is a rapidly evolving field that carries significant theoretical and practical implications. Our bibliometric analysis revealed critical insights into the implementation and effects of both approaches within teacher education, highlighting their evolving impact on learner engagement, motivation, and pedagogical effectiveness. Many insights arising from our

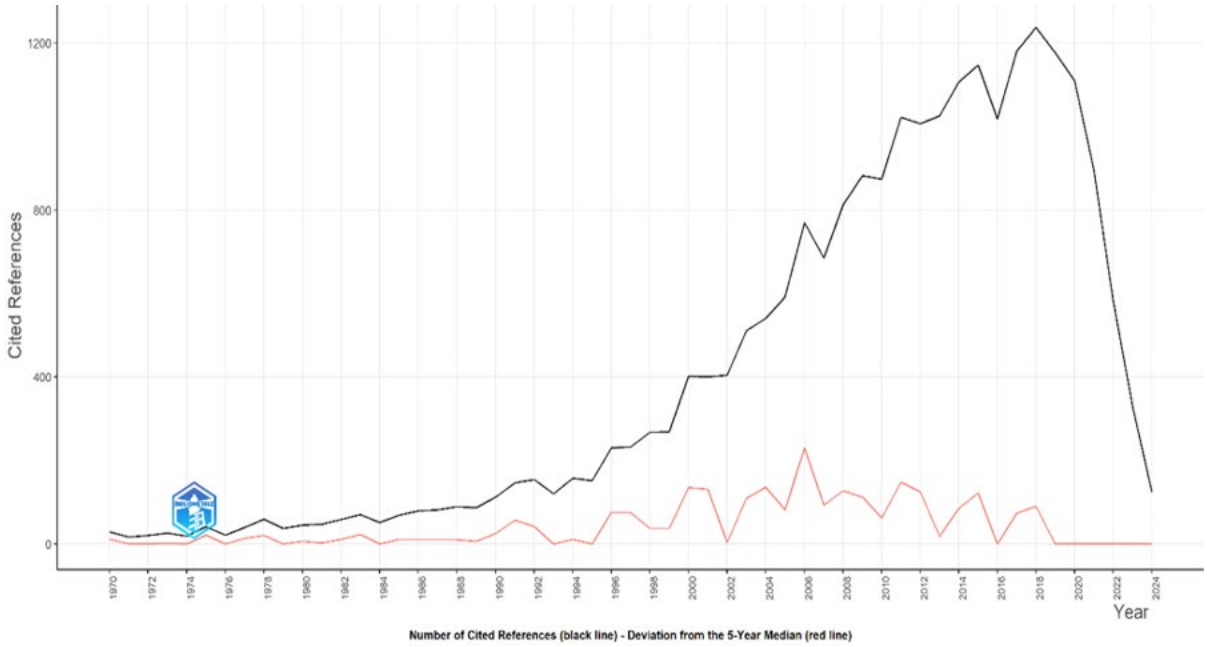

Figure 8. Spectroscopy of references in gamification and GBL research (Figure created by the authors using bibliometrix)

bibliometric analysis were embedded in the presentation of each major result This discussion presents further insights arising from our preliminary interpretation of the data.

As shown in **Figure 2**, research was scarce in the early years (n = 47 papers, averaging seven per year and representing only 7.7% of the 610 publications). Per **Table 5**, virtually all these initial papers were coauthored, thus establishing early on the pattern of collaborative research that continued to accelerate (see **Figure 6**). Early papers focused on orienting preservice teachers to GBL as well as getting computational thinking into the public school system. This upstream thinking was apropos because GBL research was in its infancy, with minimal studies on using game elements in nongame contexts or to teach complex subjects.

Per **Table 5**, the remaining influential (i.e., most frequently cited) papers (n = 6) were published between 2014 and 2018 by 18 authors. Most authors focused on game-centered teaching and examined teacher competencies, pedagogical principles, preservice teacher orientation to gamification, teachers, and students' perceptions of GBL (see **Figure 3**). The bibliometric analysis revealed no highly cited papers published within the last six years (beyond 2018, see **Figure 8**); however, this result may reflect the time it takes for a paper to gain traction within a field. Time to citation can range from a few months to 10 years (Nane, 2015). Furthermore, "most published work is rarely if ever cited. Only a small percentage of what is published is ever heard of again in the literature" (Harnad, 1996, p. 111).

Our bibliometric findings further revealed that out of 1,821 authors, 26 (1.4%) carried the torch drawing this scholarship forward (see **Table 5**). This finding underscores the importance of how just a few key researchers can be instrumental in perpetuating new thinking and attendant practice in a field. However, comparing **Table 2** and **Table 5**, there is literally no overlap between the nine most influential authors and the authors of the 24 most cited papers. How is it that the people with the most papers and citations were not authors of the most frequently cited papers? We were uncertain about how to interpret this anomalous finding.

Table 3 profiles the 10 most common journals where neither gamification nor GBL research was published. Each venue averaged nine papers over 19 years with half (*n* = 45) published in three journals. This narrow cluster both

(a) affirms an established go-to venue for the topic while

(b) revealing the opportunity for other journals to step into the gap.

Science, sustainability education, physical education, and technology education had a strong presence, but it is telling that other educational subject journals were not part of this cadre. Games have been used for thousands of years to teach strategic and tactical thinking, mathematics, and language skills with GBL now a key part of educational philosophy (Hellerstedt & Mozelius, 2019). Our bibliometric analysis supports our recommendation that a wide array of subject journals could expand their scope and vision to include and encourage gamification and GBL research.

Ten institutions emerged as the most productive generators or supporters of gamification and GBL research. The majority (80%) were from the Mediterranean region. Nearly two-thirds (60%) were from Spain and Portugal. The most cited institution was the USA-based University of Central Florida with a remarkable average citation per article of 32.69 C/P. The underrepresentation of Eastern European, African, South American, Asian, and Australian institutions points to a geographical gap that needs addressing. This recommendation is supported by the finding that researcher collaboration was mainly among scholars from the USA and the UK who tended to collaborate with researchers from other countries but not with each other (i.e., no USA with USA or UK with UK scholarship) (see **Figure 7**).

To ensure that the gamification and GBL research base continues to advance and be utilized via citations, our results suggest that fewer authors on collaborative projects might be in order because papers with more than five authors received the fewest citations (see **Figure 5**). We posit that fewer authors may lead to more enriched and diverse engagement with each other when interpreting results and findings in preparation for disseminating their scholarship. Readers of these papers may more readily grasp the weight and significance of the study and be more inclined to cite it in their research. Co-authored publications are on the increase and receive higher visibility and above-average impact in almost all academic subjects (Abramo & d'Angelo, 2015). Future research should explore if there is a threshold for collaborative gamification and GBL research because Jaksic et al. (2023) noted that "authors who repeatedly participate in multi-authored studies will attain higher *h-index* values" (p. 8). This raises the intriguing issue of whether the number of gamification and GBL studies with 10 or more authors will increase given that such a paper would get low citations, but individual authors would get higher *h-index*es.

Study Limitations

We acknowledge the problematic practice of relying on metrics to judge scholarships and recommend that future research strive to discern the true significance of this research in practice. Future research designs would, thus, include teacher training curricula, qualitative research with practitioners, and professional development literature. Obviously, with a 3,300% increase in scholarship about this issue since 2005, with a surge in 2024, future scholars should monitor the gamification and GBL research landscape going forward. In the process, they should acknowledge the potential bias introduced by choice of databases, in our case, WoS, and concurrently include nonindexed and grey literature. They should also consider the impact of the existing ambiguity between the gamification and GBL terms and how bibliometric tools might struggle to accurately differentiate them. On a final note, inspired by Jaksic et al.'s (2023) study, we recommend that researchers acknowledge self-citation and co-authorship practices, which can misrepresent research uptake, quality impressions, and influence.

CONCLUSION

The literature revealed in our bibliometric study affirmed that gamification and GBL are promising in enhancing teacher training and education. Incorporating game elements and principles can create engaging, motivating, and compelling learning experiences. However, technological limitations, inadequate educator training, and change resistance must be addressed to realize their full potential. As research in this field continues to grow, it will be essential to develop robust theoretical frameworks and practical strategies to guide the implementation of gamification and GBL in diverse educational settings.

Our bibliometric analysis provided comprehensive insights into this innovative educational approach's significant trends, impacts, and future directions. Our results underscore the remarkable growth in scholarly output on gamification from 2012 to 2024, highlighting a surge in interest and research activity. The highest research record in 2024 was 68 publications. Key results revealed that gamification and GBL have become

central themes in educational research, primarily focusing on enhancing student motivation, engagement, and academic performance. Our focus was augmenting teacher preparation programs.

Pragmatically speaking, our results reinforce the need for educational institutions to invest in gamification technologies and educator training. As demonstrated by studies in our database, enhanced pedagogical strategies that incorporate gamified learning experiences can lead to improved learner outcomes. However, our results also identified challenges and barriers, such as technological issues, change resistance, and the need for clearer distinctions between gamification and GBL. Addressing these challenges is crucial for effectively implementing gaming in educational settings. Our bibliographic study identified influential publications and authors in the field, providing a valuable resource for future researchers to build upon. Emerging research areas such as E-learning, serious games, and integrating gamification with virtual and augmented reality are exciting possibilities for the future of gamified education.

In conclusion, this bibliometric study identified research that confirms that gamification and GBL positively impacted teacher training and education by enhancing learner motivation, engagement, and academic performance. While the field has made significant strides, ongoing research and development are essential to fully understand and harness the potential of gamification and GBL in teacher education. Future research should address technological challenges, explore gamification pedagogical strategies, and investigate the long-term impact of gamified learning environments on teachers and students. By doing so, educators and researchers can continue to innovate and improve educational practices, ultimately leading to more effective and engaging teacher training and subsequent student learning experiences grounded in gamification and GBL.

Author contributions: AKHA: conceptualization, methodology, writing – original draft, writing – review & editing; **SA:** conceptualization, methodology, formal analysis, data curation, writing – original draft, writing – review & editing; **SR:** conceptualization, formal analysis, writing – original draft, writing – review & editing. All authors approved the final version of the article.

Funding: The authors received no financial support for the research and/or authorship of this article.

Ethics declaration: This article is a review of previously published literature and does not involve any studies with human participants or animals conducted by the authors. Therefore, ethical approval was not required.

AI statement: The authors declared that no AI was used in writing or any aspect of this publication.

Declaration of interest: The authors declared no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

REFERENCES

Abramo, G., & d'Angelo, C. A. (2015). The relationship between the number of authors of a publication, its citations, and the impact factor of the publishing journal: Evidence from Italy. *Journal of Informetrics, 9*, 746-761. https://doi.org/10.1016/j.joi.2015.07.003

Adl-Amini, K., Meßner, M. T., & Hardy, I. (2024). A simulation game for placement decision-making: Fostering reflection and belief change about inclusion in teacher education. *International Journal of Inclusive Education, 29*(7), 1197-1213. https://doi.org/10.1080/13603116.2024.2319095

Ahamer, G., & Kumpfmüller, K. A. (2014). Education and literature for development in responsibility: Partnership hedges globalization. In S. Mukerji, & P. Tripathi (Eds.), *Handbook of research on transnational higher education* (pp. 525-584). IGI Global. https://doi.org/10.4018/978-1-4666-4458-8.ch027

Al Fatta, H., Maksom, Z., & Zakaria, M. H. (2018). Game-based learning and gamification: Searching for definitions. *International Journal of Simulation: Systems, Science and Technology, 19*(6), 41.1-41.5. https://doi.org/10.5013/IJSSST.a.19.06.41

Aldemir, T., Celik, B., & Kaplan, G. (2018). A qualitative investigation of student perceptions of game elements in a gamified course. *Computers in Human Behavior, 78*, 235-254. https://doi.org/10.1016/j.chb.2017.10.001

Al-Hafdi, F. S., & Alhalafawy, W. S. (2024). Ten years of gamification-based learning: A bibliometric analysis and systematic review. *International Journal of Interactive Mobile Technologies, 18*(7), 188-212. https://doi.org/10.3991/ijim.v18i07.45335

Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics, 11*(4), 959-975. https://doi.org/10.1016/j.joi.2017.08.007

Boysen, M. S. W., Lund, O., Jørnø, R. L., & Skovbjerg, H. M. (2023). The role of expertise in playful learning activities: A design-based self-study within teacher education aimed at the development of tabletop role-playing games. *Teaching and Teacher Education, 128*, Article 104128. https://doi.org/10.1016/j.tate.2023.104128

Camacho-Sánchez, R., Manzano-León, A., Rodríguez-Ferrer, J. M., Serna, J., & Lavega-Burgués, P. (2023). Game-based learning and gamification in physical education: A systematic review. *Education Sciences, 13*(2), Article 183. https://doi.org/10.3390/educsci13020183

Chen, C.-M., Ming-Chaun, L., & Kuo, C.-P. (2023). A game-based learning system based on an Octalysis gamification framework to promote employees' Japanese learning. *Computers and Education, 205*, Article 104899. https://doi.org/10.1016/j.compedu.2023.104899

Copland, F. (2010). Causes of tension in post-observation feedback in preservice teacher training: An alternative view. *Teaching and Teacher Education, 26*(3), 466-472. https://doi.org/10.1016/j.tate.2009.06.001

Cózar-Gutiérrez, R., & Sáez-López, J. M. (2016). Game-based learning and gamification in initial teacher training in the social sciences: An experiment with MinecraftEdu. *International Journal of Educational Technology in Higher Education, 13*, Article 2. https://doi.org/10.1186/s41239-016-0003-4

Dahalan, F., Alias, N., & Shaharom, M. S. N. (2024). Gamification and game-based learning for vocational education and training: A systematic literature review. *Education and Information Technologies, 29*(2), 1279-1317. https://doi.org/10.1007/s10639-022-11548-w

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research, 133*, 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070

Farreras, M., Armengol, J., Bofill, P., & Hernández, A. (2022, July 6). Game-based learning vs gamification: A hands-on. In R. M. Lima, M. Farreras, M. Roma, & V. Villas-Boas (Eds.), *International symposium project approaches in engineering education* (vol. 12, pp. 307-309). University of Minho. https://doi.org/10.5281/zenodo.7062209

Fernando, P. A., & Premadasa, H. K. S. (2024). Use of gamification and game-based learning in educating generation alpha: A systematic literature review. *Educational Technology and Society, 27*(2), 114-132. https://doi.org/10.30191/ETS.202404_27(2).RP03

Geisthardt, M., Engel, L., & Schnegelberger, M. (2023). Towards gamification of advanced value stream analysis and design: A game-based learning concept. In V. Wohlgemut, D. Kranzlmüller, & M. Höb (Eds.), *Lecture notes in informatics: GI-edition proceedings* (vol. P-342, pp. 263-275). Springer.

Guerrero-Alcedo, J. M., Espina-Romero, L. C., & Nava-Chirinos, Á. A. (2022). Gamification in the university context: Bibliometric review in Scopus (2012-2022). *International Journal of Learning, Teaching and Educational Research, 21*(5), 309-325. https://doi.org/10.26803/ijlter.21.5.16

Hamdi, L. F., Hantono, B. S., & Permanasari, A. E. (2022). Gamification methods of game-based learning applications in medical competence: A systematic literature review. In *Proceedings of the International Symposium on Information Technology and Digital Innovation* (pp. 50-54). https://doi.org/10.1109/ISITDI55734.2022.9944535

Harnad, S. (1996). Implementing peer review on the net: Scientific quality control in scholarly electronic journals. In R. Peek, & G. Newby (Eds.), *Scholarly publication: The electronic frontier* (pp. 103-118). MIT Press.

Harvey, S., & Jarrett, K. (2014). A review of the game-centred approaches to teaching and coaching literature since 2006. *Physical Education and Sport Pedagogy, 19*, 278-300. https://doi.org/10.1080/17408989.2012.754005

Hellerstedt, A., & Mozelius, P. (2019, January 26-28). *Game-based learning: A long history* [Paper presentation]. The Irish Conference on Game-Based Learning.

Huang, H.-H. (2023). Using gamification and multi-agent simulation for teacher training in preventing bullying. In *Proceedings of the 11th International Conference on Human-Agent Interaction* (pp. 351-352). https://doi.org/10.1145/3623809.3623921

Huizenga, J. C., Ten Dam, G. T. M., Voogt, J. M., & Admiraal, W. F. (2017). Teacher perceptions of the value of game-based learning in secondary education. *Computers & Education, 110*, 105-115. https://doi.org/10.1016/j.compedu.2017.03.008

Jaksic, C., Gayet-Ageron, A., & Perneger, T. (2023). In health research publications, the number of authors is strongly associated with collective self-citations but less so with citations by others. *BMC Medical Research Methodology, 23*(1), Article 230. https://doi.org/10.1186/s12874-023-02037-w

Jayasinghe, U., & Dharmaratne, A. (2013, August 26-29). Game-based learning vs. gamification from the perspective of higher education students. In M. J. W. Lee (Ed.), *Proceedings of IEEE International Conference on Teaching, Assessment and Learning for Engineering* (pp. 683-688). https://doi.org/10.1109/TALE.2013.6654524

Júnior, E. S., Reis, A. C. B., Mariano, A. M., Barros, L. B., De Almeida Moysés, D., & Da Silva, C. M. A. (2019, June 10-12). Systematic literature review of gamification and game-based learning in the context of problem and project-based learning approaches. In R. M. Lima, V. Villas-Boas, L. Bettaieb, & K. Akrout (Eds.), *Proceedings of 11th International Symposium Project Approaches in Engineering Education* (vol. 9, pp. 169-177).

Kenny, R. F., & McDaniel, R. (2011). The role of teachers' expectations and value assessments of video games play in their adopting and integrating them into their classrooms. *British Journal of Educational Technology, 42*(2), 197-213. https://doi.org/10.1111/j.1467-8535.2009.01007.x

Kogan, V. V. (2023). Gamification and game-based learning: An overview and application to language teaching. In V. S. Nuss, & V. V. Logan (Eds.), *Dynamic teaching of Russian: Games and gamification of learning* (pp. 17-35). Taylor and Francis. https://doi.org/10.4324/9781003369721-3

Krath, J., Schürmann, L., & von Korflesch, H. F. O. (2021). Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games, and game-based learning. *Computers in Human Behavior, 125*, Article 106963. https://doi.org/10.1016/j.chb.2021.106963

Lester, D., Skulmoski, G. J., Fisher, D. P., Mehrotra, V., Lim, I., Lang, A., & Keogh, J. W. L. (2023). Drivers and barriers to the utilization of gamification and game-based learning in universities: A systematic review of educators' perspectives. *British Journal of Educational Technology, 54*(6), 1748-1770. https://doi.org/10.1111/bjet.13311

Manzano-León, A., Rodríguez-Ferrer, J. M., Aguilar-Parra, J. M., Fernández-Campoy, J. M., Trigueros, R., & Martínez-Martínez, A. M. (2022). Play and learn: Influence of gamification and game-based learning in the reading processes of secondary school students. *Revista de Psicodidactica, 27*(1), 38-46. https://doi.org/10.1016/j.psicod.2021.07.001

Moon, J., Yeo, S., Si, Q., & Ijeluola, A. S. (2024). A scoping review of game-based learning for mathematics teacher education. *International Journal of Mathematical Education in Science and Technology, 56*(7), 1280-1308. https://doi.org/10.1080/0020739X.2024.2337934

Nane, T. (2015, June 29-July 4). Time to first citation estimation in the presence of additional information. In *Proceedings of the 15th International Conference on Scientometrics & Informetrics* (pp. 249-260).

Ní Chróinín, D., Fletcher, T., & O'Sullivan, M. (2018). Pedagogical principles of learning to teach meaningful physical education. *Physical Education and Sport Pedagogy, 23*(2), 117-133. https://doi.org/10.1080/17408989.2017.1342789

Nolan, J., & McBride, M. (2014). Beyond gamification: Reconceptualizing game-based learning in early childhood environments. *Information Communication and Society, 17*(5), 594-608. https://doi.org/10.1080/1369118X.2013.808365

Nousiainen, T., Kangas, M., Rikala, J., & Vesisenaho, M. (2018). Teacher competencies in game-based pedagogy. *Teaching and Teacher Education, 74*, 85-97. https://doi.org/10.1016/j.tate.2018.04.012

Ortiz, W., Castillo, D., & Wong, L. (2022, April). Mobile application: A serious game based on gamification for learning mathematics in high school students. In S. Balandin, & T. Shatalova (Eds.), *Proceedings of 31st Conference of Open Innovations Association* (pp. 220-228). https://doi.org/10.23919/FRUCT54823.2022.9770917

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, Article n71. https://doi.org/10.1136/bmj.n71

Parra-González, M. E., Segura-Robles, A., & Gómez-Barajas, E. R. (2020). Assessing gamified experiences in physical education teachers and students. *International Journal of Educational Research and Innovation, 13*, 166-176. https://doi.org/10.46661/ijeri.4595

Pesare, E., Roselli, T., Corriero, N., & Rossano, V. (2016). Game-based learning and gamification to promote engagement and motivation in medical learning contexts. *Smart Learning Environments, 3*(1), Article 5. https://doi.org/10.1186/s40561-016-0028-0

Pineda-Martínez, M., Llanos-Ruiz, D., Puente-Torre, P., & García-Delgado, M. Á. (2023). Impact of video games, gamification, and game-based learning on sustainability education in higher education. *Sustainability, 15*(17), Article 13032. https://doi.org/10.3390/su151713032

PRISMA. (2024). Preferred reporting items for systematic reviews and meta-analyses. *PRISMA*. https://www.prisma-statement.org/prisma-2020

Repenning, A., Webb, D., & Ioannidou, A. (2010). Scalable game design and the development of checklist for getting computational thinking into public schools. In *Proceedings of the 41st ACM Technical Symposium on Computer Science Education* (pp. 265-269). https://doi.org/10.1145/1734263.1734357

Rocha, M., & Doyle, P. (2024). BlendMaster: A collaborative board game for training teachers in blended learning. In P. Dondio, M. Rocha, A. Brennan, A. Schönbohm, F. De Rosa, A. Koskinen, & F. Bellotti (Eds.), *Games and learning alliance* (vol. 14475, pp. 432-437). Springer. https://doi.org/10.1007/978-3-031-49065-1_45

Rodríguez-Ferrer, J. M., Manzano-León, A., Aguilar-Parra, J. M., & Cangas, A. (2023). Effectiveness of gamification and game-based learning in Spanish adolescents with dyslexia: A longitudinal quasi-experimental research. *Research in Developmental Disabilities, 141*, Article 104603. https://doi.org/10.1016/j.ridd.2023.104603

Rousseau, S., & Rousseau, R. (2021). Bibliometric techniques and their use in business and economics research. *Journal of Economic Surveys, 35*(5), 1428-1451. https://doi.org/10.1111/joes.12415

Sáez-López, J. M., Vázquez-Cano, E., Fombona Cadavieco, J., & López-Meneses, E. (2022). Gamification and gaming proposals, teachers' perceptions and practices in primary education. *Interaction Design and Architecture(s), 53*, 213-229. https://doi.org/10.55612/s-5002-053-011

Schotten, M., El Aisati, M., Meester, W. J. N., Steiginga, S., & Ross, C. A. (2017). A brief history of Scopus: The world's largest abstract and citation database of scientific literature. In F. J. Cantú-Ortiz (Ed.), *Research analytics* (pp. 31-58). Auerbach. https://doi.org/10.1201/9781315155890-3

Trowler, P., & Bamber, R. (2005). Compulsory higher education teacher training: Joined-up policies, institutional architectures and enhancement cultures. *International Journal for Academic Development, 10*(2), 79-93. https://doi.org/10.1080/13601440500281708

van Eck, N. J., & Waltman, L. (2024). VOSviewer–Visualizing scientific landscapes (1.6.20 for Microsoft Windows systems). *VOSviewer*. https://www.vosviewer.com/

van Raan, A. (2019) Measuring science: Basic principles and application of advanced bibliometrics. In W. Glänzel, H. F. Moed, U. Schmoch, & M. Thelwall (Eds.), *Springer handbook of science and technology indicators* (pp. 237-280). Springer. https://doi.org/10.1007/978-3-030-02511-3_10

Vankúš, P. (2023). Game-based learning and gamification technologies in the preparation of future mathematics teachers. *International Journal of Interactive Mobile Technologies, 17*(11), 53-67. https://doi.org/10.3991/ijim.v17i11.39227

Yazdi, A., Karimi, A., & Mystakidis, S. (2024). Gamification in online education: A visual bibliometric network analysis. *Information, 15*(2), Article 81. https://doi.org/10.3390/info15020081

Zabala-Vargas, S., García-Mora, L., Arciniegas-Hernández, E., Reina-Medrano, J., de Benito-Crosetti, B., & Darder-Mésquida, A. (2021). Strengthening motivation in the mathematical engineering teaching processes–A proposal from gamification and game-based learning. *International Journal of Emerging Technologies in Learning, 16*(6), 4-19. https://doi.org/10.3991/ijet.v16i06.16163

Zhang, Q., & Yu, Z. (2022a). Investigating and comparing the effects on learning achievement and motivation for gamification and game-based learning: A quantitative study employing Kahoot. *Education Research International, 2022*, Article 9855328. https://doi.org/10.1155/2022/9855328

Zhang, Q., & Yu, Z. (2022b). Meta-analysis on investigating and comparing the effects on learning achievement and motivation for gamification and game-based learning. *Education Research International, 2022*, Article 519880. https://doi.org/10.1155/2022/1519880

Zohari, M., Karim, N., Malgard, S., Aalaa, M., Asadzandi, S., & Borhani, S. (2022). Comparison of Gamification, game-based learning, and serious games in medical education: A scientometrics analysis. *Journal of Advances in Medical Education and Professionalism, 11*(1), 50-60. https://doi.org/10.30476/jamp.2022.94787.1608