INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 14, Issue 4, (2025) E-ISSN: 2226-6348

Global Trends and Research Frontiers in Game-Based Learning: A 2009 – 2025 Bibliometric Perspective

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DOI Link: http://dx.doi.org/10.6007/IJARPED/v14-i4/26740

Published Online: 22 October 2025

Abstract

Game-Based Learning (GBL) has emerged as a transformative educational approach, reshaping teaching and learning through interactive and student-centred strategies. This study presents a comprehensive bibliometric analysis of global GBL research published between 2009 and 2025, using the Scopus database and guided by modified Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocols. Advanced tools such as biblioMagika® for bibliometric indicators, OpenRefine for data cleaning and harmonisation, and VOSviewer for visualising research networks were employed to map scholarly patterns and knowledge structures. The analysis highlights significant and sustained growth in GBL research, as reflected in an h-index of 37, a g-index of 57, an m-index of 2.176, and a collaboration rate of 3.48 authors per paper, confirming both the maturity and international scope of the field. Following this, leading contributors include the United States, Malaysia, Spain, Finland, and Taiwan, with top publishing outlets such as Sustainability (Switzerland), International Journal of Emerging Technologies in Learning, and Computers and Education. Meanwhile, co-occurrence mapping revealed three pivotal research frontiers: the design of interactive digital environments for conceptual understanding and problem-solving, the integration of gamification elements to boost engagement, and the exploration of motivational and cognitive factors underpinning effective game-mediated learning. Overall, this study provides a global perspective on GBL's evolution and impact, offering critical insights to guide educators, researchers, and policymakers in embedding game-based approaches to strengthen student engagement and drive future educational innovation.

Keywords: Game-Based Learning, Learning, Education, Bibliometrics, Global Research Trends

Introduction

Game-Based Learning (GBL) has rapidly evolved into a transformative educational approach that leverages the motivational power of games to enhance learning outcomes. Over the past decade, the approach has gained remarkable prominence for its capacity to

improve students' academic performance while simultaneously fostering critical thinking, problem-solving, and collaborative skills (Lampropoulos & Sidiropoulos, 2024). As education systems worldwide shift toward more student-centred and technology-driven pedagogies, GBL has transitioned from being a supplementary instructional tool to an integral component of modern teaching practices. This pedagogical evolution reflects a broader recognition that interactive learning experiences can cultivate deeper cognitive engagement and promote sustained learner motivation (Setiawati et al., 2024).

The theoretical foundation of GBL rests on the notion that games create immersive, interactive, and feedback-rich environments in which learners can explore knowledge, make decisions, and solve problems safely. Whether through digital simulations or serious games, these environments encourage students to apply knowledge in context, thus bridging the gap between theoretical understanding and practical application (Setiawati et al., 2024). Recent advances in educational technology have further strengthened this potential by enabling adaptive game design, personalised learning trajectories, and data-driven feedback mechanisms (Ding & Yu, 2024). Consequently, GBL now represents a vital driver of educational innovation, aligning with twenty-first-century learning frameworks that emphasise creativity, digital literacy, and lifelong learning (Lampropoulos & Sidiropoulos, 2024).

Despite its growing adoption and documented benefits, several gaps persist in the current body of research. Prior studies have primarily focused on short-term cognitive and motivational effects, leaving the long-term academic impact of GBL and its scalability across varied educational systems underexplored (Wang et al., 2022). Moreover, limited attention has been paid to how GBL can be systematically integrated within formal curricula or adapted to different socio-cultural and institutional contexts (Lai & Hu, 2025). A further challenge lies in the absence of comprehensive bibliometric analyses that map the evolution, research frontiers, and intellectual structure of GBL scholarship. Without such analyses, it remains difficult to identify influential works, emerging themes, and leading contributors that shape the global trajectory of GBL research.

To address these gaps, the present study conducts a comprehensive bibliometric analysis of global GBL publications spanning 2009 to 2025. The objective is to trace the intellectual development and thematic evolution of GBL, highlight prominent scholars, institutions, and nations, and uncover emerging research hotspots that inform future inquiry. By synthesising patterns and trends from high-impact studies, this work provides a panoramic overview of the global GBL landscape. It advances the understanding of how game-based approaches can be more effectively embedded in educational practice. Ultimately, the findings aim to strengthen discourse on GBL's transformative potential in reshaping learning environments and fostering student engagement and achievement across diverse educational contexts.

Literature Review

GBL has developed into a powerful educational approach that leverages the immersive and interactive qualities of games to enrich learning. As education adapts to technological change and new pedagogical priorities, GBL is playing an ever more pivotal role in boosting learner engagement, motivation, and the cultivation of key cognitive and social competencies. This pedagogical approach integrates game mechanics such as challenge, competition, and reward

into educational settings to create dynamic learning environments that extend beyond passive content delivery (Edwards et al., 2023; Greipl et al., 2020). Furthermore, the centrality of GBL is underscored by its widespread adoption across various educational contexts, from primary education to higher learning and professional development (Mikrouli et al., 2024).

At the heart of GBL lies its potential to shift the learning experience from traditional, rote memorisation to active, student-centred engagement. As noted by Mikrouli et al. (2024), GBL allows students to transfer and utilise their knowledge in authentic contexts, strengthening both memory retention and the practical application of academic ideas. Moreover, the interactive design of GBL encourages higher-order cognitive engagement, cultivating essential abilities such as critical thinking, creative problem-solving, and innovation that underpin success in contemporary society (Pinedo et al., 2021). This is particularly evident in subjects that require complex, abstract reasoning, such as neuroscience, where GBL has been demonstrated to improve student understanding of intricate concepts (Edwards et al., 2023). Together, the effectiveness of GBL in cultivating these skills makes it a valuable pedagogical tool in today's educational system.

Furthermore, GBL's appeal is based on its ability to enhance cognitive outcomes and on its potential to promote emotional and social development. Greipl et al. (2020) proposed a three-dimensional framework for GBL that considers the emotional, cognitive, and social dimensions of learning. The incorporation of collaborative gameplay, which encourages communication and teamwork, helps to build critical social skills and fosters a sense of community among learners. This collaborative element is vital in modern educational settings, where teamwork and interpersonal communication are increasingly seen as essential skills (Alfarsi et al., 2020). In addition, GBL fosters self-driven motivation by drawing on students' innate enjoyment of play and competitive challenge. This consequently deepens their participation and persistence in learning activities (Putri et al., 2025).

While the benefits of GBL are widely recognised, there are challenges associated with its implementation that merit consideration. Mikrouli et al. (2024) noted that the successful application of GBL depends on aligning game content with educational objectives, as well as carefully designing games to match the cognitive levels and interests of learners. Without thoughtful integration into the curriculum, GBL risks becoming a distraction rather than an effective educational tool. Additionally, integrating emerging technologies such as Augmented Reality (AR) and Virtual Reality (VR) into GBL platforms opens up new opportunities for highly immersive learning experiences (Harpstead et al., 2023). However, as Harpstead et al. (2023) highlighted, the technical limitations and privacy concerns surrounding these technologies must be addressed before they can be effectively implemented on a large scale.

In certain educational contexts, resistance to GBL remains a significant barrier. Greipl et al. (2020) argued that misconceptions about the nature of "serious games" and the false assumption that students automatically possess the necessary skills to engage with digital games create challenges for educators. Note that effective GBL implementation requires that teachers possess both the pedagogical knowledge and technical expertise to integrate games into their teaching practices (Rajan, 2022). Building on this, although GBL has demonstrated effectiveness in improving engagement and learning outcomes across various contexts, its

implementation within diverse educational systems, especially in developing nations, has yet to be thoroughly examined (Wandana et al., 2024).

Despite these challenges, the growing body of literature affirms the central role of GBL in contemporary education. As educational institutions worldwide increasingly recognise the value of interactive, student-driven learning experiences, GBL continues to gain traction as a vital pedagogical approach. This bibliometric study examines global trends and research frontiers in GBL from **2009 to 2025**, highlighting key developments, emerging themes, and influential scholarly contributions. By mapping publication patterns, identifying leading authors, institutions, and countries, and synthesising current insights across diverse contexts, this research provides a comprehensive understanding of GBL's global evolution and its potential to shape future educational practices and learning outcomes.

Research Questions

This paper reports a bibliometric examination of GBL within educational contexts, structured around six key Research Questions (RQs):

RQ 1: What is the present state and overall landscape of research on GBL in education?
RQ 2: Which new trends and emerging directions can be identified in the body of literature on GBL in education?
RQ 3: Which academic journals and publication outlets act as key hubs for influential studies on GBL in education?
RQ 4: Which seminal or highly cited papers have significantly shaped the dialogue and progression of GBL educational research?
RQ 5: Who are the leading contributors, including prominent authors, institutions, and countries, driving innovation and advancement in GBL educational research?
RQ 6: What fundamental research themes and core topics form the foundation for the development and expansion of GBL within the education sector?

This study offers a comprehensive perspective on the global research landscape of GBL. Through bibliometric and network analysis, it charts key scholarly patterns, central themes, and research clusters that characterise this rapidly expanding field. The findings provide valuable direction for designing innovative teaching practices that incorporate GBL in response to evolving technological and educational needs. Overall, the study documents the worldwide progression of GBL research, presenting its historical development and present status while identifying pathways for future growth. Through this rigorous analysis, the work aims to strengthen the effectiveness and creativity of educational systems by embedding game-based approaches that enhance engagement and learning outcomes.

Methods

The study utilised data sourced from Scopus on 18 September 2025, selected for its recognised breadth and reliability as a premier database of peer-reviewed publications spanning science, technology, medicine, and social sciences. This makes it particularly suited for examining global trends and research frontiers in GBL. In addition, Scopus's rigorous quality control, global reach, and rich metadata, including citation information and authors' affiliations, provided a robust foundation for bibliometric analysis (Baas et al., 2020). Moreover, the dataset encompassed document and source types, language profiles, subject

classifications, publication trajectories, authorship trends, institutional involvement, global publication spread, and key keywords. This, in turn, provides a precise and comprehensive depiction of the historical and current state of GBL research while informing forecasts of its future growth (Maral, 2024; You et al., 2024).

Search Strategy

In conducting this systematic literature review, the study applied an adapted version of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol to ensure a comprehensive and structured approach (Page et al., 2021). The search string "Game-Based Learning" AND (Educat OR Teach OR Pedagog* OR Instruct* OR Curricul* OR Train* OR Learn*) was established in the Scopus database, with relevant subject filters applied to ensure comprehensive coverage. The search scope was narrowed by document type, source type, language, subject area, and time frame to exclude irrelevant records. From an initial pool of 2,661 documents, a thorough screening of titles and abstracts yielded a final dataset of 298 publications on global trends and research frontiers in GBL, which served as the foundation for analysis.

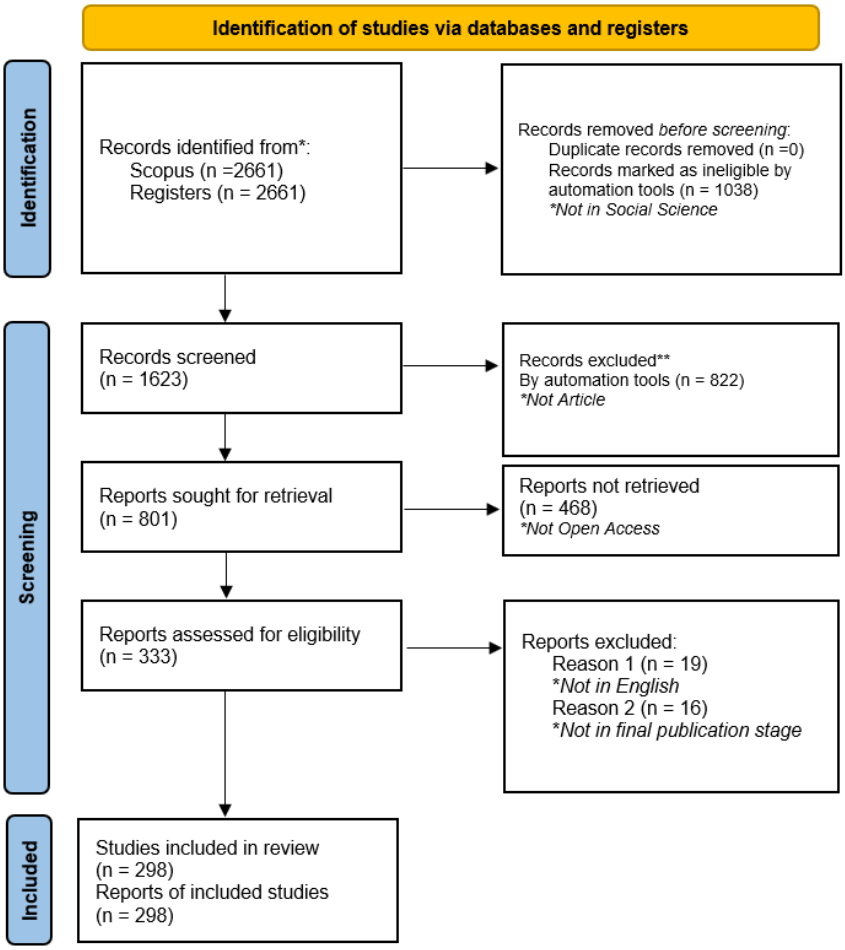

Figure 1. Flowchart of the search process (Adapted from Page et al., 2021)

Data Cleaning and Harmonisation

Ensuring accurate and dependable bibliometric results requires careful data cleaning and harmonisation as key preparatory steps (Guo et al., 2023). As such, this study utilised OpenRefine and biblioMagika® to systematically refine and harmonise key bibliographic

information such as author identities, institutional affiliations, and keywords, thereby guaranteeing data accuracy and uniformity across the entire dataset (Mongeon & Paul-Hus, 2016). The process began with downloading Scopus data in CSV format, identifying the files and columns that required refinement, and applying clustering and cleaning functions to correct inconsistencies. In line with this, biblioMagika® facilitated advanced bibliometric analyses, calculating indicators such as Total Publications (TP), Number of Contributing Authors (NCA), Number of Cited Publications (NCP), Total Citations (TC), Citations Per Publication (C/P), Citations Per Cited Publication (C/CP), citations per author, authors per publication, Annual Citation Rates (C/Y), citable years, as well as h-index, g-index, m-index, and h-core citation sums, across dimensions including year, source titles, authors, institutions, and countries (Baas et al., 2020). It also facilitated the detection and completion of missing data, reinforcing the accuracy and depth of the dataset (Guo et al., 2023). By integrating these tools, the research collectively achieved a well-structured and reliable foundation for analysing the global trends and research frontiers in GBL (Baas et al., 2020).

Data Analysis

The data analysis was carefully structured to address the RQs by charting global trends and mapping the research frontiers of GBL. It considered key dimensions, including document and source types, language use, subject coverage, and citation metrics. In addition, the findings were explored from several perspectives, including the growth of annual publications, leading scholars, major institutions, contributing nations, and highly cited source titles. This, in turn, provides insights into the main forces shaping the field and its emerging directions. To evaluate academic influence, bibliometric indicators such as TP, NCP, TC, C/P, C/CP, h-index, g-index, m-index, and total h-core citations were established. Moreover, the analysis integrated advanced visualisation methods, including co-occurrence networks, thematic mapping, and factorial analysis, to examine authors' keywords. Such an approach reveals thematic clusters, uncovering structural patterns, and highlighting connections between research subfields.

Tools

To achieve a comprehensive bibliometric assessment, the study employed multiple specialised tools. Microsoft Excel managed the initial structuring and preparation of raw data, while biblioMagika® handled the cleaning, harmonisation, and standardisation of key information such as author identities, institutional affiliations, and countries. Meanwhile, OpenRefine complemented these efforts by refining and consolidating authors' keyword data, ensuring precision and uniformity across the dataset. Once the dataset was fully prepared, VOSviewer generated detailed visual network maps to illustrate research patterns and relationships, and Mendeley functioned as the primary reference management system. Together, these tools and techniques enabled a rigorous and systematic exploration of global trends and research frontiers in GBL.

Results

The results section to follow will delve into the research landscape of GBL in education. By directly addressing the RQs, this analysis will deepen understanding of the field. Through this focused examination, the authors aim to provide a rich and comprehensive overview of GBL in education, offering practical knowledge of value to researchers, educators, and those shaping educational policy.

Current Landscape

In response to RQ 1, which investigates the current state and overall landscape of GBL research in education, the study examined the distribution of related publications and evaluated their citation performance. Over the 17 years from 2009 to 2025, 298 TP were produced, demonstrating sustained scholarly activity. Collaboration was extensive, with 1,037 NCA, reflecting a vibrant and multi-institutional research network. Ultimately, a total of 259 papers from this collection have been cited, highlighting that much of the literature has attracted attention and exerted influence in academic circles.

The impact of this body of research is further highlighted by the 5,093 TC, which translates to an average of 17.09 C/P. When focusing only on the cited papers, the figure rises to 19.66 C/CP, underscoring the substantial academic reach of the most relevant studies. In particular, the research outputs collectively achieve an impressive 318.31 C/Y, signalling consistent and ongoing scholarly attention. At the author level, the average stands at 4.91 citations per author, with an author-per-paper ratio of 3.48, indicating broad collaboration and balanced contributions among researchers.

The influence of the leading works is evident from an h-core citation count of 4,368 and an h-index of 37, demonstrating that at least 37 publications have each been cited 37 times or more. Furthermore, the g-index of 57 underscores the continued accumulation of citations by highly cited studies, while the m-index of 2.176 reflects steady growth in scholarly impact over time. Taken together, these metrics confirm that GBL research in education represents a well-established and dynamic global field.

Table 1
Citation Metric

Main Information	Data
Publication Years	2009 - 2025
Total Publications	298
Citable Year	17
Number of Contributing Authors	1037
Number of Cited Papers	259
Total Citations	5,093
Citation per Paper	17.09
Citation per Cited Paper	19.66
Citation per Year	318.31
Citation per Author	4.91
Author per Paper	3.48
Citation sum within h-Core	4,368
h-index	37
g-index	57
m-index	2.176

Source: Generated by the author(s) using biblioMagika® (Ahmi, 2024)

Publication Trends

To address the second RQ, focusing on the identification of new trends and emerging directions in the literature on GBL in education, the study analysed the evolution of this field

spanning from its initial documented output in 2009 up to 2025. Over the past seventeen years, the field has expanded steadily, producing 298 TP by 1,037 NCA. Figure 2 and Table 2 illustrate a sustained long-term rise in annual publications and TC, with notable phases of accelerated growth. The formative years from 2009 to 2018 saw small annual outputs of between one and eight papers, yet these early studies attracted high average C/P, with notable peaks of 57.00 in 2012 and 94.00 in 2016. This demonstrates the strong influence of these foundational contributions.

A pronounced acceleration occurred between 2019 and 2022. Annual publications rose sharply from 16 in 2019 to 46 in 2022, while TC increased from 370 to 828. In the same period, the h-index grew from 10 to 17 and the g-index from 16 to 27, confirming the emergence of a substantial body of highly cited work. Moreover, the NCA expanded from 47 to 162, reflecting the increasingly collaborative and interdisciplinary character of GBL research that now draws on education, psychology, computing, and related domains. In essence, this period represents a decisive phase in which GBL established itself as a major area of educational innovation and research.

From 2023 onwards, the field has remained productive while displaying the natural citation lag typical of recently published work. Annual publications reached a peak of 61 in 2024 before recording 33 up to mid-September 2025. Total C/Y, however, declined from 547 in 2023 to 28 as of 2025. At the same time, average C/P dropped from 10.32 in 2023 to 0.85 in 2025, and the average C/CP fell from 11.16 to 2.33. These patterns primarily reflect the time required for new papers to accumulate citations and do not indicate a loss of scholarly relevance.

Throughout the examined timeframe, GBL research has accumulated 5,093 TC from 259 NCP, corresponding to an average of 17.09 C/P and 19.66 C/CP work. The field's robust scholarly impact is further demonstrated by a C/Y rate of 318.31 and key bibliometric indicators, including an h-index of 37, g-index of 57, m-index of 2.176, and an h-core citation total of 4,368. Moreover, with an average of 3.48 NCA for each paper, the research community exhibits strong collaborative tendencies and an inherently global and cross-disciplinary orientation. Collectively, these findings portray GBL in education as a mature and dynamic field characterised by rising publication numbers, sustained global impact, and a continuing central role in contemporary educational research and innovation.

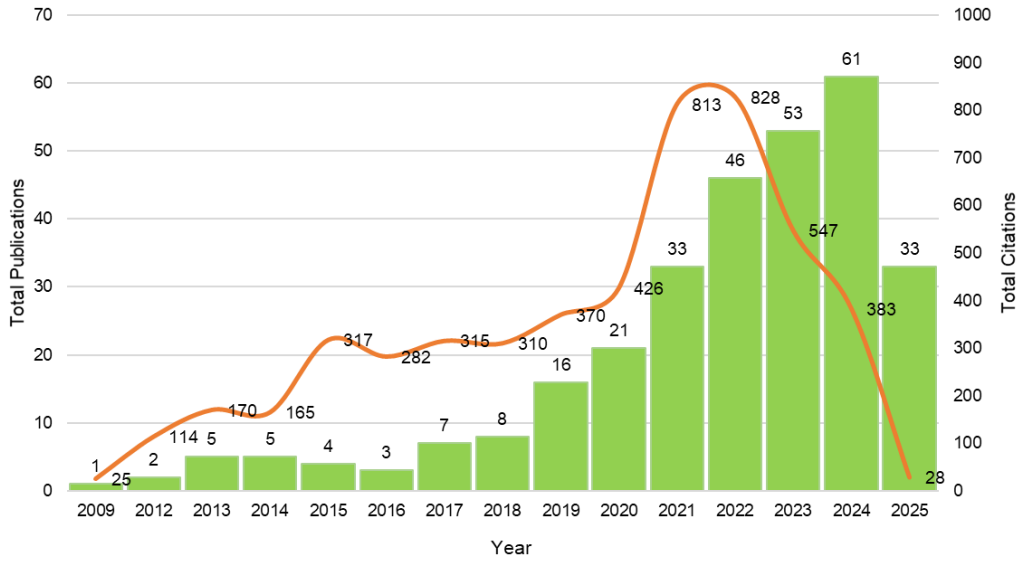

Figure 2. Total publications and citations by year (data is only available up to 18 September 2025)

Table 2
Annual Research Output and Citation Metrics

Year	TP	NCA	NCP	TC	C/P	C/CP	*h*	*g*	*m*
2009	1	3	1	25	25.00	25.00	1	1	0.059
2012	2	3	2	114	57.00	57.00	2	2	0.143
2013	5	15	5	170	34.00	34.00	4	5	0.308
2014	5	20	5	165	33.00	33.00	5	5	0.417
2015	4	7	4	317	79.25	79.25	4	4	0.364
2016	3	9	3	282	94.00	94.00	3	3	0.300
2017	7	17	6	315	45.00	52.50	6	7	0.667
2018	8	21	8	310	38.75	38.75	6	8	0.750
2019	16	47	16	370	23.13	23.13	10	16	1.429
2020	21	65	21	426	20.29	20.29	13	20	2.167
2021	33	110	33	813	24.64	24.64	19	28	3.800
2022	46	162	44	828	18.00	18.82	17	27	4.250
2023	53	207	49	547	10.32	11.16	14	20	4.667
2024	61	209	50	383	6.28	7.66	9	17	4.500
2025	33	142	12	28	0.85	2.33	3	4	3.000
Total	298	1037	259	5093	17.09	19.66	37	57	2.176

Notes: 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. ** Publication data for 2025 is only up to 18 September 2025.*

Publications by Source Titles

Figure 3 and Table 3 present the leading journals that have published at least five documents on GBL in education, highlighting the key publication venues that anchor this field. Specifically, Sustainability (Switzerland) stands out as the most prolific outlet, recording 17 TP and 313 TC. This strong presence is supported by an h-index of 12 and a g-index of 17,

reflecting sustained scholarly impact and the journal's pivotal role in shaping research that connects educational innovation with sustainable development. Following closely, the International Journal of Emerging Technologies in Learning has 14 TP and received 304 TC, with an h-index of 8 and a g-index of 14, affirming its role as a key outlet for research on integrating emerging technologies into education. On a similar note, Education Sciences and Frontiers in Education also play major roles; each has nine TP with TC of 85 and 126, respectively, and h-indices of 4 and 5, underscoring their influence in the broader educational technology landscape.

A second tier of influential journals further enriches the publication ecosystem. The Eurasia Journal of Mathematics, Science and Technology Education plays a prominent role with eight TP and 200 TC, supported by an h-index of 6 and a g-index of 8. This highlights the integration of GBL in STEM-related research. Likewise, the International Journal of Game-Based Learning and the International Journal of Serious Games have each seven TP, earning 59 and 93 TC, respectively, and sharing an h-index of 4. This reflects their significance as key platforms for studies on game design and serious games pedagogy. Meanwhile, Computers and Education, despite a smaller count of six TP, achieved an exceptional 223 TC and a C/P of 37.17, demonstrating the high visibility and influence of the GBL research it publishes.

Several additional journals make steady contributions that broaden the field's thematic and methodological reach. The Journal of Learning Analytics, Educational Technology Research and Development, and Cogent Education each contributed five TP, with TC ranging from 31 to 108, offering fertile ground for research that intersects analytics, pedagogy, and technology. Furthermore, journals with four publications, including the International Journal of Evaluation and Research in Education, the Asian Journal of University Education, the Journal of Computer Assisted Learning, and the British Journal of Educational Technology, also serve as crucial interdisciplinary outlets. Although their TP is more modest, their bibliometric indicators, such as consistent h- and g-indices and competitive average C/P, signal their continuing relevance. Collectively, these high-performing and emerging journals demonstrate that impactful GBL scholarship thrives both in specialised GBL titles and in broader educational technology outlets. This, in turn, creates a dynamic and diversified publication landscape that supports the advancement of groundbreaking research in GBL.

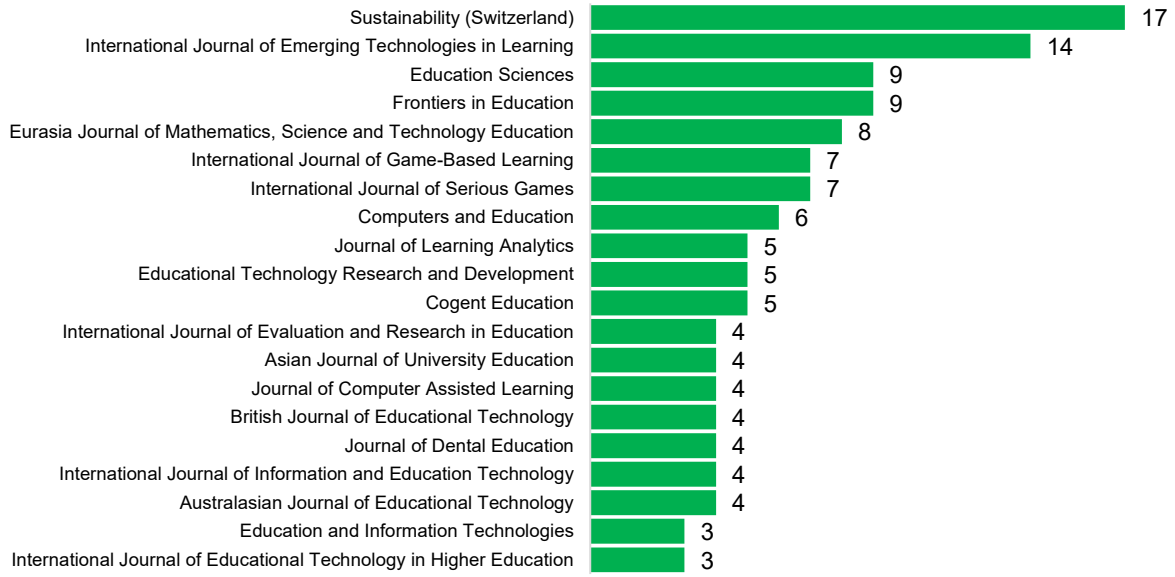

Figure 3. Top 20 Most Productive Source Titles

Table 3
Most active source titles that have published five (5) or more documents

Source Title	TP	NCA	NCP	TC	C/P	C/CP	*h*	*g*	*m*
Sustainability (Switzerland)	17	79	17	313	18.41	18.41	12	17	1.091
International Journal of Emerging Technologies in Learning	14	48	14	304	21.71	21.71	8	14	0.615
Education Sciences	9	36	7	85	9.44	12.14	4	9	0.667
Frontiers in Education	9	31	7	126	14.00	18.00	5	9	0.714
Eurasia Journal of Mathematics, Science and Technology Education	8	26	8	200	25.00	25.00	6	8	0.600
International Journal of Game-Based Learning	7	17	6	59	8.43	9.83	4	7	0.364
International Journal of Serious Games	7	28	7	93	13.29	13.29	4	7	0.571
Computers and Education	6	16	6	223	37.17	37.17	6	6	0.667
Journal of Learning Analytics	5	21	4	31	6.20	7.75	3	5	0.600
Educational Technology Research and Development	5	12	5	108	21.60	21.60	4	5	0.571
Cogent Education	5	13	5	46	9.20	9.20	3	5	0.250

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.

Highly Cited Documents

In addressing the fourth RQ, Table 4 highlights the top five highly cited articles that have shaped the discourse and direction of GBL in education. These key publications form the foundational and contemporary scholarship that continues to shape research and practice in the field. At the forefront is the article by Reinders and Wattana (2015), "Affect and Willingness to Communicate in Digital Game-Based Learning," published in ReCALL, which has garnered 174 TC and a C/Y rate of 15.82. This seminal study demonstrates how digital game-based environments foster learners' affective engagement and willingness to communicate, offering lasting theoretical and empirical insights into the motivational aspects of GBL.

The paper by Cózar-Gutiérrez and Sáez-López (2016), "Game-Based Learning and Gamification in Initial Teacher Training in the Social Sciences: An Experiment with MinecraftEdu," published in the International Journal of Educational Technology in Higher Education, stands as the second most frequently cited study, with 147 TC and an average C/Y of 14.70. By integrating MinecraftEdu into teacher education, this article has been pivotal in demonstrating how immersive, game-based platforms can enrich professional training and pedagogical innovation, inspiring a wide range of applications in teacher preparation and social science education.

Ranked third, the study by Dahalan, Alias, and Shaharom (2024), "Gamification and Game-Based Learning for Vocational Education and Training: A Systematic Literature Review," published in Education and Information Technologies, has rapidly garnered 113 TC, with an outstanding C/Y of 56.50. This rapid impact reflects the timeliness and breadth of their synthesis, which maps current knowledge and identifies research gaps in applying GBL within vocational and technical training. In fourth place, Pesare, Roselli, Corriero, and Rossano (2016) contributed the article "Game-Based Learning and Gamification to Promote Engagement and Motivation in Medical Learning Contexts," featured in Smart Learning Environments. With 106 TC and a C/Y of 10.60, this work affirms the significance of GBL in specialised and professional training. Completing the top five is Carr's (2012) "Does Math Achievement h'APP'en When iPads and Game-Based Learning Are Incorporated into Fifth-Grade Mathematics Instruction?" published in the Journal of Information Technology Education: Research. This pioneering study, with 101 TC and 7.21 C/Y, offers early and influential support for GBL's positive impact on primary mathematics instruction.

Collectively, these landmark papers illuminate key trajectories within GBL research, from language learning and teacher preparation to vocational training, medical education, and mathematics instruction. Their strong citation profiles and diverse thematic coverage reveal how game-based approaches have transformed educational practice across multiple contexts. Moreover, this bibliometric overview underscores the central role these studies have played in defining research priorities, shaping theoretical frameworks, and inspiring innovative applications in GBL over the past decade.

Table 4
Top 5 highly cited articles

No.	Author(s)	Title	Source Title	TC	C/Y	DOI
1	H., Reinders, Hayo; S., Wattana, Sorada (2015)	Affect and willingness to communicate in digital game-based learning	ReCALL	174	15.82	10.1017/S0958344014000226
2	R., Cózar-Gutiérrez, Ramón; J.M., Sáez-López, José Manuel (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	147	14.70	10.1186/s41239-016-0003-4
3	F., Dahalan, Fazlida; N.A., Alias, N. A.; M.S.N., Shaharom, Mohd Shahril Nizam (2024)	Gamification and Game-Based Learning for Vocational Education and Training: A Systematic Literature Review	Education and Information Technologies	113	56.50	10.1007/s10639-022-11548-w
4	E., Pesare, Enrica; T., Roselli, Teresa; N., Corriero, Nicola; V., Rossano, Veronica (2016)	Game-based learning and Gamification to promote engagement and motivation in medical learning contexts	Smart Learning Environments	106	10.60	10.1186/s40561-016-0028-0
5	J.M., Carr, Jennie M. (2012)	Does math achievement h'APP'en when iPads and game-based learning are incorporated into fifth-grade mathematics instruction?	Journal of Information Technology Education: Research	101	7.21	10.28945/1725

Notes: TC = Total Citations: C/Y = Average Citations By Year

Publications by Authors

Based on Table 5, several authors stand out as the main drivers of GBL research. Kristian Kiili of Tampere University, Finland, leads with five TP and an impressive TC count of 146,

coupled with an h-index of 5 and g-index of 5. His high m-index (1.000) and average C/P of 29.20 highlight sustained productivity and strong influence on the field's development.

Equally notable is Elina Jääskä from Industrial Engineering and Management, Oulun Yliopisto, Finland, who has only four TP yet the highest TC of 208 and an outstanding C/P of 52.00, reflecting exceptional citation impact. Manuel Ninaus of Universität Graz, Austria, follows with four TP and 135 TC (C/P = 33.75), indicating broad international reach and consistent scholarly contributions. Carla Sousa from Lusófona University, Portugal, with four TP and a TC of 34, and James C. Lester of NC State College of Engineering, United States, with four TP and a TC of 107 (C/P = 26.75), also play influential roles, albeit with different citation dynamics.

Collectively, these authors represent the core intellectual network advancing GBL in education. Their strong bibliometric profiles spanning high productivity, significant citation impact, and robust h- and g-indexes demonstrate their leadership in shaping research trends, theoretical frameworks, and innovative applications within the GBL domain.

Table 5
Most productive authors who have published more than four (4) documents

Full Name	Current Affiliation	Country	TP	NCP	TC	C/P	C/CP	*h*	*g*	*m*
Kiili, Kristian	Tampere University	Finland	5	5	146	29.20	29.20	5	5	1.000
Jääskä, Elina	Industrial Engineering and Management	Oulun Yliopisto, Oulu, Finland	4	4	208	52.00	52.00	4	4	0.800
Ninaus, Manuel	Universität Graz	Austria	4	4	135	33.75	33.75	4	4	0.800
Sousa, Carla	Lusófona University	Portugal	4	4	34	8.50	8.50	2	4	0.250
Lester, James C.	NC State College of Engineering	United States	4	4	107	26.75	26.75	4	4	0.308

Notes: 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.

Publications by Institutions

Based on Table 6, several institutions emerge as key drivers of research in GBL. Tampere University (Finland) leads the field with seven TP and the highest productivity index (m = 1.200). Its strong citation profile (TC = 155; h = 6; g = 7; C/P = 22.14) underscores both volume and influence, positioning Tampere as a global leader in GBL scholarship.

Other prominent contributors include Industrial Engineering and Management, Oulun Yliopisto (Finland), with four TP, yet a remarkable TC of 208 and C/P of 52.00, indicating exceptional citation impact per paper. National Taiwan Normal University (Taiwan) follows with five TP and TC of 144 (C/P = 28.80), reflecting strong international visibility. From the United States, NC State University records five TP (TC = 121; h = 3), while its NC State College of Engineering adds another four TP (TC = 38). European institutions such as Universiteit Utrecht (Netherlands) with 4 TP (TC = 67; h = 3), and Malaysian universities Universiti Kebangsaan Malaysia (4 TP; TC = 39) and Universiti Pendidikan Sultan Idris (4 TP; TC = 13) further strengthen the global network.

Together, these universities form the institutional backbone of GBL research, combining high productivity with notable citation influence. Tampere University's consistent output, Oulun Yliopisto's exceptional citation efficiency, and National Taiwan Normal University's high impact per paper highlight the geographic breadth and scholarly depth driving advancements in GBL within education.

Table 6
Most productive institutions with a minimum of four (4) publications

Institution Name	Country	TP	NCA	NCP	TC	C/P	C/CP	*h*	*g*	*m*
Tampere University	Finland	7	19	7	155	22.14	22.14	6	7	1.200
Universitas Negeri Jakarta	Indonesia	6	16	5	74	12.33	14.80	4	6	0.444
National Taiwan Normal University	Taiwan	5	9	5	144	28.80	28.80	5	5	0.500
NC State University	United States	5	10	4	121	24.20	30.25	3	5	0.231
Universiti Kebangsaan Malaysia	Malaysia	4	10	4	39	9.75	9.75	3	4	0.500
Universiti Pendidikan Sultan Idris	Malaysia	4	13	4	13	3.25	3.25	2	3	0.286
Universiteit Utrecht	Netherlands	4	11	4	67	16.75	16.75	3	4	0.600
NC State College of Engineering	United States	4	14	3	38	9.50	12.67	3	4	0.600
Industrial Engineering and Management, Oulun Yliopisto, Oulu	Finland	4	12	4	208	52.00	52.00	4	4	0.800

Notes: 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.

Publications by Countries

Table 7 and Figure 4 identify the leading countries with eight or more publications in GBL, showcasing global research productivity and citation impact. The United States leads with 33 TP and 538 TC, supported by an h-index of 12 and a g-index of 23, emphasising its pivotal role in advancing GBL scholarship. Malaysia follows as the second key player with 26 TP and 381 TC, presenting a strong m-index of 1.286, which indicates sustained and influential research output. Spain also makes a notable impact with 23 TP and 556 TC, supported by a high C/P of 24.17 and an h-index of 12, reflecting both quantity and quality of research contributions.

Several other countries demonstrate significant influence and citation strength. Finland stands out with 18 TP and 558 TC, achieving the highest m-index of 1.917 and a C/P of 31.00, which reflects remarkable consistency and per-publication impact. Taiwan, with 15 TP and 562 TC, records the highest C/P of 37.47, signalling exceptional citation intensity relative to output. China also exhibits a strong profile with 14 TP and 362 TC, alongside an h-index of 11 and a notable C/P of 25.86, underscoring its growing prominence in the field. The United Kingdom, Indonesia, and the Netherlands contribute between 11 and 22 TP each, with stable h- and g-indices that reinforce their notable yet varied roles.

Additional contributors such as Germany, Canada, Austria, and Norway maintain steady publication outputs, each with at least eight GBL publications and meaningful citation impacts. Germany, for example, indicates a C/P of 19.36 and an h-index of 7. At the same time, Canada records a C/P of 36.22 and an m-index of 0.900, indicating solid per-paper influence despite a more modest total output. Collectively, these data illustrate a broad and dynamic international research network. High-volume producers such as the United States, Malaysia, and Spain collaborate in parallel with countries that achieve outstanding citation

impact per study, such as Finland and Taiwan, thereby shaping and advancing the global landscape of GBL research.

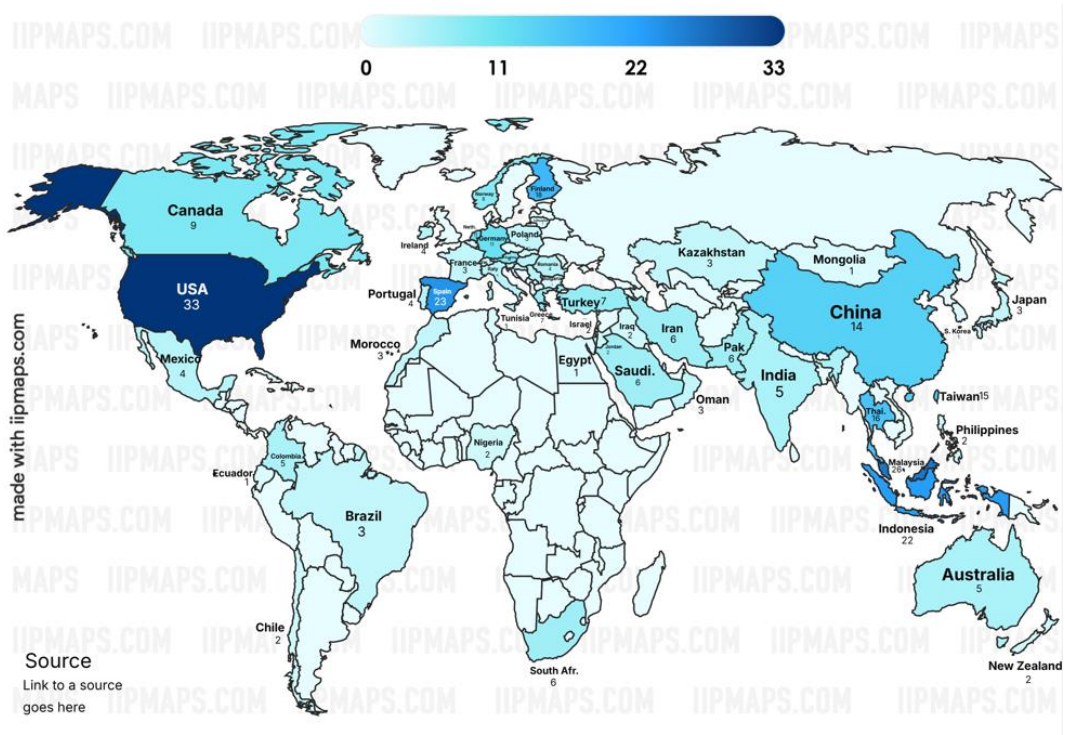

Figure 4. Visualisation of Global Distribution of Global Trends and Research Frontiers in Game-Based Learning

Table 7
Countries that contributed eight (8) or more publications

Country	TP	NCA	NCP	TC	C/P	C/CP	*h*	*g*	*m*
United States	33	118	28	538	16.30	19.21	12	23	0.857
Malaysia	26	79	24	381	14.65	15.88	9	19	1.286
Spain	23	72	20	556	24.17	27.80	12	23	1.200
Indonesia	22	89	15	180	8.18	12.00	6	13	0.667
United Kingdom	20	37	18	388	19.40	21.56	10	19	0.769
Finland	18	55	18	558	31.00	31.00	11	18	0.917
Thailand	16	40	14	238	14.88	17.00	5	15	0.455
Taiwan	15	37	15	562	37.47	37.47	12	15	0.923
China	14	31	12	362	25.86	30.17	11	14	1.833
Netherlands	11	37	9	149	13.55	16.56	7	11	0.583
Germany	11	22	10	213	19.36	21.30	7	11	1.000
Canada	9	20	9	326	36.22	36.22	7	9	0.583
Austria	8	15	7	153	19.13	21.86	5	8	0.385
Norway	8	22	8	144	18.00	18.00	5	8	0.417

Notes: 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

Co-Occurrence Analysis

To address RQ 6, which seeks to uncover the fundamental themes and core topics underpinning the development and expansion of GBL in the education sector, the thematic analysis of the co-occurrence network in Figure 5 highlights GBL as the central hub. This core theme is closely linked with key concepts such as students, motivation, engagement, active learning, digital games, and digital GBL. These close linkages reveal three main strands shaping the field: (i) the design of interactive digital environments that strengthen conceptual understanding and problem solving skills, (ii) the adoption of gamification elements such as points, levels and challenges across learning and education to sustain participation and enhance outcomes, and (iii) the study of psychological and cognitive factors, including intrinsic motivation and collaborative learning, that drive effective game mediated instruction. Collectively, these intertwined themes demonstrate how GBL research integrates technological innovation with learner-centred pedagogies to foster deeper engagement and improved educational achievement.

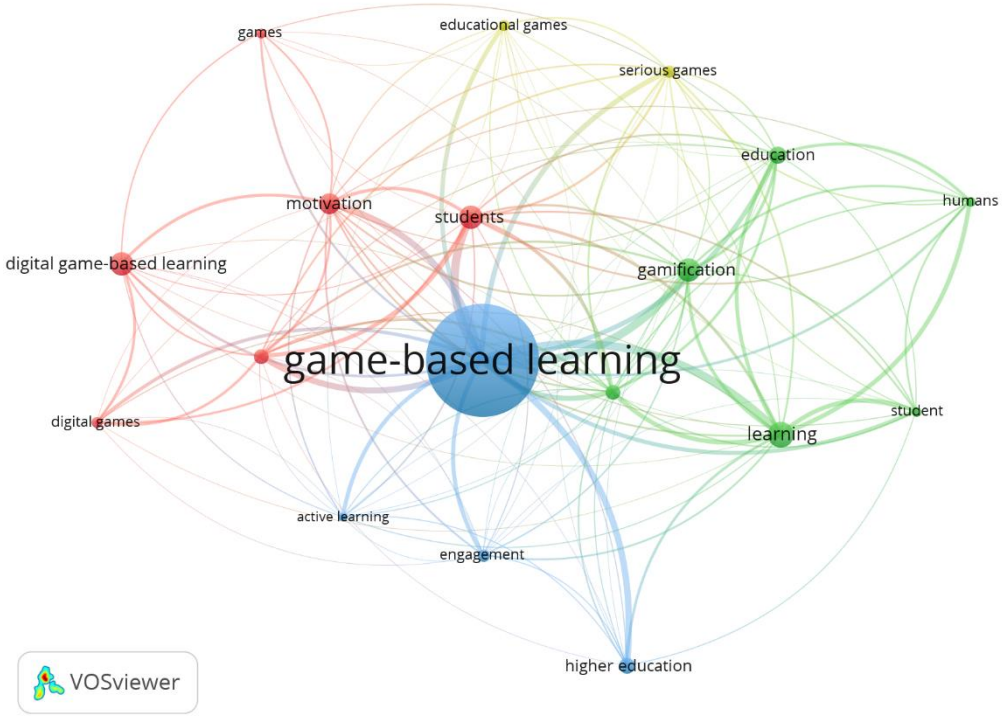

Figure 5. Co-occurrence network of the author's keywords with at least 11 occurrences

The co-occurrence network of keywords in GBL highlights several interlinked research clusters that collectively drive the field's development and growth. The largest blue cluster is centred on "GBL" itself, surrounded by related concepts such as engagement, active learning, and higher education. This cluster underlines the fundamental pedagogical role of games in stimulating student participation and sustaining motivation in both school and university contexts. In addition, strong links with digital games and digital GBL also demonstrate that researchers are focusing on designing interactive learning environments that improve conceptual understanding and problem-solving skills.

A green cluster connects “gamification,” “learning,” and “education,” reflecting interest in embedding game mechanics such as points, levels, or challenges into non-game educational settings. Accordingly, the appearance of terms such as student and humans within this cluster signals a sustained emphasis on learner-centred approaches and the human factors that determine how game elements influence learning outcomes and behaviour.

Meanwhile, a red cluster focuses on “students,” “motivation,” and “educational games,” highlighting a strong psychological and behavioural dimension in current GBL research. This grouping indicates that understanding how games foster intrinsic motivation and collaborative learning is central to the field. Together, these interconnected clusters reveal that the growth of GBL is being shaped by three pivotal themes: the integration of digital and serious games for deep engagement, the strategic use of gamification to enrich formal education, and the exploration of motivational and cognitive processes that underpin effective game-mediated learning.

Discussion

The findings of this bibliometric study confirm that research on GBL has evolved into a well-established and dynamic field with enduring scholarly importance. Over a period of 17 years, the field has produced 298 TP involving strong collaboration among 1,037 NCA and accumulating a substantial 5,093 TC. The robust bibliometric indicators, including an h-index of 37, a g-index of 57, and an m-index of 2.176, demonstrate both maturity and sustained influence. Furthermore, the steady C/Y rate of 318.31 highlights the global recognition and academic impact of GBL, underscoring its significant role in advancing innovative educational practices worldwide (Baas et al., 2020).

The analysis of the significant growth phase from 2019 to 2022, during which annual publications surged from 16 to 46 and citations rose sharply, indicates intensified interest and global collaboration. Although citations in 2023 to 2025 are naturally lower, this reflects the usual citation lag, not a decline in relevance (Yazdi et al., 2024). Moreover, the average of 3.48 authors per paper reinforces the interdisciplinary and international nature of the field. These trends confirm that GBL continues to develop as an influential educational innovation (Akhmetova et al., 2025).

The most influential journals shaping GBL include Sustainability (Switzerland) with 17 TP and 313 TC, International Journal of Emerging Technologies in Learning with 14 TP and 304 TC, and Computers and Education with an outstanding average C/P (~37.17) (Mongeon & Paul-Hus, 2016). Specialist titles such as International Journal of Game-Based Learning and International Journal of Serious Games coexist with broader educational technology outlets, offering both niche depth and interdisciplinary breadth. These journals collectively comprise an ecosystem that supports both theoretical development and practical innovation (Yazdi et al., 2024).

Critical review of landmark works such as Reinders and Wattana (2015) on affect and willingness to communicate, Cózar-Gutiérrez and Sáez-López (2016) on teacher training using MinecraftEdu, Dahalan et al. (2024) in vocational education, Pesare et al. (2016) in medical learning contexts, and Carr (2012) in primary mathematics reveals that these papers provide theoretical, empirical, and methodological foundations for current research. In line with this,

their high citation counts illustrate how certain studies become cornerstones in GBL scholarship (Videnovik et al., 2023).

The global knowledge network sustaining GBL is evident through leading authors such as Kristian Kiili (5 TP, 146 TC) and Elina Jääskä (4 TP, 208 TC), whose h- and g-indices indicate consistent influence. Key institutions such as Tampere University (7 TP, 155 TC) and Oulun Yliopisto (4 TP, 208 TC), alongside strong contributors such as National Taiwan Normal University and NC State University, play major roles. At the same time, significant country-level contributions are led by the United States (33 TP, 538 TC), Malaysia (26 TP, 381 TC), and Spain (23 TP, 556 TC), with Finland and Taiwan achieving exceptional citation-per-paper rates, presenting high productivity and quality (Ekin & Gul, 2022).

Thematic insights from the co-occurrence network emphasise that “GBL” is the central hub, strongly connected to engagement, motivation, digital games, and higher education. Three core strands shape the field: designing interactive digital environments to support conceptual understanding and problem-solving; embedding gamification elements such as points, levels, and challenges to sustain participation and improve outcomes; and investigating psychological and cognitive factors, including intrinsic motivation and collaborative learning, that underpin game-mediated instruction. These intertwined themes illustrate how GBL harmonises technological innovation with learner-centred pedagogy to drive global educational practice forward (De La Hera et al., 2024; Fante et al., 2024).

In summary, the novelty of this research lies in presenting the first longitudinal bibliometric mapping of global GBL studies spanning 17 years (2009–2025), offering a systematic understanding of how GBL has evolved as a social science domain grounded in educational technology. Unlike previous reviews limited to thematic or empirical scopes, this study integrates performance metrics, network visualisation, and thematic evolution to uncover interdisciplinary linkages across psychology, pedagogy, and digital innovation. Its key contribution is the establishment of an evidence-based knowledge structure that informs future research and policymaking in the social sciences, particularly in designing engaging, technology-mediated learning environments that enhance motivation, inclusion, and global educational equity.

Conclusion

This bibliometric analysis provides a comprehensive global perspective on GBL research conducted between 2009 and 2025. By examining 298 TP with 5,093 TC and mapping key authors, institutions, countries, and thematic clusters, the study highlights GBL as a mature and influential field of educational innovation. Additionally, the consistent rise in annual publications, high h-index (37), g-index (57), and strong collaboration rate (3.48 authors per paper) collectively confirm both the sustained growth and international, interdisciplinary character of GBL scholarship.

The findings reveal three interlinked research frontiers: (i) the design of interactive digital environments to enhance conceptual understanding and problem-solving skills; (ii) the strategic integration of gamification elements to boost engagement and learning outcomes; and (iii) the exploration of motivational and cognitive processes that underpin effective game-mediated instruction. As such, influential contributions from leading journals, authors, and

institutions across North America, Europe, and Asia underscore the worldwide diffusion and impact of GBL research.

Overall, this study demonstrates that GBL is no longer peripheral; rather, it is central to contemporary education. Thus, by synthesising global trends and mapping emerging themes, it provides a critical knowledge base to guide educators, policymakers, and researchers in embedding game-based approaches more effectively. The evidence presented supports GBL's potential to transform teaching and learning practices, enrich student engagement, and inform future research directions, thereby strengthening its role in shaping the next generation of educational innovation.

The novelty of this research lies in presenting the first longitudinal bibliometric mapping of GBL from a social science perspective, integrating performance indicators, network analysis, and thematic evolution to capture the intellectual structure of the field. Its key contribution extends beyond descriptive metrics by offering theoretical and methodological insights that bridge educational technology, psychology, and pedagogy. By uncovering the social, cognitive, and institutional dynamics driving GBL scholarship, this study enriches the social science discourse on how game-based learning fosters collaboration, motivation, and inclusive educational transformation on a global scale.

Data availability**:** The data used and analysed in this study are accessible through the Scopus database, with retrieval and screening procedures detailed in the Methods section.

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