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Review Article

Evolution of game-based learning research: A cross-database bibliometric analysis and visualization study (2015-2024)

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ABSTRACT

This study presents the first comprehensive dual-database bibliometric analysis of game-based learning research, investigating its evolution between 2015 and 2024 through analysis of 34,125 documents from Scopus (18,487) and Web of Science (WoS) (15,638) using advanced visualization techniques. The findings reveal consistent field expansion with notable database variations: Scopus demonstrates steady growth while WoS experienced a significant 2020 decline. Citation analysis shows a higher impact on 2015-2018 studies, with Hwang, G. J. as the most influential author and "Computers and Education" as the top journal. Co-keyword analysis reveals distinct conceptual structures—Scopus exhibits two clusters (human-centered studies and game-based learning/serious games) versus three in WoS (education-motivation, health-rehabilitation, technology-design). Thematic analysis demonstrates that game-based learning, serious games, and virtual reality occupy different maturity positions across databases, indicating varied theoretical consolidation. Collaboration networks show US, China, and European dominance, with weaker ties involving developing countries. These findings provide critical insights for educational policymakers and curriculum designers, identifying research clusters to guide targeted funding, collaboration gaps requiring international partnerships, and evidence-based guidance on established versus emerging game-based learning approaches. The dual-database methodology offers comprehensive research landscape mapping that

supports strategic decisions in educational technology implementation and research prioritization.

Keywords: game-based learning, bibliometric analysis, scientific mapping, data visualization, research trends

INTRODUCTION

Rapid developments in educational technologies have led to the adoption of innovative approaches in learning-teaching processes. Among these approaches, game-based learning (GBL), which has come to the fore in recent years, draws attention as a method that increases students' motivation, supports their active participation and improves their cognitive skills (Plass et al., 2015; Qian & Clark, 2016). By including game dynamics and mechanics into learning activities, GBL gives students interactive and interesting educational experiences (Hamari et al., 2016). This method gives teachers and researchers the chance to help students' knowledge building processes and more successfully transmit instructional materials.

GBL is being used in many fields and is becoming more and more important daily in the classroom. From science, technology, engineering, and mathematics (STEM) education (Zhao et al., 2022) to health sciences (Sardi et al., 2017) from vocational education (Dahalan et al., 2024) to historical education (Stack & Bunt, 2023). This wide range of applications has led to a rapid increase in GBL research and created a rich literature (Avci et al., 2024; Dimitra et al., 2020; Mettarikanon et al., 2023).

Although the number of GBL studies has increased significantly in the last decade, there is a paucity of studies that provide a comprehensive analysis of the scientific production in this field. Existing research often focuses on GBL practices in a specific discipline or educational level (Chen & Syu, 2024), but bibliometric studies that comprehensively reveal the overall structure and development trends of the field are lacking. In particular, there is a need for studies that include comparative analysis of different databases, examining the conceptual structure, collaboration networks, and research frontiers of the field.

In order to fill this research gap, the current study aims to examine the research in the field of GBL between 2015 and 2024 through bibliometric analysis and visualization methods. The paper attempts to expose the scientific structure, research trends and development dynamics of the area comparatively by means of analysis of the publications in Scopus and Web of Science (WoS) databases. This will clarify the present situation and the next areas of study in the subject of GBL.

Accordingly, the main research questions of the study are as follows:

1. How have publication and citation trends in the field of GBL changed between 2015 and 2024?
2. Which are the most influential sources, authors and studies in the field of GBL in Scopus and WoS databases?
3. How are the collaboration networks between institutions and countries contributing to the field of GBL shaped?
4. What are the conceptual structure and thematic trends in the field of GBL and how do they differ across databases?
5. In which direction is the research frontier and intellectual structure in the field of GBL developing?

The responses to these questions will be very valuable in terms of methodically evaluating the body of current knowledge in the field of GBL and pointing up new directions of research. The results of the research will direct teachers, scientists, and legislators into the efficient application and design of GBL strategies.

LITERATURE REVIEW

Fundamental Principles of Game-Based Learning

GBL is an educational approach that aims to increase student engagement, motivation and knowledge retention. This method makes learning processes more effective by utilizing the interactive and immersive nature of games (Lai et al., 2014; Plass et al., 2015; Wan et al., 2021). The basic principles of GBL include participation, motivation, interaction and the application of real-world scenarios.

GBL actively involves students in engagement and motivation. Elements in games, such as rewards, challenges and competition, engage students and make them more focused on the learning process. For example, role-playing games allow students to solve problems from a character's perspective, while puzzle-based games can develop logical thinking and analytical skills. Research shows that digital games promote a student-centered environment as well as independent inquiry and critical thinking abilities (Deng et al., 2020; Haruna et al., 2018). Moreover, gaming systems increase students' inherent desire and inspire more want to participate in the learning process (Chen et al., 2020a; Jackson & McNamara, 2013).

One of the most important advantages of GBL is that it enables students to actively participate in the process. The interactive nature of games supports experiential learning by facilitating the practical application of knowledge. For example, simulation games develop problem-solving skills in engineering and health education, while cooperative multiplayer games and role-playing games can help students develop communication and teamwork skills (Deshpande & Huang, 2011; Tekman & Yeniasır, 2023). This process enables students not only to acquire theoretical knowledge but also to develop real-world applications.

GBL makes learning more meaningful by making abstract concepts concrete. Especially in STEM education, GBL helps students better understand complex concepts (Zhao et al., 2022). Moreover, in vocational education, simulations provide hands-on experiences and students have the opportunity to improve their professional skills (Dahalan et al., 2024).

GBL supports the learning process by providing instant feedback to students. Digital games allow students to see what they lack and make instant corrections. They also offer personalized learning pathways, providing content that suits the individual needs of each student (Sun et al., 2023). This is an important factor that increases student achievement.

In conclusion, GBL is a powerful educational model that increases participation, supports motivation and makes learning processes more effective. It can be successfully applied in many fields from STEM education to professional development. The integration of GBL into educational systems helps students develop critical thinking, problem solving and communication skills, preparing them for real-world challenges.

Milestones in the Historical Evolution of Game-Based Learning Research

The historical development of GBL research has been shaped by efforts to understand the role of games in education and integrate them into effective learning processes. While GBL's roots trace back to traditional board games, its evolution into digital educational contexts represents a paradigm shift in pedagogical approaches.

The emergence of serious games and gamification in the early 2000s accelerated GBL's entry into academic research. During this period, studies examining the relationship between computer-based games and learning outcomes increased, establishing digital educational games (DEGs) as an important field. Wouters et al. (2013) provided a foundational meta-analysis that demonstrated games' potential to increase motivation and engagement through cognitive adaptation to learning processes. This seminal work established the theoretical basis for GBL by systematically reviewing empirical evidence of games' cognitive and motivational effects.

A critical milestone came with Plass et al. (2015), who established the "Foundations of Game-Based Learning," providing a comprehensive theoretical framework that remains highly influential (as evidenced by its high citation count in our bibliometric analysis). This work systematically outlined how game mechanics align with learning principles, creating a bridge between educational psychology and game design.

As GBL research matured, studies expanded across diverse disciplines. The integration of emerging technologies, particularly virtual and augmented reality, has created new research frontiers. Recent systematic reviews, such as Hamari et al. (2016) on engagement and flow in GBL, have provided empirical validation of theoretical frameworks while identifying key factors that contribute to effective educational gaming experiences.

The field has evolved from theoretical exploration to practical applications, demonstrating the cognitive, motivational, and social benefits of games in education. Through technological advances, multidisciplinary research, and structured approaches, GBL has become a powerful tool for supporting learning processes, with ongoing research continuing to refine how games can be most effectively utilized in educational contexts.

Theoretical Frameworks in Game-Based Learning

Several theoretical models have been developed to understand and enhance GBL's effectiveness. These frameworks enable the integration of game dynamics with instructional goals, thereby increasing student engagement and creating meaningful learning opportunities.

The Inquiry, Communication, Construction, and Expression (ICCE) framework evaluates educational games' impact on learning processes by aligning game mechanics with teaching objectives (Foster & Shah, 2015). Similarly, the Learning Mechanics-Game Mechanics (LM-GM) approach enables game designers to create experiences that are both informative and enjoyable (Arnab et al., 2015; Callaghan et al., 2016). These frameworks directly correspond to the "technology-design" cluster identified in our WoS analysis, where technical aspects of educational game development emerge as a distinct research theme.

Self-Determination Theory (SDT) is fundamental to GBL, positing that meeting individuals' needs for autonomy, competency, and relatedness stimulates intrinsic motivation (Proulx et al., 2017). Educational games can address these needs by providing students with freedom of choice and fostering a sense of achievement. Our bibliometric analysis reveals that this theoretical foundation manifests in the "education-motivation" cluster in WoS, where terms like "motivation," "engagement," and "performance" cluster together, reflecting the field's emphasis on motivational aspects.

Flow Theory (Czikszentmihalyi, 1990) explains the optimal state of experience where players lose their sense of time and become completely focused on the game. Well-designed educational games can provide this flow experience by balancing difficulty levels with player capabilities (Chan et al., 2021; Wan et al., 2021). This theoretical emphasis is reflected in our Scopus analysis through the prominence of "flow" and "engagement" terms in human-centered studies clusters.

Vygotsky's Sociocultural Learning Theory explains how social interaction in educational games can support learning, while Constructivist Learning Theory emphasizes students' active knowledge construction. These social and constructivist elements appear prominently in both databases' analyses, particularly in clusters focusing on collaborative learning and student-centered approaches.

Situated Learning Theory emphasizes learning within authentic contexts, while the Theory of Multiple Intelligences highlights the importance of designing educational games for different learning styles (Gardner & Moran, 2006; Garmen et al., 2019). These frameworks align with the diverse application clusters identified in our analysis, particularly the health-rehabilitation cluster in WoS, which represents contextualized learning in specific professional domains.

The convergence of these theoretical frameworks is evident in current GBL research trends. Our thematic analysis reveals that concepts like "serious games," "virtual reality," and "gamification" occupy different maturity positions across databases, suggesting that theoretical applications vary according to research contexts and disciplinary focuses. This theoretical diversity explains the emergence of distinct research clusters and highlights how different theoretical lenses shape research directions in the field.

The Effect of Game-Based Learning on Students

GBL supports digital literacy and cognitive skills as well as digital literacy and cognitive skills (Chen & Syu, 2024; Patmanthara et al., 2019; Wang et al., 2023; Zheng et al., 2024). This method creates an interactive environment rather than more traditional ones, thereby enabling students to participate more actively in the learning process (Bakhsh et al., 2022; Gordillo et al., 2022; Holbrey, 2020). Some research underlines that although GBL does not directly raise academic performance, it creates a suitable learning environment since it raises student attention and concentration (Alarcon Fortepiani, 2023).

In fields like digital literacy and cyber etiquette as well, GBL generates favorable results (Wang et al., 2023; Zheng et al., 2024). In particular, it is reported to contribute to avoiding internet addiction and developing healthy digital behaviors (Wang et al., 2023). It also increases the sense of self-efficacy in technical areas such as programming education and supports the development of computational thinking skills (Ma et al., 2023; Tsai et al., 2024). This interactive approach also encourages personalized learning experiences, helping students access content at their own pace and preferences (Liu & Lu, 2021; Tlili et al., 2019). The development

of social-emotional skills also plays an important role in GBL, with qualities such as cooperation and empathy being strengthened (Boghian & Cojocariu, 2023; Natucci & Borges, 2021).

While game design, student prior knowledge, and instructional strategy must be correctly constructed to be effective (Chen & Syu, 2024; Hwang et al., 2023; Selvi & Çoşan, 2018), GBL might not always directly lead in higher academic results. Several studies show that GBL applied in big courses or online contexts increases engagement and enhances learning results (Gordillo et al., 2022). Its effect on academic performance could, however, be limited in some specific situations (Alarcon Fortepiani, 2023; Holbrey, 2020; Selvi & Çoşan, 2018). Still, there is broad understanding that GBL raises students's desire, interaction, and information acquisition (Holbrey, 2020; Selvi & Çoşan, 2018). GBL is finally a quite effective tool for establishing a student-centered and interesting learning environment when correctly developed and used.

The Challenges of Game-Based Learning

According to studies (Boghian & Cojocariu, 2023; Hwang et al., 2023); GBL offers a lot of opportunities to include students and enhance classroom settings. If this approach is to be effectively introduced into the curricula, technical and logistical challenges must thus be properly handled (Lester et al., 2023). The design of games calls for multidisciplinary cooperation involving software engineering and visuals. Moreover combined with learning goals should be game mechanics (Hamari et al., 2016; Hanghøj et al., 2022). By means of combined training programs, common project platforms, and frequent meetings, instructional designers and teachers should coordinate to reach this integration (Aslan & Balci, 2015; Wan Mohd Isa et al., 2022). Moreover considered should be students' technological knowledge and ages (Li, 2021; Tay et al., 2022; Wang & Kartika Sari, 2024).

Effective implementation of teaching strategies appropriate for game literacy and GBL depends on instructors developing them (Chen et al., 2020b; Shernoff et al., 2020). Educators should receive adequate professional support to acquire these skills. Technological infrastructure and resources are also required to facilitate the adoption of games in the classroom (Petrović et al., 2022; Trinidad et al., 2021). Compatibility with learning management systems and flexible software options enable more effective applications in different environments (Ali et al., 2023). Planned should be content and assessment tools (e.g., rubrics, data analytics methodologies, and in-game assessment tools) to guarantee consistent measuring of student learning outcomes so protecting educational integrity (Kim et al., 2022; Stohlmann, 2022).

Unneeded elements should improve the learning process instead than complicate game design procedures (Tay et al., 2022; Wang & Kartika Sari, 2024). Adequate administrative support, strategic planning, and funding sources such as public or private grant programs enable teachers to devote time to GBL implementation (Lester et al., 2023). In this way, game-based methods can be adopted more widely (Hwang et al., 2023; Liu & Lu, 2021; Natucci & Borges, 2021). When well-designed and implemented with comprehensive planning, GBL increases student engagement and motivation (Ali et al., 2023; Li, 2021). Thus, instructional designers and educators can overcome technical and logistical barriers to deliver more effective and enjoyable learning experiences.

METHOD

This study adopts a comprehensive bibliometric analysis and visualization approach to examine the evolution of research in the field of GBL between 2015 and 2024. The research was conducted on data from Scopus and WoS databases. The use of two different databases allowed for a broader perspective of research trends in the field. In the data collection process, a detailed search query covering key terms related to GBL was used, and studies published between 2015 and 2024 and written in English were included.

Data Collection Process

In this study, the data collection process was carried out in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) model (**Figure 1**). In the first stage, a comprehensive search query related to the field of GBL was created. The query was structured to include the terms "game-based learning", "game based learning", "educational gaming", "game-based education", "game based education", "educational game*", "learning game*", "game-based teaching", "game based teaching",

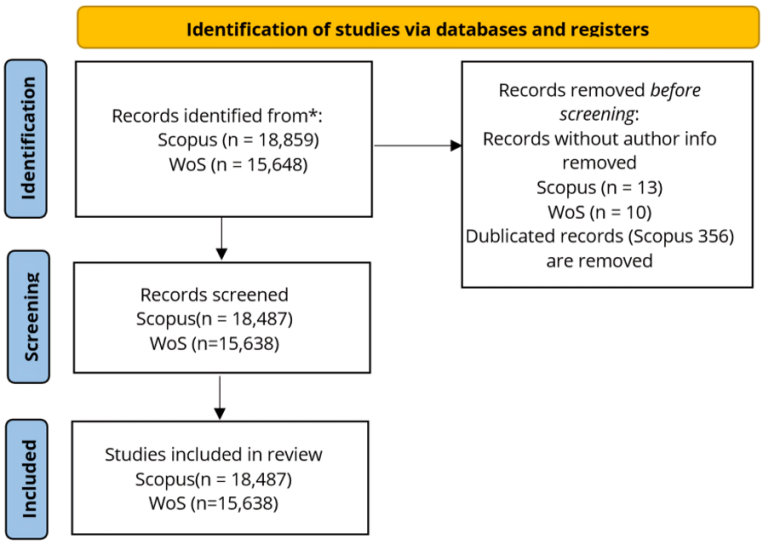

Figure 1. Data collection process (modified from PRISMA 200)

"educational digital game*", "serious game*", "instructional game*" and "gamified learning" (search query is shared below).

"gamification" as a standalone term was deliberately excluded because it encompasses broader applications beyond education (e.g., marketing, healthcare, business), which would introduce noise and reduce precision for our GBL focus.

Validation of search terms

The search query was pilot-tested and refined through iterative searches. Key validation criteria included:

1. Relevance to educational contexts (> 90% of results should relate to learning/education)
2. Coverage of established literature (inclusion of known seminal works)
3. Precision vs. recall balance (avoiding over-broad results while capturing domain comprehensively)

Search query

("game-based learning" OR "game based learning" OR "educational gaming" OR "game-based education" OR "game based education" OR "educational game*" OR "learning game*" OR "game-based teaching" OR "game based teaching" OR "educational digital game*" OR "serious game*" OR "instructional game*" OR "gamified learning").

The search was limited to English-language studies published between 2015 and 2024. The initial search yielded 18,859 studies from the Scopus database and 15,648 studies from the WoS database. Then, the data cleaning phase started. In the Scopus database, 13 documents with no author and 359 duplicate documents were removed, resulting in 18,487 documents. In the WoS database, 10 documents with no author were removed, it was determined that there were no duplicate documents, and as a result, 15,638 documents were included in the analysis. Studies without authors were manually removed. Duplicate publications were automatically cleaned using the Bibliometrix application

Data Analysis

We used RStudio (2024.12.0) with the "Bibliometrix 4.3.2" package for analysis. Designed especially for extensive scientific mapping and bibliometric analysis, the open-source R package Bibliometrix helps researchers investigate the structure and dynamics of scientific literature (Aria & Cuccurullo, 2017). As researchers, we chose Bibliometrix because it is open-source and offers more comprehensive analyses compared to alternatives.

In the first stage of the analysis, basic descriptive statistics of the data obtained from both databases were calculated. In this context, basic bibliometric indicators such as annual publication numbers, average annual growth rates, document types, source types, authors and countries were determined. Citation studies using

the basic indicators helped to evaluate the influence of articles. Normalized TC is calculated as Total Citations ÷ (Current Year – Publication Year + 1). Calculated at this point were year-adjusted citation counts, the average number of citations per publication, and the overall sum of citations (Donthu et al., 2021).

Different network analysis were used to expose field research trends and intellectual structure. Co-word analysis was used to map the key concepts in the field and the relationships between these concepts (Callon et al., 1983). This analysis was used to identify clusters of topics in the field of GBL and to reveal the conceptual structure. Different clustering features were observed in Scopus and WoS databases and these differences were evaluated comparatively.

Thematic analysis was conducted through strategic diagrams to understand the cognitive structure and developmental trends of the domain. In this analysis, centrality and density values of the themes were calculated and thematic maps were created separately for both databases (Cobo et al., 2011). Thus, core, emerging, niche and peripheral themes were identified. The results of the analysis showed that themes such as GBL, serious games and virtual reality are located in different positions in both databases.

Collaboration network analyses examined patterns of scientific collaboration between authors and countries. With co-authorship analysis, the main research groups in the field and the links between these groups were identified (Glänzel & Schubert, 2004). In the cross-country collaboration analysis, international scientific collaboration networks were visualized, thus revealing the global collaboration structure in the field of GBL.

Furthermore, performance studies were carried out to pinpoint the most significant field writers, institutions, and sources. Scientific significance of the sources and authors was assessed using bibliometric indicators including h-index, g-index, and m-index (Egghe, 2006; Hirsch, 2005). All analyses were interpreted and visualized in detail in line with the purpose of the study. The graphs and network visualizations provided by the Bibliometrix package clearly illustrated the findings. The analysis methods used provide a comprehensive bibliometric profile of the field of GBL, providing researchers with valuable information about the current state of the field and future research directions.

RESULTS

In the field of GBL, bibliometric analysis produces noteworthy variations between Scopus and WoS databases (**Table 1**).

While WoS has 15,561 papers and 4,358 sources, the Scopus database shows 18487 documents and 4676 sources in the investigated period (2015-2024). When annual growth rates are compared, it is seen that Scopus is growing faster than WoS (4.66%) with 6.25%. Scopus (10.18) is slightly ahead of WoS (9.36) in the average number of citations per document.

In terms of author profile and collaboration, Scopus has 43,550 authors while WoS has 41,662 authors. Single-author studies were 1692 in Scopus and 1384 in WoS. WoS (4.28) has a higher rate of co-authors per document than Scopus (3.92). International collaboration rates are close to each other in both databases (Scopus: 20.32%, WoS: 21.39%).

When the types of publications are analyzed, articles constitute the largest group in both databases. There are 7,416 articles on Scopus and 7,468 articles on WoS. There is a significant difference in conference proceedings, with 9,335 papers in Scopus and 7,012 in WoS. A similar situation is observed for book chapters. While Scopus contains 967 book chapters, WoS has only 21 book chapters. In review articles, WoS (801) has more publications than Scopus (582).

In terms of keywords, Scopus has 32,863 Keywords Plus and 27,305 author keywords, while WoS has 6,920 Keywords Plus and 25,088 author keywords. In the light of these data, it can be said that Scopus database has a more comprehensive content in the field of GBL, author collaboration is higher in WoS, articles are the most common type of publication in both databases, and Scopus has a richer content especially in conference proceedings and book chapters.

Table 1. Descriptive information on datasets

Description	Scopus	WoS
Main information about data		
Timespan	2015:2024	2015:2024
Sources (journals, books, etc.)	4,676	4,358
Documents	18,487	15,561
Annual growth rate (%)	6.25	4.66
Document average age	5.01	5.31
Document contents		
Keywords plus (ID)	32,863	6,920
Author's keywords (DE)	27,305	25,088
Authors		
Authors	43,550	41,662
Authors of single-authored docs	1,412	1,113
Authors collaboration		
Single-authored documents	1692	1,384
Co-authors per document	3.92	4.28
International co-authorships %	20.32	21.39
Document types		
Article	7,416	7,468
Book	78	9
Book chapter	967	21
Book chapter article	5	
Book chapter book chapter	2	
Book chapter conference paper	5	
Book chapter review	1	
Book conference paper	1	
Conference paper	9,335	7,012
Conference paper article	32	
Conference paper book chapter	1	
Conference paper conference paper	52	
Conference paper review	5	
Review	582	801
Review article	1	
Review book chapter	1	5
Review conference paper	3	

The distribution of the number of publications in the field of GBL between 2015 and 2024 shows different trends in Scopus and WoS databases (as shown in **Figure 2**). The publications in the Scopus database show a continuous upward trend. From approximately 1,250 publications in 2015, the number of publications increased steadily to 2,123 in 2020. In 2021, there was a small decrease to 2,094, but in 2022 it reached its highest level with 2,236. In 2023, it remained at a similar level with 2,231 publications.

The number of publications in the WoS database has followed a more variable course. The number of publications, which was approximately 1,215 in 2015, increased and reached 1,927 in 2019. However, it dropped sharply to 1,346 in 2020. After this decline, the number of publications increased to 1,465 in 2021 but decreased again to 1,343 in 2022. In 2024, it reached 1,840 with a remarkable increase.

When the two databases are compared, it is seen that the number of publications in Scopus is generally higher than in WoS. While a steady upward trend was observed in Scopus, WoS experienced a significant decline, especially in 2020. The biggest difference between the two databases emerged in 2022. By 2024, a significant increase in the number of publications in WoS was observed. These data show that academic studies in the field of GBL are more consistently found in Scopus.

The average citation data of publications in the field of GBL over the years show different trends in Scopus and WoS databases (**Table 2**). When the average number of citations per article (Mean TC/Art) is analyzed, high values are observed in both databases between 2015-2018. During this period, the average number of citations of articles in Scopus (between 15.63-17.98) is higher than in WoS (between 12.37-13.93).

Since 2019, a decrease in the number of citations has been observed in both databases. The average number of citations per article in Scopus, which was 11.59 in 2019, increased briefly to 12.92 in 2020, but showed a steady decline in the following years. Likewise, the average number of citations in WoS—which fell

Figure 2. Trends in the studies in game-based learning (Elaborated by authors)

Table 2. Compare citation over years

Year	Scopus		WoS	
	Mean TC/Art	Mean TC/Year	Mean TC/Art	Mean TC/Year
2015	17.00	1.55	13.89	1.26
2016	17.98	1.80	13.93	1.39
2017	16.73	1.86	12.37	1.37
2018	15.63	1.95	12.62	1.58
2019	11.59	1.66	10.01	1.43
2020	12.92	2.15	13.49	2.25
2021	8.87	1.77	9.15	1.83
2022	6.23	1.56	6.58	1.65
2023	3.32	1.11	3.65	1.22
2024	1.04	0.52	1.03	0.52

to 10.01 in 2019—rose to 13.49 in 2020 and then began to fall. The quantity of references in both databases kept dropping at like rates starting in 2021.

Looking at the average number of citations annually (Mean TC/Year), 2020 had the greatest numbers in both databases. These values declined slowly until 2020: 2.15 in Scopus and 2.25 in WoS. By 2024 both databases showed lowest values of 0.52. The fact that newly published papers lack enough time for citations helps one to explain the declining trend. Generally speaking, older papers in the field of GBL have more citations; publications in Scopus usually have higher citation rates; and 2020 marks a major turning point in terms of citation performance in both databases.

When the performance indicators of the 10 most influential sources in the field of GBL in Scopus and WoS databases are analyzed, it is seen that the journal "Computers and Education" ranks first in both databases (**Table 3**). This journal has the highest values in Scopus with h-index:63, g-index:108, m-index:5.727 and 12,318 citations, and in WoS with h-index:55, g-index:92, m-index:5 and 9,527 citations.

Table 3. Top 10 sources in GBL

No	Source	h_index	g_index	m_index	TC	NP
Scopus						
1	Computers and Education	63	108	5.727	12,318	151
2	Computers in Human Behavior	42	83	3.818	6,986	88
3	JMIR Serious Games	30	44	2.727	3,651	262
4	British Journal of Educational Technology	28	55	2.545	3,313	91
5	Educational Technology and Society	28	46	2.545	2,192	61
6	Sustainability (Switzerland)	26	36	2.364	2,080	140
7	Interactive Learning Environments	26	48	2.364	2,789	119
8	Education and Information Technologies	26	41	2.364	2,177	118
9	Journal of Computer Assisted Learning	26	50	2.364	2,639	71
10	Lecture Notes in Computer Science	25	36	2.273	5,282	1,306
WoS						
1	Computers and Education	55	92	5.000	9,527	157
2	JMIR Serious Games	38	55	3.455	7,329	586
3	Computers in Human Behavior	38	74	3.455	5,696	90
4	British Journal of Educational Technology	28	48	2.545	2,690	95
5	Educational Technology and Society	26	39	2.364	1,646	62
7	Interactive Learning Environments	24	42	2.182	2,269	130
8	Journal of Computer Assisted Learning	24	44	2.182	2,080	79
6	Education and Information Technologies	24	34	2.182	1,734	145
9	International Journal of Serious Games	23	32	2.091	2,040	228
10	Games for Health Journal	22	38	2.000	1,671	91

Notes: TC: Total citations; NP: Number of publications.

There are differences between databases in the second and third ranks. In Scopus, "Computers in Human Behavior" ranks second (h-index:42, 6,986 citations) and "JMIR Serious Games" ranks third (h-index:30, 3,651 citations), while in WoS, "JMIR Serious Games" ranks second (h-index:38, 7,329 citations) and "Computers in Human Behavior" ranks third (h-index:38, 5,696 citations).

"British Journal of Educational Technology" and "Educational Technology and Society" are other important sources in the top five of both databases. In terms of number of publications, "Lecture Notes in Computer Science" (1,306 publications) and "JMIR Serious Games" (262 publications) in Scopus, and "JMIR Serious Games" (586 publications) and "International Journal of Serious Games" (228 publications) in WoS.

When the impact values of the journals common to both databases are compared, it is seen that the values in Scopus are generally higher. In addition, it is understood that the majority of the journals in the list focus on the fields of educational technologies and computer sciences, and GBL is an important research topic in these fields.

The data of the 10 most influential authors in the field of GBL show some similarities and differences in Scopus and WoS databases (**Table 4**). Hwang, G. J. ranks first in both databases. He has the highest values in Scopus with h-index:22, g-index:45, m-index:2 and 2,044 citations, and in WoS with h-index:20, g-index:39, m-index:1.818 and 1,574 citations.

There are differences between databases in the second and third ranks. Scopus has Lester, J. (h-index: 17, 980 citations) and Azevedo, R. (h-index: 16, 724 citations), while WoS has Ninaus, M. (h-index: 16, 689 citations), and Fernandez-Manjon, B. (h-index: 15, 708 citations). In terms of number of publications, Lester, J. (80 publications) and Hou, H. (64 publications) stand out in Scopus, while Tembine, H. (68 publications), and Hwang, G. J. (52 publications) stand out in WoS.

The co-authors in the top 10 in both databases are Hwang G. J., Ninaus, M., Fernandez-Manjon, B., Chen, C., Azevedo, R., and Hou, H. These authors generally have higher citation counts and index values in Scopus than in WoS. For example, Chen, C. has 989 citations in Scopus and 854 citations in WoS.

When the data in both databases are compared, it is seen that authors in Scopus have higher citation numbers and index values in general. In addition, it is understood that the majority of the most influential authors in the field of GBL have a continuous and stable publication performance and have made significant contributions in this field. It is observed that the most productive authors generally specialize in the fields of educational technologies and computer-assisted learning.

Table 4. Top 10 authors in GBL field

No	Source	h_index	g_index	m_index	TC	NP
Scopus						
1	Hwang, G. J.	22	45	2.000	2,044	55
2	Lester, J.	17	28	1.545	980	80
3	Azevedo, R.	16	26	1.600	724	43
4	Ninaus, M.	15	39	1.364	1,572	49
5	Lester, J.	15	26	1.364	679	26
6	Fernández-Manjón, B.	14	27	1.273	798	43
7	Chen C.	13	23	1.182	989	23
8	Hou, H.	13	27	1.182	792	64
9	Chen, S.	13	24	1.182	588	29
10	Shute, V.	13	17	1.182	573	17
WoS						
1	Hwang, G. J.	20	39	1.818	1,574	52
2	Ninaus, M.	16	25	1.455	689	43
3	Fernandez-Manjon, B.	15	25	1.364	708	52
4	Chen, C.	14	25	1.273	854	25
5	Azevedo, R.	14	27	1.400	744	36
7	Tembine, H.	13	25	1.182	702	68
8	Hou, H.	13	24	1.182	628	43
6	Lester, J.	13	22	1.182	580	48
9	Kim, S.	13	22	1.182	535	45
10	Ke, F.	12	24	1.200	610	25

Notes: TC: Total citations; NP: Number of publications.

The most influential studies in the field of GBL show significant similarities in Scopus and WoS databases (**Table 5**). In both databases, Hamari et al.'s (2016) study titled "Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning" stands out as the most cited study. This study received 1,147 citations in Scopus (114.70 per year) and 878 citations in WoS (87.80 per year).

The second and third places differ throughout the datasets. While in WoS, Boyle et al.'s (2016) (627 citations) ranked second and Plass et al.'s (2015) research (606 citations), in Scopus, Plass et al.'s (2015) "foundations of game-based learning" (866 citations) and Boyle et al.'s (2016) literature review placed second and third, respectively.

Other notable papers shared by both databases include the 2015 analysis of serious games by Arnab et al. (2015); the 2016 research on 21st century skills by Qian and Clark (2016); and the 2017 systematic review on gamification in e-health by Sardi et al. (2017). Regarding yearly citation rates, Sailer and Homner's (2020) meta-analysis shows great rates in both databases (Scopus: 101.17, WoS: 73.50).

The fact that most of the most significant research are systematic reviews, meta-analyses, or literature reviews underlines the need to improve the theoretical underpinnings of the topic and merging already accessible knowledge. Usually, these research concentrate on the effectiveness of GBL, student involvement and motivation, and a conceptual framework for the field. Usually speaking, Scopus has more citations than WoS.

Scopus and WoS databases provide differing values for the contributions made by institutions in the field of GBL (**Table 6**). With 176 papers, North Carolina State University ranks first in Scopus; National Taiwan University of Science and Technology leads with 248 papers in WoS.

The quantity of publications of the institutions ranked in the top 10 in both databases differs noticeably. Aristotle University of Thessaloniki, for instance, ranks second in WoS with 219 articles while fourth in Scopus with 135 publications. Similarly, National Taiwan Normal University ranks fifth in Scopus with 127 publications and in the middle with 187 publications in WoS.

In a striking difference, the University of California ranks third with 158 publications only in Scopus but is not in the top 10 in WoS. On the other hand, some universities have significantly higher publication numbers in WoS than in Scopus. For example, University Porto (Scopus: 66, WoS: 193), University Complutense Madrid (Scopus: 65, WoS: 190), and University Sao Paulo (Scopus: 29, WoS: 177).

Table 5. The most influential studies in GBL

No	Paper	Title	TC	TCpY	NTC
Scopus					
1	Hamari et al. (2016)	Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning	1,147	114.70	63.78
2	Plass et al. (2015)	Foundations of game-based learning	866	78.73	50.94
3	Boyle et al. (2016)	An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games	803	80.30	44.65
4	Dichev and Dicheva (2017)	Gamifying education: What is known, what is believed and what remains uncertain: A critical review	728	80.89	43.53
5	Qian and Clark (2016)	Game-based learning and 21st century skills: A review of recent research	698	69.80	38.81
6	Sardi et al. (2017)	A systematic review of gamification in e-health	631	70.11	37.73
7	Arnab et al. (2015)	Mapping learning and game mechanics for serious games analysis	609	55.36	35.82
8	Sailer and Homner (2020)	The gamification of learning: A meta-analysis	607	101.17	46.98
9	Hsu et al. (2018)	How to learn and how to teach computational thinking: Suggestions based on a review of the literature	494	61.75	31.61
10	Zainuddin et al. (2020)	The impact of gamification on learning and instruction: A systematic review of empirical evidence	491	81.83	38.00
WoS					
1	Hamari et al. (2016)	Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning	878	87.80	63.01
2	Boyle et al. (2016)	An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games	627	62.70	45.00
3	Plass et al. (2015)	Foundations of game-based learning	606	55.09	43.64
4	Freina and Ott (2015)	A literature review on immersive virtual reality in education: State of the art and perspectives	589	53.55	42.41
5	Sardi et al. (2017)	A systematic review of gamification in e-health	505	56.11	40.82
6	Qian and Clark (2016)	Game-based learning and 21st century skills: A review of recent research	492	49.20	35.31
7	Dichev and Dicheva (2017)	Gamifying education: What is known, what is believed and what remains uncertain: A critical review	491	54.56	39.69
8	Arnab et al., 2015)	Mapping learning and game mechanics for serious games analysis	446	40.55	32.12
9	Sailer and Homner (2020)	The gamification of learning: A meta-analysis	441	73.50	32.68
10	Voinov et al. (2016)	Modelling with stakeholders–Next generation	388	38.80	27.85

Notes: TC: Total citations; TCpY: TC per year; NTC: Normalized TC.

Table 6. Contribution of institutions

Affiliation	Scopus	WoS
North Carolina State University	176	193
National Taiwan University of Science and Technology	168	248
University of California	158	-
Aristotle University of Thessaloniki	135	219
National Taiwan Normal University	127	187
Delft University of Technology	106	194
University of Minho	106	198
University of Twente	105	157
University of Central Florida	103	171
Arizona State University	101	151
University Porto	66	193
University Complutense Madrid	65	190
University Utrecht	101	178
University Sao Paulo	29	177

Overall, the leading institutions in the field of GBL are from North America, Asia and Europe. In addition, it is understood that technology and education-oriented universities are more active in this field. The differences in the number of publications between databases may be due to the publication strategies of the institutions and the indexing policies of the databases.

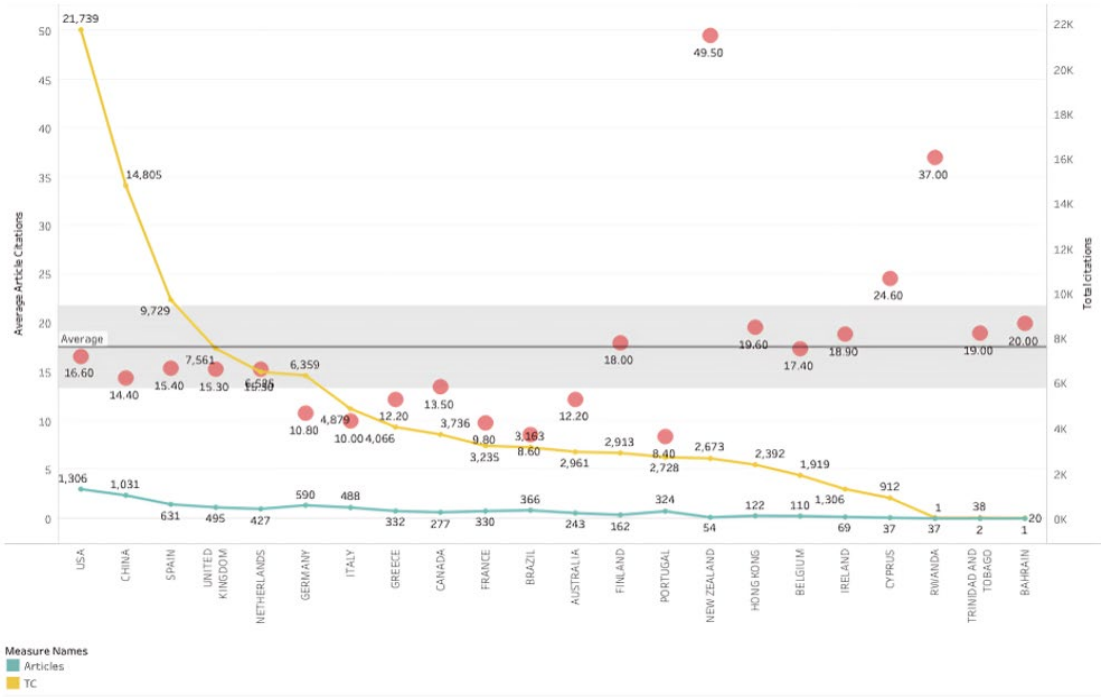

Figure 3. Citation and production based on countries in Scopus (Elaborated by authors)

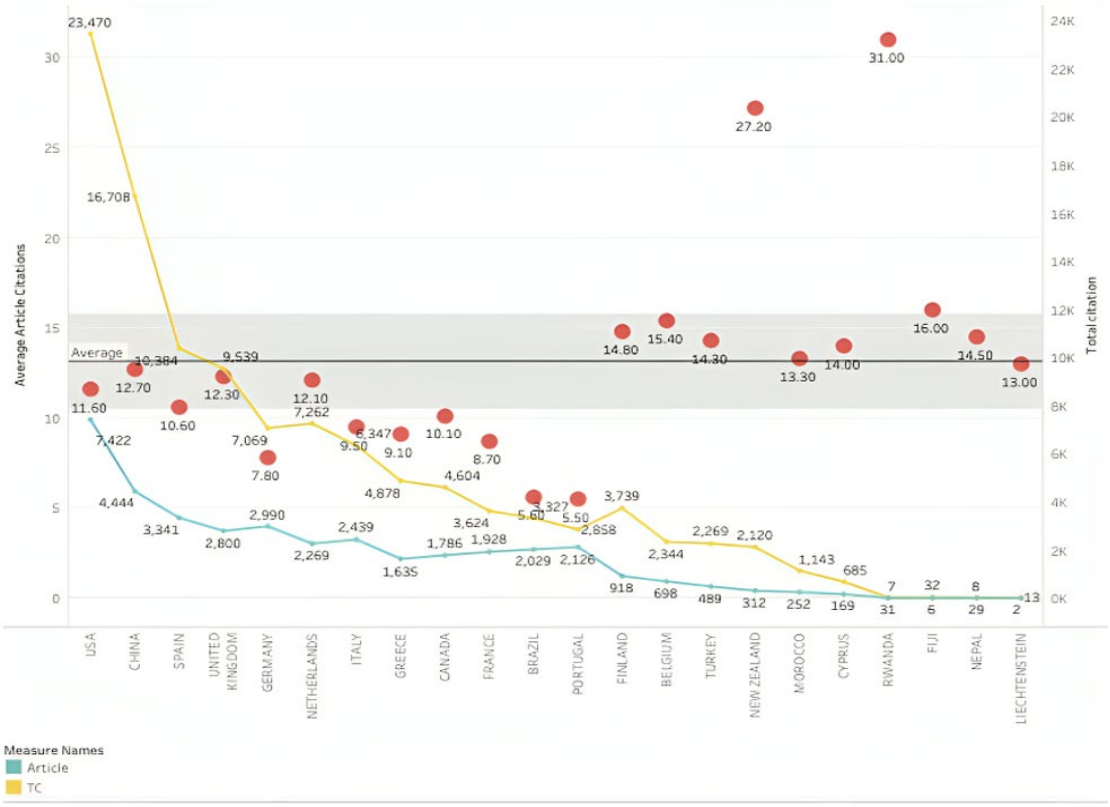

Figure 4. Citation and production based on countries in WoS (Elaborated by authors)

The publication and citation performance of countries in the field of GBL show similar trends in Scopus (**Figure 3**) and WoS (**Figure 4**) databases. In both databases, the USA is the leader in terms of both the number of publications and the total number of citations. It has 1,306 articles and 21,739 citations in Scopus and similarly high numbers in WoS. China, in second place, performs similarly in WoS, with 1031 articles and 14,805 citations in Scopus.

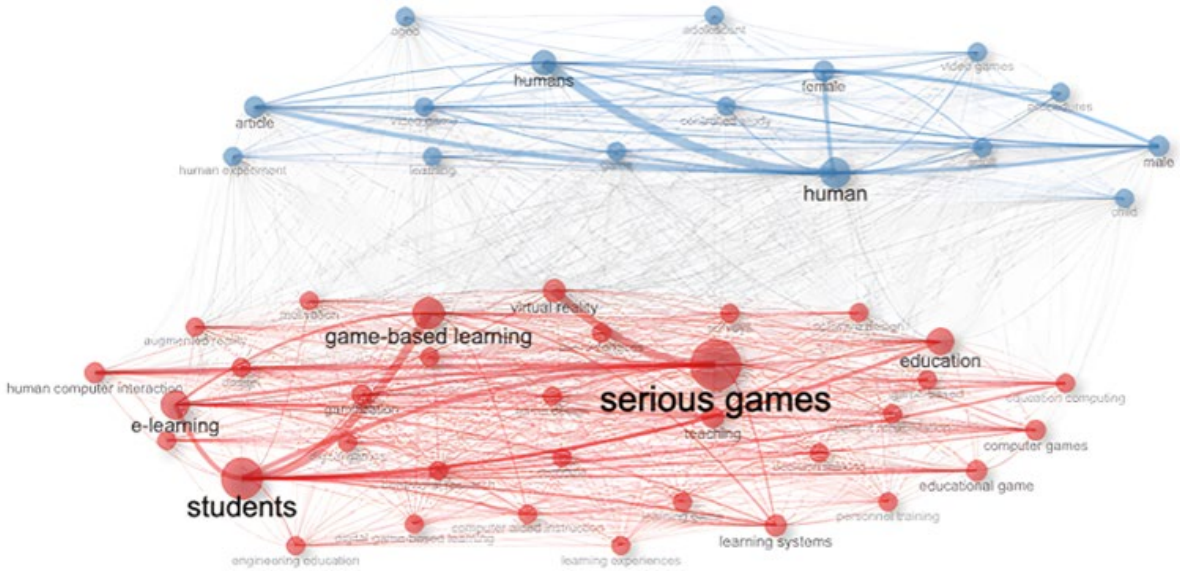

Figure 5. Co-keyword clusters in Scopus (Elaborated by authors)

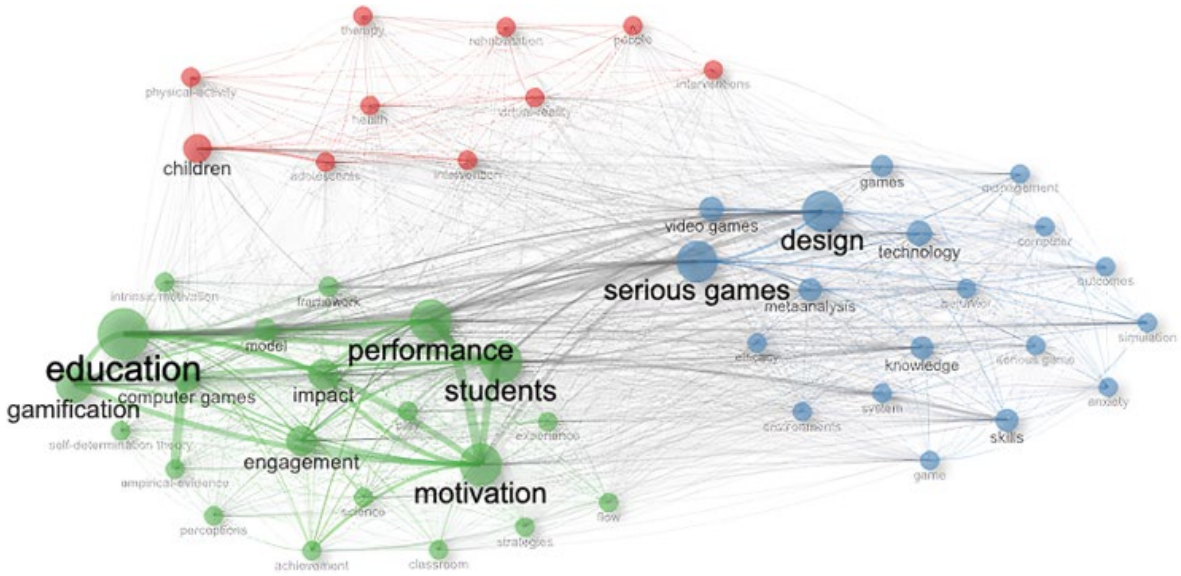

Figure 6. Co-keyword clusters in WoS (Elaborated by authors)

European countries such as Spain, the United Kingdom and the Netherlands make significant contributions in both databases. These nations have modest publishing rates, yet their average citations per piece show amazing levels. For instance, with 631 papers and 9,729 references, Spain comes third in Scopus. Countries with less publications—Bahrain, Trinidad & Tobago, Cyprus—have notably higher average citations per article in both databases. This suggests that these nations generate little but very influential research. For instance, Cyprus 24.60, Trinidad and Tobago 37.00, Bahrain averages 49.50 citations per article in Scopus.

The way that references and articles are distributed in both databases reveals comparable trends generally. Dominance on the field comes from North America, Asia, and Europe. Although the total number of citations and the number of publications usually show a positive correlation, some tiny nations have a strong citation influence. These numbers indicate that GBL is attracting worldwide interest and making important contributions from many locations.

We examined the co-keyword cluster analyses on GBL for Scopus (**Figure 5**) and WoS (**Figure 6**) databases. Firstly, two main clusters stand out in the studies in the Scopus database. The blue-colored clusters represent human-oriented studies and the red-colored clusters represent GBL and serious games. In the Scopus

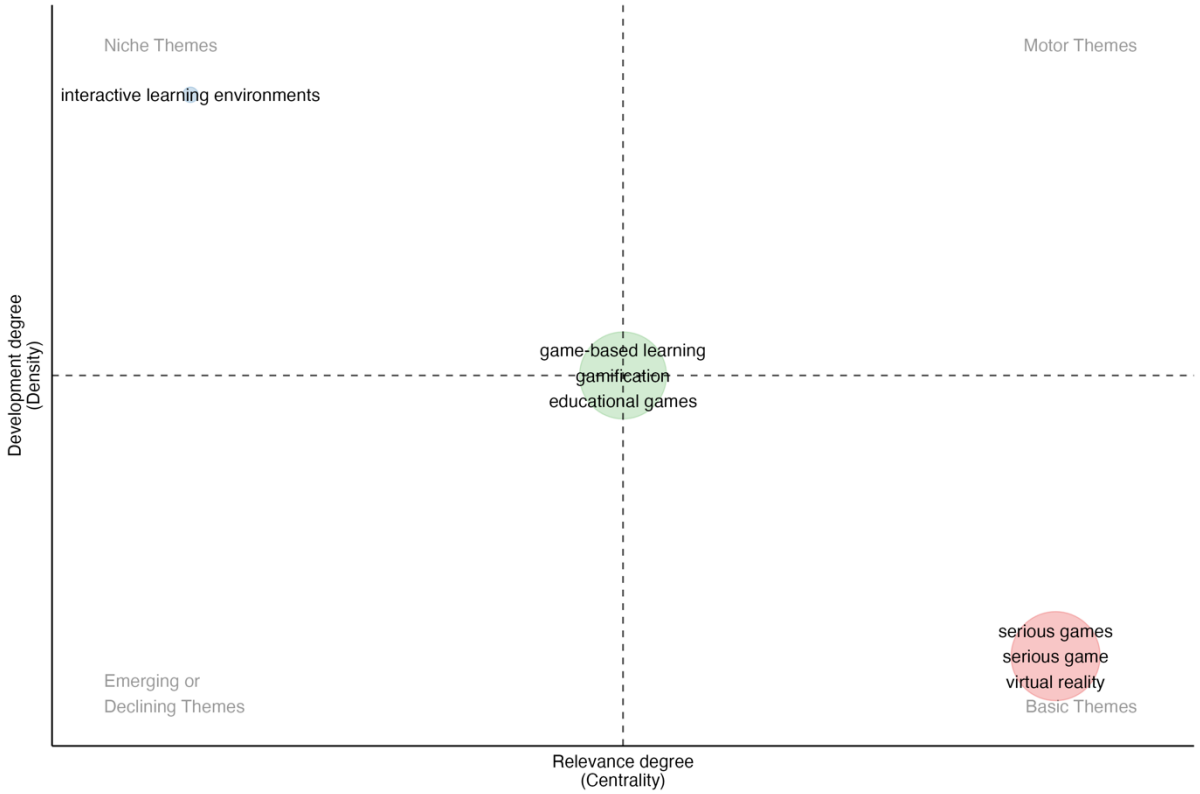

Figure 7. Thematic map based on keywords in Scopus (Elaborated by authors)

database, the keywords “serious games” and “game-based learning” are at the center of the network. In addition, the word “students” shows strong links with other concepts and emphasizes the target audience of educational games. In this database, e-learning and virtual reality also stand out as important sub-topics.

In the network structure of the WoS database, there are three different clusters indicated by the colors green, red and blue. The green cluster includes the topics of education and motivation and contains the words “education”, “motivation” and “performance”. The blue cluster is centered around the words “design” and “technology” and represents the technical aspects of the studies. The red cluster includes health applications and the word “children” indicates the target audience in this field.

When the two databases are compared, significant differences stand out. While research in Scopus is divided into two main clusters: human factors and educational applications, research in WoS is divided into three different clusters: education-motivation, health-rehabilitation and technology-design. In both databases, the concept of “serious games” stands out as an important research area.

While research in WoS focuses more on learning processes (motivation, performance, engagement), research in Scopus emphasizes more on human factors and educational practices. In addition, the fact that the studies in the WoS database are divided into three different clusters shows that research in this field is conducted in a wider range of different disciplines. This reveals that GBL is studied in more diverse application areas in WoS.

The thematic map in the Scopus database (**Figure 7**) shows four distinct regions. Educational games, GBL and gamification are among the central and emerging themes. These themes have a high density value. Interactive learning environments are located in the niche themes zone. Serious games and virtual reality are located in the core themes. This indicates that these topics are established and mature research topics in the field.

In the thematic map in the WoS database (**Figure 8**), the distribution of themes varies. Serious games and virtual reality are located in the niche themes region, while GBL, gamification and learning are located in the core themes region. This suggests that GBL and gamification are more mature and established research areas in the WoS.

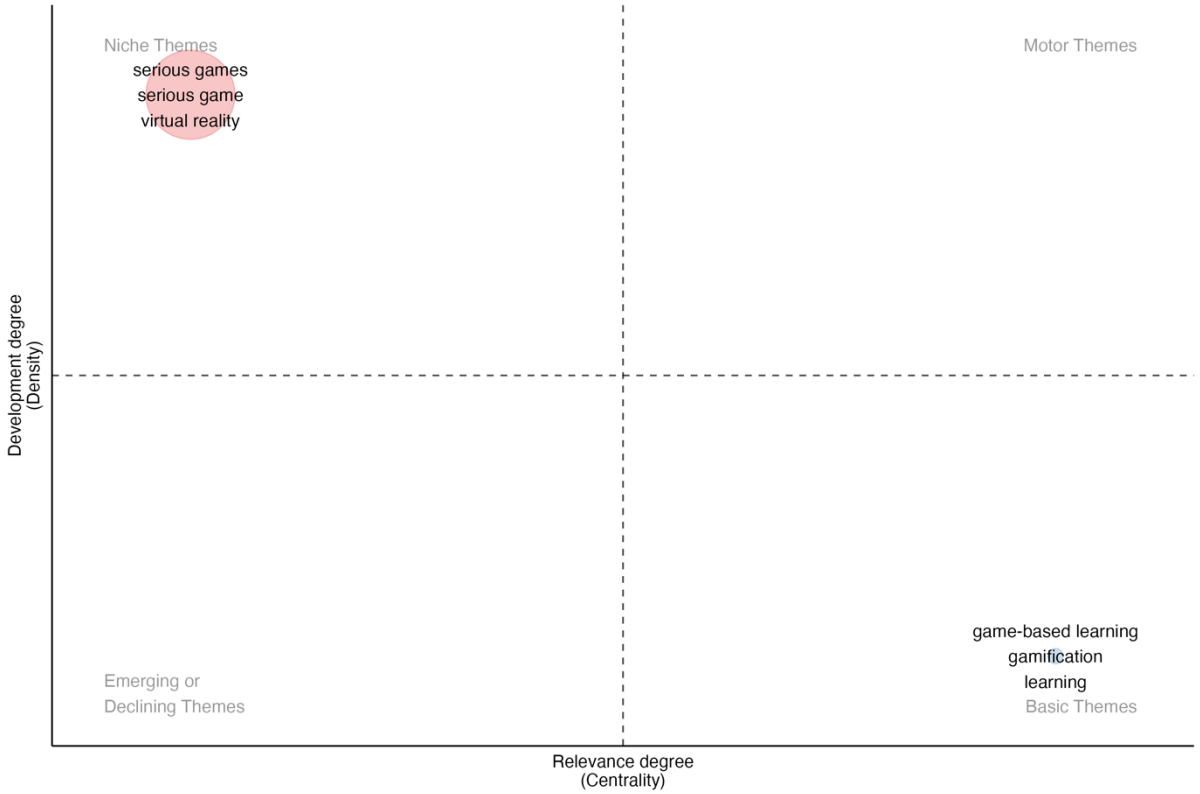

Figure 8. Thematic map based on keywords in WoS (Elaborated by authors)

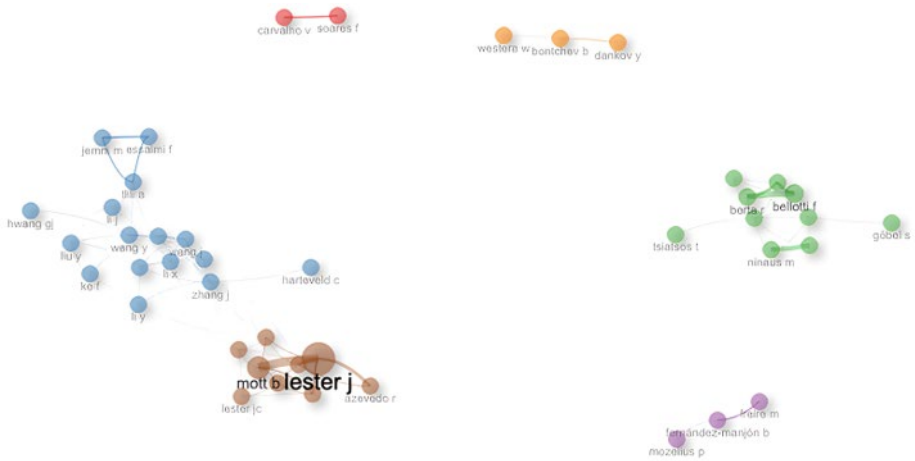

Figure 9. Collaboration network in Scopus (Elaborated by authors)

Interesting differences emerge when comparing the two databases. GBL and gamification, which is seen as an emerging theme in Scopus, appears as a core theme in WoS. Similarly, serious games, which is a core theme in Scopus, is positioned as a niche theme in WoS. This is due to the differences in the journals and research areas covered by the two databases.

The results show that research in the field of GBL is at different levels of maturity in both databases. For researchers, especially the topics in niche themes indicate potential research areas for future studies.

Collaboration Network

The collaboration network in the Scopus database (**Figure 9**) shows six different groups of researchers. These groups are represented by different colors. The brown group led by Lester J. is centrally located and has connections with other groups. The blue group is composed of Asian researchers and has strong

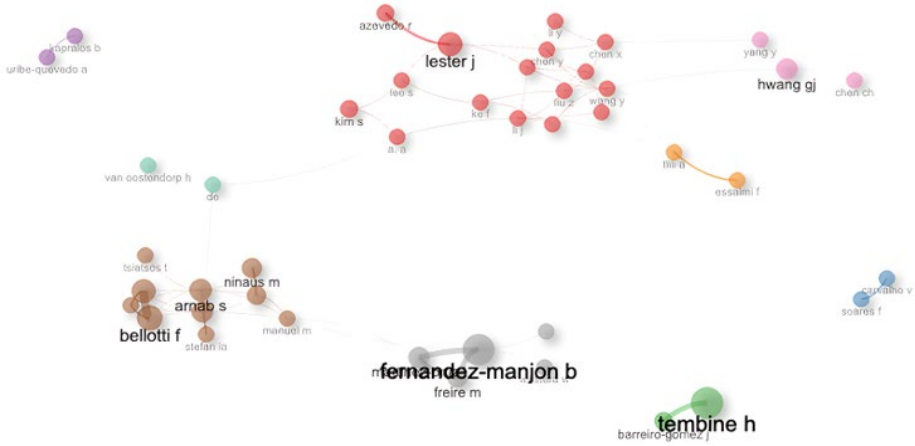

Figure 10. Collaboration network in WoS (Elaborated by authors)

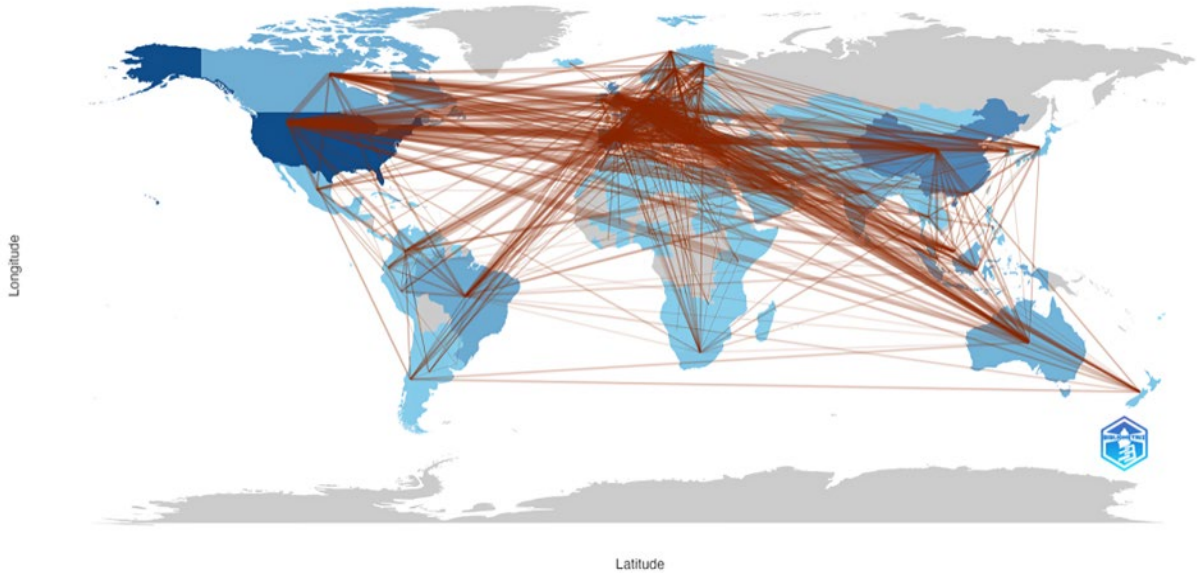

Figure 11. Country collaboration map in Scopus (Elaborated by authors)

connections within the network. The green, orange and purple groups represent smaller communities of researchers.

In the collaboration network in the WoS database (**Figure 10**), there are nine different groups of researchers. The Lester, J. group (red) and the Bellotti, F. group (brown) constitute the largest collaboration networks. The groups led by Fernandez-Manjon, B. and Tembine, H. (gray and green) represent smaller but important collaboration networks. The groups shown in other colors consist of a smaller number of researchers.

Comparing the two databases, some important differences stand out. Lester J. appears to be an important researcher in both databases. However, the collaboration networks are structured differently. While there are more centralized and interconnected groups in Scopus, the groups in WoS seem to be more independent and discrete. This reflects the tendency of researchers to publish in different journals.

Links between groups are weaker in the collaboration network in WoS. This indicates that research groups work more independently. The network in Scopus, on the other hand, is more interconnected, indicating that interdisciplinary studies are more common. The co-researchers seen in both databases can be considered as the leading names in the field. Their work plays an important role in the development of the field of GBL.

In the country collaboration network in the Scopus database (**Figure 11**), the USA and European countries occupy a central position. The red lines on the map indicate collaboration links. There are particularly dense

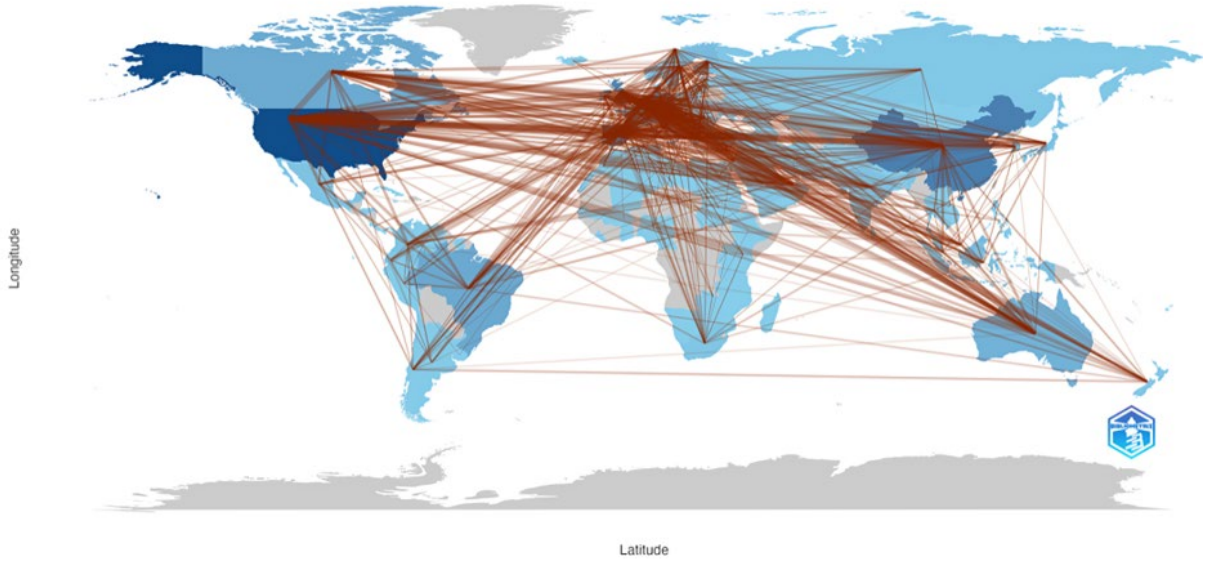

Figure 12. Country collaboration map in WoS (Elaborated by authors)

collaboration networks between the US, the UK, Spain and Germany. In the Asia-Pacific region, China, Japan and South Korea stand out as important cooperation hubs. Australia also appears to be a regional collaboration center.

The country collaboration map in the WoS database (**Figure 12**) shows a similar structure. However, there are also some differences. Collaboration ties between the USA and European countries are more intense. The collaboration network between South American countries is more prominent. There are also more cooperation links between Southeast Asian countries.

Comparing the two databases, both show that North American and European countries are the leaders in GBL research. Collaboration networks between developing countries and countries in Africa are weaker. This reflects the unequal distribution of research opportunities and resources.

South American and Asian countries are trying to increase their research capacity in this area by collaborating with developed countries. Particularly China comes out as a significant study partner for both databases. Acting as link between Asia-Pacific countries, Australia and New Zealand enhance regional cooperation.

These results imply that although GBL research is spreading internationally, geographical and financial elements shape cooperation networks. Future developments of the area should reflect the involvement of developing nations in particular in these networks.

DISCUSSION

General Trends of Game-Based Learning Research

According to the bibliometric research carried out in this paper, GBL is attracting more and more attention between 2015 and 2024. The results show that although the WoS database saw a dramatic drop in 2020, the number of publications in the Scopus database shows a constant increasing trend. This could show differences in database content coverage as well as the consequences of the COVID-19 outbreak on scholarly publication. Similar growing interest in GBL and 21st century abilities was seen by Qian and Clark (2016).

Reviewing the citation analysis shows that studies published between 2015 and 2018 had greater rates in both databases. Particularly in 2020, the average annual citation count was noted to rise. This may be associated with the increasing interest in digital learning approaches during the pandemic period. The fact that Hamari et al.'s (2016) study on flow and engagement in GBL is the most cited study in both databases shows the importance of the concepts of motivation and engagement in the field.

Scope Differences Between Scopus and WoS Databases

The higher citation counts observed in Scopus (average 10.18 citations per document) compared to WoS (9.36) can be attributed to significant differences in content coverage and indexing policies. Scopus includes substantially more conference proceedings (9,335 vs. 7,012) and book chapters (967 vs. 21), which are important publication venues in GBL research. Educational technology conferences such as ECGBL serve as primary platforms for early research dissemination, often generating citations before journal publication. This broader content coverage creates additional citation opportunities and cross-referencing within the field. Similarly, the systematic review drew attention to the use of different types of publications in GBL research.

The dramatic decline in WoS publications during 2020 (from 1,927 in 2019 to 1,346) likely reflects COVID-19's impact on academic publishing, while Scopus maintained steady growth throughout the pandemic period. WoS' focus on established, high-impact journals made it more susceptible to pandemic-related publication delays and editorial disruptions. Additionally, the temporary shift in academic priorities toward COVID-19-related research may have affected GBL publication patterns. Notably, both databases showed increased citation rates in 2020, suggesting heightened interest in digital learning technologies during the pandemic, followed by recovery in subsequent years indicating the resilience of the research field.

Conceptual Structure and Research Frontier of Game-Based Learning

The co-keyword analysis reveals significant differences in the conceptual structure of GBL research across databases, which can be explained by disciplinary focus and journal coverage patterns. In Scopus, research is organized into two main clusters: human-centered studies and GBL/serious games, reflecting the field's emphasis on user experience and practical applications. Conversely, WoS displays three distinct clusters: education-motivation, health-rehabilitation, and technology-design, indicating a more diverse disciplinary approach where GBL research intersects with educational psychology, health sciences, and technical development. This diversification aligns with findings by Tekman and Yeniasır (2023), who emphasized the impact of GBL on communication and teamwork skills, demonstrating the field's expansion beyond traditional cognitive learning outcomes.

The divergent positioning of "serious games" exemplifies these differences—appearing as a core theme in Scopus but as a niche theme in WoS. This reflects Scopus' stronger representation of educational technology venues and industry-academia collaborations where serious games have matured as established implementation tools. WoS' positioning of serious games as a niche reflects its emphasis on traditional educational research journals that may treat serious games as a specialized application rather than a core concept. Similarly, while "gamification" appears as an emerging theme in Scopus, it is positioned as a core theme in WoS, suggesting different levels of theoretical consolidation across academic communities. These patterns indicate that GBL research exists at different maturity stages depending on disciplinary perspective, with technological applications (emphasized in Scopus) potentially outpacing theoretical development in traditional educational frameworks (focused in WoS). This evolution mirrors broader trends in educational technology research, where practical implementations often precede comprehensive theoretical frameworks (Boghian & Cojocariu, 2023; Zhao et al., 2022).

Collaboration Dynamics and Strategies for Global Research Equity

The collaboration network analysis reveals that North American, European, and Asian countries dominate GBL research, with the United States leading in both publication counts and citations across databases. Strong collaborative ties exist among developed countries, particularly between the US, UK, Spain, and Germany, while collaboration networks between developing countries and African nations remain significantly weaker. This pattern aligns with broader trends in educational technology research, where resource availability and technological infrastructure influence research capacity (Petrović et al., 2022; Trinidad et al., 2021).

To address these global research inequities, several strategic interventions are necessary. First, targeted funding initiatives should prioritize partnerships between developed and developing countries, creating capacity-building grants specifically for GBL research infrastructure in underrepresented regions. As emphasized by Boghian and Cojocariu (2023), international cooperation plays a crucial role in developing social-emotional skills through GBL, highlighting the importance of diverse cultural perspectives in research.

Second, open access mandates and technical infrastructure support can democratize knowledge sharing, while mentorship programs connecting established researchers with emerging scholars from developing countries can build sustainable research networks. Finally, culturally responsive research frameworks should encourage context-specific studies that address local educational challenges, recognizing that GBL effectiveness may vary across different cultural and socioeconomic contexts (Ali et al., 2023). These strategies acknowledge that global research equity is essential not just for inclusion, but for harnessing diverse perspectives to advance GBL in ways that serve all learners worldwide.

Common Characteristics of High Impact Studies and Their Role in the Field

The fact that the majority of the most cited studies are systematic reviews, meta-analyses or literature reviews shows the need to develop the theoretical foundations of the field and to consolidate existing knowledge. The study by Hamari et al. (2016) reveals important findings on student engagement and motivation in GBL, while Plass et al.'s (2015) study defines the basic principles of the field.

These studies generally focus on the effectiveness of GBL, student engagement and motivation, and the relationships between game mechanics and learning principles. Meta-analysis (Sailer & Homner, 2020) focuses on the effects of gamification on learning, with high annual citation rates indicating the growing interest in this topic. The study by Arnab et al. (2015) also provides a valuable framework for the analysis of serious games by matching learning mechanics and game mechanics.

Interdisciplinary Approaches to Game-Based Learning Research

The importance of interdisciplinary approaches in GBL research is evident in both the common keyword analysis and thematic maps. Three distinct clusters in the WoS database (education-motivation, health-rehabilitation, and technology-design) illustrate the field's interaction with different disciplines. This finding is in line with the findings of Zhao et al. (2022) on the role of GBL in STEM education.

The interdisciplinary collaboration between health sciences, computer sciences and educational sciences is particularly noteworthy. Systematic review by Sardi et al. (2017) on gamification in e-health is among the most cited studies. Dahalan et al. (2024) also stated that simulations in vocational education provide practical experiences and students have the opportunity to improve their professional skills. These findings emphasize the interactive nature of GBL in different disciplines.

Gaps Between Theoretical Frameworks and Practices

The findings show that there is a significant gap between theoretical frameworks and applied research in the field of GBL. A large proportion of the most cited studies focus on developing theoretical frameworks, while implementation-oriented studies are cited less frequently. This suggests that theoretical frameworks, such as Arnab et al.'s (2015) Learning Mechanics-Game Mechanics approach, are not sufficiently integrated into applied studies.

Moreover, systematic approaches such as the Digital Educational Game Lifecycle proposed by Wan Mohd Isa et al. (2022) are underutilized in applied studies, despite providing an important framework for more effective development of educational games. This gap suggests the need for stronger links between theoretical knowledge and practical experiences.

Trends in Research Methods and Methodological Issues

The diversity of methodological approaches in GBL research draws attention. The distribution of publication types in the findings shows that both experimental and theoretical studies have been conducted in the field. However, as emphasized by Kim et al. (2022) and Stohlmann (2022), there are methodological problems in consistently planning assessment tools and measuring student learning outcomes.

Furthermore, Hwang et al. (2023) emphasized that technical and logistical challenges need to be addressed to effectively integrate GBL approaches into the curriculum. Similarly, Ali et al. (2023) emphasized the need for technological infrastructure and resources. These findings suggest that there is a need to overcome methodological issues and develop stronger research designs in GBL research.

For future research, studies focusing specifically on long-term impact studies, the effectiveness of GBL in different student groups, and the impact of game design on learning outcomes are recommended. Furthermore, examining GBL practices in developing countries and investigating the impact of cultural differences will expand the body of knowledge in the field.

CONCLUSION

This study provides a bibliometric analysis of publications related to GBL from 2015 to 2024. It examined the current status and expansion trends of GBL. Scopus and WoS databases were used for the analysis. The results show that GBL has expanded in the last decade and has been applied in many different disciplines. The findings of the study reveal that research that focuses on student engagement and motivation, such as Hamari et al.'s (2016) study, are the most effective studies in the field. This highlights the student-centered nature and motivational impact of GBL.

Bibliometric analysis shows that research in the field of GBL is concentrated in the USA, China and European countries, but international collaborations are increasing. Journals such as "Computers and Education" and "JMIR Serious Games" play a leading role in the field of GBL, and authors such as Hwang G. J. have made significant contributions to the field. In terms of research topics, serious games, virtual reality, gamification and interactive learning environments are prominent themes. Comparative analyses between Scopus and WoS databases show that Scopus has a broader content coverage, but the core structure of the field is similar in both databases.

Although this research provides a comprehensive bibliometric analysis, it has some limitations. First, the study only includes publications indexed in Scopus and WoS databases. Therefore, studies in other databases or non-indexed journals were excluded from the analysis. Secondly, the study only includes studies published in English, which leads to the omission of contributions in other languages. Furthermore, since bibliometric analyses are based on quantitative indicators such as the number of publications and citation rates, the assessment of the content and quality of the studies is limited. Finally, the limited time span of the analysis (2015-2024) may not fully reflect the long-term development of the field.

Future researchers can conduct field-specific or general studies to address the gaps in the field of GBL. In this context, studies evaluating the effectiveness of GBL in different socioeconomic and cultural contexts can be conducted. In particular, the field of expertise will be expanded by examining GBL initiatives in underdeveloped nations. Second, empirical research exploring in-depth the link between game design aspects and learning outcomes is much needed. Long-term impact research will show how GBL affects lifetime learning. Moreover, studies can help to close the distance between theoretical models and practical investigation. Finally, research examining the integration of emerging technologies such as artificial intelligence and augmented reality with GBL will shape the future of the field. Studies to be conducted in line with these suggestions will make significant contributions to the development of the field of GBL.

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REFERENCES

Alarcon Fortepiani, M. (2023). Impact of game-based learning strategies in student engagement in health professions education. *Physiology, 38*(S1). https://doi.org/10.1152/physiol.2023.38.S1.5735283

Ali, K., Burgos, D., & Affouneh, S. (2023). Educational loss at times of crisis: The role of games in students' learning in Palestine and Iraq. *Sustainability, 15*(6), Article 4983. https://doi.org/10.3390/su15064983

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

Arnab, S., Lim, T., Carvalho, M. B., Bellotti, F., de Freitas, S., Louchart, S., Suttie, N., Berta, R., & De Gloria, A. (2015). Mapping learning and game mechanics for serious games analysis. *British Journal of Educational Technology, 46*(2), 391–411. https://doi.org/10.1111/bjet.12113

Aslan, S., & Balci, O. (2015). GAMED: Digital educational game development methodology. *SIMULATION, 91*(4), 307–319. https://doi.org/10.1177/0037549715572673

Avci, H., Pedersen, S., & Thomas, A. (2024). Reflections of art history instructors on an educational digital game: A narrative case study. *Journal of Digital Educational Technology, 4*(1), Article ep2404. https://doi.org/10.30935/jdet/14116

Bakhsh, K., Hafeez, M., Shahzad, S., Naureen, B., & Farid, M. F. (2022). Effectiveness of digital game based learning strategy in higher educational perspectives. *Journal of Education and E-Learning Research, 9*(4), 258–268. https://doi.org/10.20448/jeelr.v9i4.4247

Boghian, I., & Cojocariu, V.-M. (2023). Using games to build social emotional learning skills. *Revista Romaneasca Pentru Educatie Multidimensionala, 15*(1), 622–656. https://doi.org/10.18662/rrem/15.1/715

Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., Lim, T., Ninaus, M., Ribeiro, C., & Pereira, J. (2016). An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Computers and Education, 94*, 178–192. https://doi.org/10.1016/j.compedu.2015.11.003

Callaghan, M. J., McShane, N., Eguiluz, A. G., Teilles, T., & Raspail, P. (2016). Practical application of the learning mechanics-game mechanics (LM-GM) framework for serious games analysis in engineering education. In *Proceedings of the 2016 13th International Conference on Remote Engineering and Virtual Instrumentation* (pp. 391–395). https://doi.org/10.1109/REV.2016.7444510

Callon, M., Courtial, J.-P., Turner, W. A., & Bauin, S. (1983). From translations to problematic networks: An introduction to co-word analysis. *Social Science Information, 22*(2), 191–235. https://doi.org/10.1177/053901883022002003

Chan, K., Wan, K., & King, V. (2021). Performance over enjoyment? Effect of game-based learning on learning outcome and flow experience. *Frontiers in Education, 6*. https://doi.org/10.3389/feduc.2021.660376

Chen, C. H., & Syu, J. Y. (2024). Effects of integrating a role-playing game into a virtual reality-based learning approach on students' perceptions of immersion, self-efficacy, learning motivation and achievements. *British Journal of Educational Technology, 55*(5), 2339–2356. https://doi.org/10.1111/bjet.13436

Chen, M. B., Wang, S. G., Chen, Y. N., Chen, X. F., & Lin, Y. Z. (2020a). A preliminary study of the influence of game types on the learning interests of primary school students in digital games. *Education Sciences, 10*(4), Article 96. https://doi.org/10.3390/educsci10040096

Chen, S., Zhang, S., Qi, G. Y., & Yang, J. (2020b). Games literacy for teacher education: Towards the implementation of game-based learning. *Educational Technology & Society, 23*(2), 77–92.

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the fuzzy sets theory field. *Journal of Informetrics, 5*(1), 146–166. https://doi.org/10.1016/j.joi.2010.10.002

Czikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper & Row.

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

Deng, L., Wu, S., Chen, Y., & Peng, Z. (2020). Digital game-based learning in a Shanghai primary-school mathematics class: A case study. *Journal of Computer Assisted Learning, 36*(5), 709–717. https://doi.org/10.1111/jcal.12438

Deshpande, A. A., & Huang, S. H. (2011). Simulation games in engineering education: A state-of-the-art review. *Computer Applications in Engineering Education, 19*(3), 399–410. https://doi.org/10.1002/cae.20323

Dichev, C., & Dicheva, D. (2017). Gamifying education: What is known, what is believed and what remains uncertain: A critical review. *International Journal of Educational Technology in Higher Education, 14*, Article 9. https://doi.org/10.1186/s41239-017-0042-5

Dimitra, K., Konstantinos, K., Christina, Z., & Katerina, T. (2020). Types of game-based learning in education: A brief state of the art and the implementation in Greece. *The European Educational Researcher, 3*(2), 87–100. https://doi.org/10.31757/euer.324

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

Egghe, L. (2006). Theory and practise of the g-index. *Scientometrics, 69*(1), 131–152. https://doi.org/10.1007/s11192-006-0144-7

Foster, A., & Shah, M. (2015). The ICCE framework: Framing learning experiences afforded by games. *Journal of Educational Computing Research, 51*(4), 369–395. https://doi.org/10.2190/EC.51.4.a

Freina, L., & Ott, M. (2015). A literature review on immersive virtual reality in education: State of the art and perspectives. In *Proceedings of the International Scientific Conference E-Learning and Software for Education* (pp. 133–141). https://doi.org/10.12753/2066-026X-15-020

Gardner, H., & Moran, S. (2006). The science of multiple intelligences theory: A response to Lynn Waterhouse. *Educational Psychologist, 41*(4), 227–232. https://doi.org/10.1207/s15326985ep4104_2

Garmen, P., Rodríguez, C., García-Redondo, P., & San-Pedro-Veledo, J. C. (2019). Multiple intelligences and video games: Assessment and intervention with TOI software. *Comunicar, 27*(58), 95–104. https://doi.org/10.3916/C58-2019-09

Glänzel, W., & Schubert, A. (2004). Analysing scientific networks through co-authorship. In H. F. Moed, W. Glänzel, & U. Schmoch (Eds.), *Handbook of quantitative science and technology research: The use of publication and patent statistics in studies of S&T systems* (pp. 257–276). Springer. https://doi.org/10.1007/1-4020-2755-9_12

Gordillo, A., Lopez-Fernandez, D., & Tovar, E. (2022). Comparing the effectiveness of video-based learning and game-based learning using teacher-authored video games for online software engineering education. *IEEE Transactions on Education, 65*(4), 524–532. https://doi.org/10.1109/TE.2022.3142688

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior, 54*, 170–179. https://doi.org/10.1016/j.chb.2015.07.045

Hanghøj, T., Hajslund, S., & Ejsing-Duun, S. (2022). The challenges of designing learning games: Interviewing professional learning game designers. *European Conference on Games Based Learning, 16*(1), 263–270. https://doi.org/10.34190/ecgbl.16.1.669

Haruna, H., Hu, X., Chu, S. K. W., Mellecker, R. R., Gabriel, G., & Ndekao, P. S. (2018). Improving sexual health education programs for adolescent students through game-based learning and gamification. *International Journal of Environmental Research and Public Health, 15*(9), Article 2027. https://doi.org/10.3390/ijerph15092027

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences, 102*(46), 16569–16572. https://doi.org/10.1073/pnas.0507655102

Holbrey, C. E. (2020). Kahoot! Using a game-based approach to blended learning to support effective learning environments and student engagement in traditional lecture theatres. *Technology, Pedagogy and Education, 29*(2), 191–202. https://doi.org/10.1080/1475939X.2020.1737568

Hsu, T. C., Chang, S. C., & Hung, Y. T. (2018). How to learn and how to teach computational thinking: Suggestions based on a review of the literature. *Computers and Education, 126*, 296–310. https://doi.org/10.1016/j.compedu.2018.07.004

Hwang, G.-H., Chen, B., & Chen, S.-P. (2023). Impacts of digital game-based flipped teaching approach on learning effectiveness of the students with different prior knowledge levels. *Interactive Learning Environments, 32*(9), 5156–5173. https://doi.org/10.1080/10494820.2023.2211630

Jackson, G. T., & McNamara, D. S. (2013). Motivation and performance in a game-based intelligent tutoring system. *Journal of Educational Psychology, 105*(4), 1036–1049. https://doi.org/10.1037/a0032580

Kim, Y. J., Valiente, J. A. R., Ifenthaler, D., Harpstead, E., & Rowe, E. (2022). Analytics for game-based learning. *Journal of Learning Analytics, 9*(3), 8–10. https://doi.org/10.18608/jla.2022.7929

Lai, C. H., Lin, Y. C., Jong, B. S., & Hsia, Y. T. (2014). Adding social elements to game-based learning. *International Journal of Emerging Technologies in Learning, 9*(3), 12–15. https://doi.org/10.3991/ijet.v9i3.3294

Lester, D., Skulmoski, G. J., Fisher, D. P., Mehrotra, V., Lim, I., Lang, A., & Keogh, J. W. L. (2023). Drivers and barriers to the utilisation 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

Li, R. (2021). Does game-based vocabulary learning APP influence Chinese EFL learners' vocabulary achievement, motivation, and self-confidence? *SAGE Open, 11*(1). https://doi.org/10.1177/21582440211003092

Liu, F. J., & Lu, C. M. (2021). Design and implementation of a collaborative educational gamification authoring system. *International Journal of Emerging Technologies in Learning, 16*(17), 277–289. https://doi.org/10.3991/ijet.v16i17.24087

Ma, J., Zhang, Y., Zhu, Z., Zhao, S., & Wang, Q. (2023). Game-based learning for students' computational thinking: A meta-analysis. *Journal of Educational Computing Research, 61*(7), 1430–1463. https://doi.org/10.1177/07356331231178948

Mettarikanon, D., Tawanwongsri, W., Wanchai, A., & Chookerd, N. (2023). Comparison of the efficacy between game-based learning and pamphlet on enhancing recognition of common cutaneous malignancies in Thai younger adults. *Contemporary Educational Technology, 15*(2), Article ep419. https://doi.org/10.30935/cedtech/13013

Natucci, G. C., & Borges, M. A. F. (2021). Balancing pedagogy, emotions and game design in serious game development. In *Proceedings of the 20th Brazilian Symposium on Games and Digital Entertainment* (pp. 1013–1016). https://doi.org/10.5753/sbgames_estendido.2021.19749

Patmanthara, S., Yuliana, O. D., Dwiyanto, F. A., & Wibawa, A. P. (2019). The use of ladder snake games to improve learning outcomes in computer networking. *International Journal of Emerging Technologies in Learning, 14*(21), 243–249. https://doi.org/10.3991/ijet.v14i21.10953

Petrović, L., Stojanović, D., Mitrović, S., Barać, D., & Bogdanović, Z. (2022). Designing an extended smart classroom: An approach to game-based learning for IoT. *Computer Applications in Engineering Education, 30*(1), 117–132. https://doi.org/10.1002/cae.22446

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist, 50*(4), 258–283. https://doi.org/10.1080/00461520.2015.1122533

Proulx, J. N., Romero, M., & Arnab, S. (2017). Learning mechanics and game mechanics under the perspective of self-determination theory to foster motivation in digital game based learning. *Simulation and Gaming, 48*(1), 81–97. https://doi.org/10.1177/1046878116674399

Qian, M., & Clark, K. R. (2016). Game-based learning and 21st century skills: A review of recent research. *Computers in Human Behavior, 63*, 50–58. https://doi.org/10.1016/j.chb.2016.05.023

Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review, 32*(1), 77–112. https://doi.org/10.1007/s10648-019-09498-w

Sardi, L., Idri, A., & Fernández-Alemán, J. L. (2017). A systematic review of gamification in e-health. *Journal of Biomedical Informatics, 71*, 31–48. https://doi.org/10.1016/j.jbi.2017.05.011

Selvi, M., & Çoşan, A. Ö. (2018). The effect of using educational games in teaching kingdoms of living things. *Universal Journal of Educational Research, 6*(9), 2019–2028. https://doi.org/10.13189/ujer.2018.060921

Shernoff, D. J., Ryu, J. C., Ruzek, E., Coller, B., & Prantil, V. (2020). The transportability of a game-based learning approach to undergraduate mechanical engineering education: Effects on student conceptual understanding, engagement, and experience. *Sustainability, 12*(17), Article 6986. https://doi.org/10.3390/su12176986

Stack, M., & Bunt, B. (2023). Developing a game-based learning pedagogy for teaching history using Napoleon total war. *Yesterday and Today, 30*(1), 9–35. https://doi.org/10.17159/2223-0386/2023/n30a2

Stohlmann, M. (2022). Two modes of game-based learning for middle school mathematics. *Journal of Mathematics Education at Teachers College, 12*(2), 9–20. https://doi.org/10.52214/jmetc.v12i2.7561

Sun, L., Kangas, M., & Ruokamo, H. (2023). Game-based features in intelligent game-based learning environments: A systematic literature review. *Interactive Learning Environments, 32*(7), 3431–3447. https://doi.org/10.1080/10494820.2023.2179638

Tay, J., Goh, Y. M., Safiena, S., & Bound, H. (2022). Designing digital game-based learning for professional upskilling: A systematic literature review. *Computers and Education, 184*, Article 104518. https://doi.org/10.1016/j.compedu.2022.104518

Tekman, T. K., & Yeniasır, M. (2023). The impact of play-based learning settings on reading, writing, listening, and speaking skills. *Sustainability, 15*(12), Article 9419. https://doi.org/10.3390/su15129419

Tlili, A., Denden, M., Essalmi, F., Jemni, M., Kinshuk, Chen, N. S., & Huang, R. (2019). Does providing a personalized educational game based on personality matter? A case study. *IEEE Access, 7*, 119566–119575. https://doi.org/10.1109/ACCESS.2019.2936384

Trinidad, M., Calderon, A., & Ruiz, M. (2021). GoRace: A multi-context and narrative-based gamification suite to overcome gamification technological challenges. *IEEE Access, 9*, 65882–65905. https://doi.org/10.1109/ACCESS.2021.3076291

Tsai, C. Y., Chen, Y. A., Hsieh, F. P., Chuang, M. H., & Lin, C. L. (2024). Effects of a programming course using the GAME model on undergraduates' self-efficacy and basic programming concepts. *Journal of Educational Computing Research, 62*(3), 702–724. https://doi.org/10.1177/07356331231206071

Voinov, A., Kolagani, N., McCall, M. K., Glynn, P. D., Kragt, M. E., Ostermann, F. O., Pierce, S. A., & Ramu, P. (2016). Modelling with stakeholders–Next generation. *Environmental Modelling and Software, 77*, 196–220). https://doi.org/10.1016/j.envsoft.2015.11.016

Wan Mohd Isa, W. A. R., Suhaimi, A. I. H., Noordin, N., & Hassan, S. S. (2022). Mobile game-based learning application about Semai people. *International Journal of Academic Research in Progressive Education and Development, 11*(3), 607–618. https://doi.org/10.6007/ijarped/v11-i3/14759

Wan, K., King, V., & Chan, K. (2021). Examining flow antecedents in game-based learning to promote self-regulated learning and acceptance. *The Electronic Journal of E-Learning, 19*(6), 531–547. https://doi.org/10.34190/ejel.19.6.2117

Wang, K., Liu, P., Zhang, J., Zhong, J., Luo, X., Huang, J., & Zheng, Y. (2023). Effects of digital game-based learning on students' cyber wellness literacy, learning motivations, and engagement. *Sustainability, 15*(7), Article 5716. https://doi.org/10.3390/su15075716

Wang, W. T., & Kartika Sari, M. (2024). Examining the effect of the task-technology fit of game mechanisms on learning outcomes in online gamification platforms. *Journal of Educational Computing Research, 61*(8), 32–59. https://doi.org/10.1177/07356331231187285

Wouters, P., van Nimwegen, C., van Oostendorp, H., & van Der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology, 105*(2), 249–265. https://doi.org/10.1037/a0031311

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review, 30*, Article 100326. https://doi.org/10.1016/j.edurev.2020.100326

Zhao, D., Muntean, C. H., Chis, A. E., Rozinaj, G., & Muntean, G. M. (2022). Game-based learning: Enhancing student experience, knowledge gain, and usability in higher education programming courses. *IEEE Transactions on Education, 65*(4), 502–513. https://doi.org/10.1109/TE.2021.3136914

Zheng, Y., Zhang, J., Li, Y., Wu, X., Ding, R., Luo, X., Liu, P., & Huang, J. (2024). Effects of digital game-based learning on students' digital etiquette literacy, learning motivations, and engagement. *Heliyon, 10*(1), Article e23490. https://doi.org/10.1016/j.heliyon.2023.e23490