

# Exploring Gamification in Education: A Network Visualization of Co-authorship, Co-citations, and Keyword Co-occurrence

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## Abstract

*This study employs network visualization techniques to explore the collaborative and intellectual landscape of gamification research in education. Using a dataset of 2712 peer-reviewed documents retrieved from the Web of Science database and analyzed with VOSviewer, the research identifies key authors, influential works, and emerging themes. The analysis encompasses co-authorship networks, co-citations, and keyword co-occurrence, offering insights into the collaborative relationships among researchers, institutions, and countries. The findings reveal significant clusters of research activity and thematic areas such as motivation, engagement, and design. By mapping these patterns, the study provides actionable recommendations for future research and practical applications, contributing to the ongoing development of gamification in education.*

**Keywords:** Gamification, Education, Network Visualization, Bibliometric Analysis, Collaborative Networks.

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## 1. Introduction

Gamification, the application of game design elements in non-game contexts, has gained significant traction in education, promising to enhance student motivation, engagement, and learning outcomes (Deterding et al., 2011). In educational settings, gamification often incorporates elements such as points, badges, leaderboards, and narrative elements to create immersive learning experiences (Kapp, 2012). The widespread interest in this field has fueled an extensive body of research, with scholars from diverse disciplines contributing to its theoretical underpinnings and practical applications. The increasing scholarly attention on gamification in education calls for a deeper understanding of the research landscape, including the collaborative networks and thematic trends shaping the field. Network visualization methods, which analyze co-authorship, co-citations, and keyword co-occurrence, offer valuable insights into the structure and dynamics

of academic discourse (van Eck & Waltman, 2010). These methods not only highlight influential authors and works but also reveal emerging themes and knowledge gaps, guiding future research efforts.

This study aims to explore the evolving research landscape of gamification in education through network visualization techniques. By analyzing co-authorship networks, co-citation patterns, and keyword co-occurrence, this research seeks to illuminate the intellectual structure of the field and provide a roadmap for scholars and practitioners alike. In doing so, it addresses the need for a comprehensive overview of the academic community's engagement with gamification in education and the theoretical and methodological approaches that underpin this engagement.

## 2. Review of Literature

### 2.1. Gamification in Education

Gamification has gained significant traction as an innovative educational approach, integrating game mechanics into non-game settings to promote learner engagement, motivation, and performance. Its application spans diverse educational contexts, from K-12 to higher education and professional training, with evidence supporting its ability to improve learning outcomes (Hamari et al., 2014). Key gamification elements, such as leaderboards, progress bars, and virtual rewards, have been shown to positively influence intrinsic motivation by fostering a sense of achievement and competition (Seaborn & Fels, 2015). The self-determination theory (SDT) frequently underpins these findings, emphasizing the roles of autonomy, competence, and relatedness in driving motivation (Ryan & Deci, 2000). However, challenges such as over-reliance on extrinsic rewards and the potential for disengagement among less competitive learners underscore the need for thoughtful gamification design (Dichev & Dicheva, 2017).

Recent advancements highlight the importance of adaptive and personalized gamification, where elements are tailored to learners' preferences and skill levels. For instance, dynamic difficulty adjustment and adaptive feedback mechanisms ensure that learning remains challenging yet achievable (Sailer et al., 2017). Moreover, hybrid models combining gamification with emerging technologies, such as augmented reality (AR) and virtual reality (VR), are redefining interactive learning landscapes (Hwang & Chiu, 2022). Despite its growing popularity, research into gamification's long-term effectiveness and scalability remains an area of ongoing investigation.

## 2.2. Network Analysis in Research

Network analysis has emerged as a powerful tool for mapping and analyzing relationships among researchers, concepts, and publications in a given field. Its application to bibliometric studies allows for the visualization of co-authorship, co-citation, and keyword co-occurrence networks, shedding light on collaboration patterns, intellectual structures, and thematic evolution. Co-authorship networks, for

instance, reveal the density and distribution of collaborative relationships, highlighting key contributors and institutions driving research advancements (Newman, 2001).

Co-citation analysis, introduced by Small (1973), is instrumental in identifying influential works and theoretical frameworks within a research domain. By analyzing pairs of documents cited together in subsequent studies, co-citation networks uncover the intellectual roots and foundational theories shaping the field. Similarly, keyword co-occurrence networks capture the frequency and relationships between terms, offering insights into emerging themes and research trends (Zupic & Čater, 2015). These techniques have been extensively applied across disciplines, from healthcare to information science, to track knowledge diffusion and identify research gaps.

## 2.3. Integration of Gamification and Network Analysis

Applying network analysis to gamification research in education is a relatively recent endeavor, providing a systematic means of understanding the collaborative and thematic dimensions of the field. Such studies often reveal clusters of researchers and institutions driving innovation, as well as evolving topics of interest, such as adaptive learning and serious games (Li et al., 2021). By integrating bibliometric data with advanced visualization tools, scholars can uncover latent patterns and generate actionable insights for guiding future research. This dual focus on content and collaboration fosters a more nuanced understanding of gamification's interdisciplinary reach and its intersections with educational psychology, instructional design, and technology.

## 3. Objectives

- Identify and visualize collaborations among researchers, institutions, and countries in gamification research.
- Highlight key works, authors, and theories shaping the field of gamification in education.
- To map thematic trends and emerging research topics in gamification through keyword analysis.

- To provide recommendations for future research and practice based on findings from network visualizations and identifying gaps in the research landscape.

#### 4. Scope and Methodology

The scope is confined to peer-reviewed documents indexed in the Web of Science (WoS) database, ensuring the inclusion of high-quality and impactful research. The dataset was collected from the Web of Science (WoS) database, focusing on research related to gamification in education. A filtering process was applied to ensure relevance, narrowing the scope to

educational contexts. The final dataset consisted of 2712 documents. The extracted data was saved in .text format, compatible with bibliometric analysis tools. This format facilitated seamless import and processing in visualization software. The analysis was conducted using VOSviewer, a powerful software for constructing and visualizing bibliometric networks. The findings provide a comprehensive overview of the collaborative and thematic dimensions shaping the discourse, offering valuable implications for researchers and practitioners.

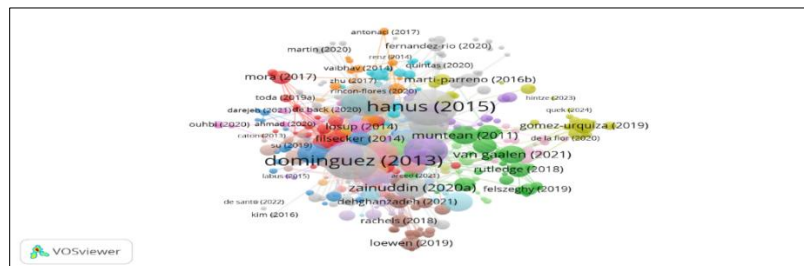
#### 5. Data Analysis and Interpretation

**Table 1. Co-authorship of documents**

Sl.no	Document	Citations	links
1	Dominguez (2013)	951	111
2	Hanus (2015)	945	121
3	Dicheva (2015)	897	85
4	Plass (2015)	596	12
5	Dichev (2017)	477	57
6	De-marcos (2014)	363	55
7	Zainuddin (2020a)	329	57
8	Buckley (2016)	320	36
9	Su (2015)	289	28
10	Wang (2020)	269	7

Table 1 shows the co-authorship of documents highlights influential works in the field of gamification in education. Dominguez (2013) and Hanus (2015) are the most cited works with 951 and 945 citations, respectively, and strong co-authorship networks, indicating significant impact and collaboration. Dicheva (2015) and Dichev (2017) have also made notable contributions, with substantial citation counts and moderate collaborative links. The table also shows

that Hanus (2015) has the highest co-authorship links (121), demonstrating extensive collaboration, while Plass (2015) and Wang (2020) have fewer links, indicating more focused contributions. Recent documents like Zainuddin (2020a) and Wang (2020), though newer, are gaining attention, reflecting active and evolving research in the field. High co-authorship links are associated with greater dissemination and influence, emphasizing the importance of collaboration in advancing research impact.



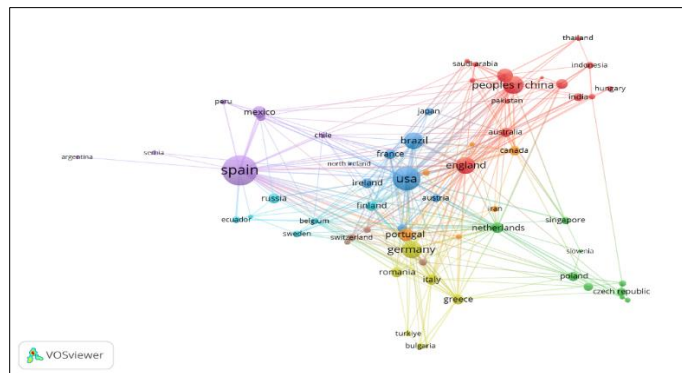
**Figure 1. Network Visualization of Co-authorship of Documents**

**Table 2. Co-authorship of Countries**

Sl. no	Country	Documents	Citations	Total link strength
1	USA	302	6992	95
2	Spain	485	5121	82
3	Peoples R China	176	2900	67
4	Taiwan	102	1630	37
5	England	150	1520	93
6	Germany	160	1288	58
7	Bulgaria	24	929	8
8	Netherlands	62	837	45
9	Brazil	150	830	53
10	Canada	50	797	36

Table 2 reveals the co-authorship of countries' key insights into the global research landscape of gamification in education. The global research landscape of gamification in education is dominated by the USA and Spain, with the USA leading in influence (302 documents, 6992 citations, and highest collaboration strength of 95). Spain produces the most documents (485) but slightly lower impact and

collaboration strength. China and England are key contributors, with England excelling in international collaboration (link strength 93). Bulgaria stands out for high impact despite limited collaboration, while the Netherlands and Brazil balance moderate output with strong networks. Emerging players like Taiwan and Canada are growing contributors. Strong international collaboration, as shown by countries like the USA and England, is a critical driver of research impact.

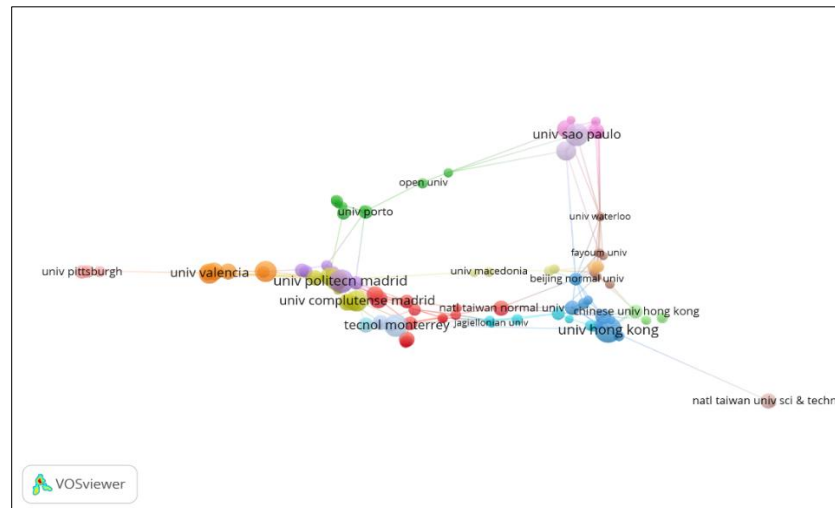
**Figure 2. Network Visualization of Co-authorship of Countries****Table 3. Co-authorship of organizations**

Sl. no	Organization	Documents	Citations	Total link strength
1	University of Hong Kong	42	1975	24
2	University of Alcala	9	1719	1
3	Winston Salem State University	18	1445	7
4	Ohio State University	5	1338	1
5	Bulgarian Academy of Science	5	907	1
6	University of Limerick	5	539	1

7	National Yunlin University of Science & Technology	10	467	8
8	SHU TE University	7	456	4
9	University of Sao Paulo	32	447	50
10	University Carlos iii Madrid	12	344	6

The analysis of co-authorship among organizations in gamification in education research reveals (Table 3) that the University of Hong Kong is the leader in productivity (42 documents), impact (1975 citations), and collaboration strength (24). The University of Alcala and Ohio State University excel in high-impact research with limited collaboration, while Winston Salem State University balances productivity and moderate collaboration. The Bulgarian Academy of Science and the University of Limerick achieve significant impact with small outputs and minimal networks.

The University of Sao Paulo stands out for its strong collaboration network (link strength 50) despite modest citation numbers. Institutions like the National Yunlin University of Science & Technology and SHU TE University maintain moderate productivity, impact, and collaboration. Collaborative strength, as seen in the University of Sao Paulo, enhances research visibility, while impactful standalone research is exemplified by the University of Alcala and Ohio State University. Balancing productivity, impact, and collaboration is key to advancing research influence.



**Figure 3. Network Visualization of Co-authorship of Organizations**

**Table 4. Top 10 keyword co-occurrence**

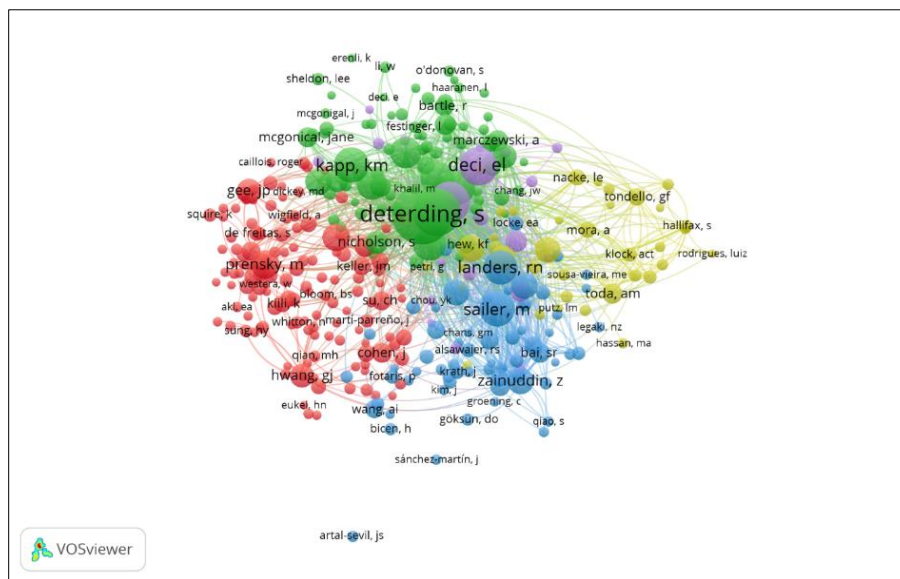
Sl.no	Keyword	Occurrences	Total link strength
1	Gamification	423	1354
2	Education	255	798
3	Motivation	218	788
4	Students	175	655
5	Engagement	138	591
6	Performance	134	669
7	Design	115	499





The co-citation analysis (Table 5) reveals the most influential authors in gamification research. Deterding, S. and Hamari, J. lead in citations and interconnectedness, reflecting their foundational role. Psychological theorists Ryan, RM and Deci, EL are pivotal, highlighting the importance of Self-Determination Theory in gamification studies. Practical contributors like Kapp, KM and Werbach, K

focus on applying gamification concepts, while emerging figures such as Sailer, M, Landers, RN, and Hanus, MD drive innovation in design and evaluation. Dicheva, D adds significant contributions to educational applications. The high total link strengths across authors reflect a dense, collaborative research network blending theory and application, with significant contributions shaping the field's development.



**Figure 5. Network Visualization of Co-authorship of Authors**

**Table 6. Co-citations of top ten sources**

Sl. No	Source	Citations	Total link strength
1	Computers & Education	3814	121401
2	Computers in Human Behaviour	1975	68567
3	Educational Technology and Society	707	23105
4	British Journal of Educational Technology	640	24901
5	Interactive Learning Environment Journal	608	25423
6	Education and Information Technology	559	23123
7	Journal of Chemical Education	542	7036
8	Lecture Notes in Computer Science	499	12150
9	Education Technology Research and Development	489	19286
10	Simulation and Gaming	461	15887

Table 6 shows the co-citation analysis of the top ten sources. The table highlights *Computers & Education*

as the most influential journal in gamification research, with the highest citations (3814) and total







gamification research and practice. Scholars and practitioners are encouraged to leverage these insights to design innovative, inclusive, and impactful educational experiences.

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