OPEN ACCESS
Jurnal Ilmiah Ilmu Terapan Universitas Jambi
Vol. 10 No. 2. April 2026, pp. 768-782 DOI. 10.22437/jiituj.v10i2.54672
Research Article

MAPPING RESEARCH TRENDS IN GAME-BASED ICT LEARNING FOR INTERACTIVE EDUCATIONAL APPLICATIONS: A BIBLIOMETRIC STUDY

Epi Suryani[1], Alwen Bentri[1], Nofri Hendri[1], Rayendra[1]*, and Anggi Prasetia[1]
[1] Education Technology, Postgraduate Program, Universitas Negeri Padang, Padang, Indonesia
Corresponding author email: rayendra@fip.unp.ac.id

Article Info
Recieved: Jan 28, 2026
Revised: Mar 1, 2026
Accepted: Apr 12, 2026
OnlineVersion: Apr 30, 2026

Abstract
The rapid growth of digital technology in the education sector requires effective and innovative information and communication technology (ICT) solutions to enhance student engagement and support interactive learning. This study aims to analyse existing research patterns, collaborative structures, central themes, and future research opportunities in the field of game-based ICT learning. A bibliometric assessment was conducted using publications indexed in Scopus published between 2021 and 2025. The data were examined using VOSviewer to examine the co-occurrence of keywords, collaborative networks among authors, and the structural themes of the research. The findings indicate a significant increase in academic literature on game-based ICT learning, underscoring a strong focus on factors such as learning motivation, student engagement, digital literacy, and the development of 21st-century competencies. The study of visual depictions categorises three main research areas: the development of game-centred educational applications, the adoption of interactive digital instructional methods, and the measurement of educational outcomes. The uniqueness of this study lies in the provision of an extensive bibliometric mapping that explains the development of research themes on immersive technology and the integration of artificial intelligence in educational applications. These empirical results make a substantial contribution to the field of educational technology research by providing evidence-based insights for the design of learner-centred adaptive digital learning environments, while also directing future research toward a sustainable implementation framework and measurable impact on students' digital competencies and educational outcomes.

Keywords: Bibliometric Analysis, Digital Learning, Game-Based ICT, Game-Based Learning, Interactive Learning Applications

INTRODUCTION

The rapid movement of global education systems underscores the need for digital technology integration to promote an inclusive, adaptive, and sustainable learning ecosystem. International policy frameworks, exemplified by UNESCO's Education 2030 agenda and the OECD's Education 2030

initiative, emphasise the importance of developing 21st-century competencies through the effective use of information and communication technologies (ICTs). These frameworks position the integration of ICTs as a fundamental driver of educational innovation, adept at addressing evolving social, technological, and economic demands (Balaban et al., 2023; Graham et al., 2024).

The development of Information and Communication Technology (ICT) through its ongoing movement has shifted the educational paradigm from traditional teacher-centred methodologies to interactive, student-centred frameworks. Teachers have become facilitators and designers of instructional design, and teachers must not stop and be consumed by age, because the times demand teachers to be human beings who are relevant to the situation and conditions (Prasetia, 2023b). Interactive digital learning applications facilitate adaptive, collaborative, and individual learning experiences through online platforms, multimedia environments, and simulation technologies, enabling students to learn with facilitators who act as learning designers (Elmi et al., 2024; Geng & Su, 2025). In the context of this transformation, Game-Based Learning (GBL) has emerged as a pioneering pedagogical framework that integrates game mechanics into the educational environment to increase student motivation, engagement, and active participation. Information and Communication Technology (ICT)-supported game pedagogy further fosters essential competencies, including critical analysis, problem-solving skills, creativity, and digital literacy, which are fundamental to contemporary education (Ramadhan et al., 2023; N. S. Sulaiman et al., 2025; Suci Q A et al., 2025).

Despite the significant growth in scholarly investigations on Game-Based Learning in recent years, most existing research focuses on pedagogical efficacy, media creation, or learner performance outcomes (Nadolny et al., 2020; Gris & Bengtson, 2021). Less scholarly attention has been directed to understanding the broad scholarly evolution of Game-Based ICT Learning as a distinct research domain, encompassing its global publication patterns, intellectual architecture, collaborative frameworks, and thematic developments (Do et al., 2025). Therefore, a clear research gap is evident due to the lack of a comprehensive systematic analysis of the development of Game-Based ICT Learning research on a global scale and the identification of perspective streams for future investigations (A/P Ong Long et al., 2025).

Bibliometric analysis provides a robust methodological approach to address this gap by quantitatively examining scientific publications and visualising the structure of scientific knowledge. Using science mapping techniques, bibliometric studies enable the identification of research growth patterns, influential contributors, collaborative relationships, and emerging research themes (De Sousa et al., 2024). Such analysis not only reveals past developments but also supports strategic forecasting of future innovation directions in ICT-based educational research (Hsu & Hsu, 2025). This study aims to investigate the global research landscape of Game-Based ICT Learning through a bibliometric lens. The objectives include: (1) analysing publication growth patterns; (2) identifying key authors, journals, and countries; (3) mapping common research themes and frameworks; and (4) outlining research prospects in this area. Thus, this study formulates the following research questions.

RESEARCH METHOD

This study combines a Systematic Literature Review (SLR) with bibliometric analysis to systematically examine the evolution of research on Game-Based ICT Learning for interactive educational applications. The methodological framework adopts two complementary analytical perspectives, namely performance analysis and science mapping, as proposed Donthu et al. (2021). Performance analysis is employed to evaluate scientific productivity by examining publication growth, influential authors, contributing countries, and leading publication sources (Kumar, 2025; Vaishya et al., 2025). Meanwhile, science mapping aims to uncover the intellectual and conceptual structure of a field by identifying dominant themes, emerging topics, and evolving research clusters (Aria & Cuccurullo, 2017; Xie & Waltman, 2023). By integrating these approaches, the study provides a comprehensive understanding of the development trajectory, knowledge structure, and future direction of Game-Based ICT Learning research within contemporary digital education (Fan et al., 2024).

To ensure transparency and methodological rigour, this study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). Systematic review procedures are designed to maintain consistency and replicability throughout the research process, beginning with the formulation of research objectives and the development of a reproducible literature search strategy. The PRISMA framework supports a structured workflow for identifying, screening, assessing eligibility, and including relevant publications (Lamb, 2024; Tohirin, 2026). This approach

allows the study to minimise selection bias while ensuring that only scientifically relevant literature is included in the bibliometric mapping process (Guskov et al., 2025). Furthermore, in the final stage, relevant criteria were found, namely Exclusion criteria, which confirm that the study manuscript containing the literature review and subsequently published is no more than 5 years old (Prasetia, 2023a).

Bibliographic data were retrieved from the Scopus database between March 10 and March 15, 2026. Scopus was selected due to its extensive international coverage, rigorous indexing standards, and availability of comprehensive bibliometric metadata suitable for science mapping analysis (Hallinger & Chatpinyakoop, 2019). The search strategy employed combinations of keywords related to game-based learning, ICT learning, educational games, gamification, and interactive educational applications. Searches were conducted within the title, abstract, and keyword fields to ensure conceptual alignment with the research focus. Boolean operators were applied to broaden search coverage while maintaining thematic precision, and publication filters were set to include English-language documents, finalised publications, journal articles, and conference proceedings published between 2020 and 2025 to capture recent developments in digital learning innovation (Hallinger & Chatpinyakoop, 2019; Page et al., 2021). Following data retrieval, a rigorous screening process was conducted to refine the dataset. Duplicate records and publications unrelated to educational technology or learning contexts were excluded to preserve analytical relevance (Durak et al., 2026).

Only studies addressing the integration, implementation, or impact of Game-Based ICT Learning within interactive educational environments were retained (Demir et al., 2025). Editorial materials, book reviews, and non-research documents were removed to maintain analytical originality and methodological consistency. The resulting dataset represents a curated body of contemporary scientific literature reflecting the global progression of ICT-supported game-based learning research (Sanfo, 2023). The selected bibliographic records were exported in RIS format and analysed using VOSviewer and Biblioshiny (Bibliometrix package in RStudio) (Moral-Muñoz et al., 2020). VOSviewer was utilised to construct visualisation networks illustrating co-authorship collaboration, citation relationships, and keyword co-occurrence patterns that reveal intellectual linkages among studies (Hassan & Duarte, 2024). Complementarily, Biblioshiny was applied to perform descriptive bibliometric analysis, including annual scientific production trends, citation performance, source impact evaluation, and thematic evolution analysis. The combined use of these analytical tools strengthens methodological robustness by integrating statistical evaluation with visual exploration of knowledge structures (Palos-Sánchez et al., 2022).

In bibliometric research, analytical variables are derived from publication metadata rather than survey instruments or experimental measurements (González-Alcaide, 2021). Accordingly, this study examines publication productivity, citation impact, author and country collaboration networks, and conceptual structures reflected in keyword relationships (D. B. Abdullah & B. Mahmood, 2020; Khalid et al., 2021). These indicators serve as measurable representations of scientific development and research influence within the Game-Based ICT Learning domain. Because the data originate from standardised Scopus indexing, variable measurement remains objective, consistent, and fully reproducible across future studies (Yeung, 2023; Ng et al., 2024).

The validity and reliability of this study are ensured through methodological rigour in the systematic search design, transparent selection procedures, and reliance on peer-reviewed Scopus-indexed publications (Koul et al., 2025). Validity is strengthened by aligning research objectives, keyword formulation, and analytical techniques, while reliability is supported through reproducible search strategies and automated analysis using established bibliometric software (H. Chen et al., 2023; Shaikh & Kiranli Güngör, 2025). Through this carefully structured methodology, the study generates a comprehensive and trustworthy mapping of global research trends and future directions in Game-Based ICT Learning for interactive educational applications (Hsu & Hsu, 2025; Timor et al., 2025). The study selection procedure following the PRISMA framework is illustrated in Figure 1, which shows the stages of identification, eligibility screening, and final inclusion of the analysed publications.

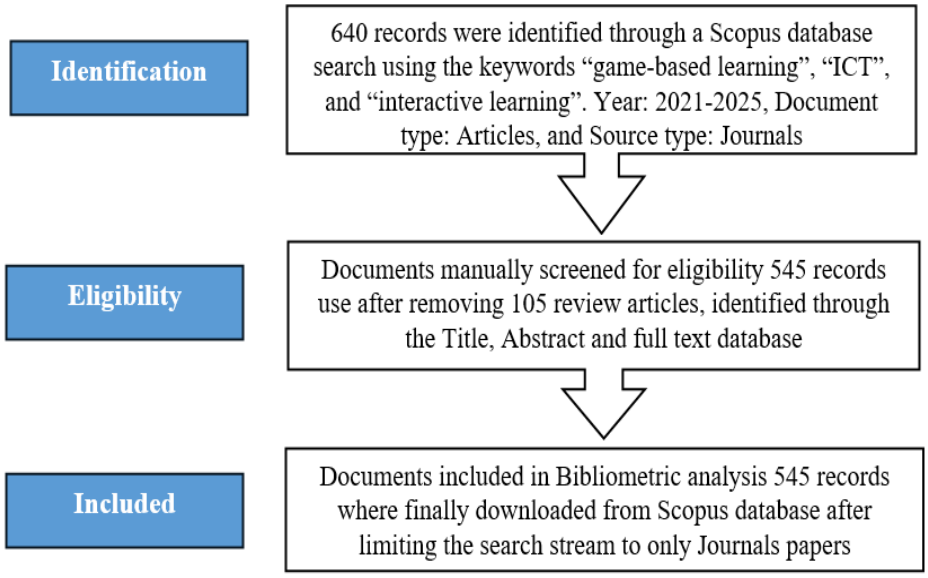

Figure 1. Flowchart depicting the collection of higher education internationalization publications from the Scopus index.

Based on the PRISMA selection procedure presented in Figure 1, a total of 545 publications were identified as eligible and retained for the final dataset. These publications represent a curated body of peer-reviewed scholarly works reflecting the global development of Game-Based ICT Learning within interactive educational application contexts. The dataset captures recent scientific progress during a period marked by rapid digital transformation in education, enabling a comprehensive exploration of research productivity, intellectual collaboration, and thematic evolution in the field (X. Chen et al., 2023). Building on this systematically validated dataset, the subsequent analysis applies bibliometric performance metrics and science-mapping techniques to reveal publication growth patterns, influential contributors, collaboration networks, and dominant research themes (Oliveira et al., 2019). Through this analytical framework, the results provide an integrated overview of how Game-Based ICT Learning research has evolved, identify emerging research directions, and highlight future opportunities to advance interactive, learner-centred digital education.

RESULTS AND DISCUSSION

This study aims to uncover the fascinating development of Game-Based ICT Learning (GBL) in digital education through a bibliometric analysis. By reviewing over 1,000 scientific publications from 2020 to 2025, the findings revealed a significant trend of rapid growth in the use of Information and Communication Technology (ICT) in game-based learning. This discussion will present in detail the main findings of the bibliometric analysis, explore relationships between topics, and project how Game-Based ICT Learning will develop in the future, supported by scientific visualisations that provide a clear picture of existing patterns. Game-based learning has become essential in ICT education. Interactive and entertaining, games are transforming the perception of teaching and learning. Digital platforms like Wordwall facilitate interactive educational games, gaining popularity among educators aiming to enhance the learning experience. A bibliometric analysis has clearly demonstrated that the application of ICT in game-based learning has become a growing area of interest among researchers worldwide. This phenomenon is evidenced by the growing body of literature on integrating technology and gamification in education (Renteria et al., 2025; Zakaria & Mahat, 2024). This study aims to map academic research on Game-Based ICT Learning, categorise emerging themes, and analyse connections among core topics in global discourse. We will present these findings using scientific visualisation to clarify the field's research trajectory and future directions.

Figure 2. Distribution of Game-Based ICT Learning Topics through Thematic Maps (Density Visualization)

Figure 2 Thematic Map presents themes in Game-Based ICT Learning research by relevance and development, with ICT centrally positioned and directly connected to related themes such as students, e-learning, and learning systems. These interconnections provide the basis for this study's analysis of how such themes illustrate the impact and growth of game-based learning in ICT, emphasising both the influence of digital technology on education and the pivotal role of ICT in this advancement. According to Nakunsong (2024), technology-based learning enables adaptive and flexible educational opportunities. However, student engagement in digital learning remains insufficient. In this context, games are a proven mechanism for capturing and sustaining student interest (Rivera & Garden, 2021a; Brito Júnior et al., 2023). The map clearly demonstrates that the e-learning theme regarding educational technology is highly relevant, and game-based learning stands out as a leading strategy in contemporary education systems.

This visualisation supports the hypothesis that the integration of Information and Communication Technology (ICT) with game-based pedagogy is adept at providing a more interactive and enjoyable educational experience, while simultaneously assisting learners in cultivating 21st-century competencies such as critical analysis, problem-solving, and digital literacy (Lampropoulos, 2023; Yolviansyah et al., 2023). Consequently, this Thematic Map provides a comprehensive picture of the evolution of research emphasis in game-based education, which increasingly prioritises technological advancements (Karagöz & Ateş, 2022; Ekin et al., 2023). Beyond illustrating thematic relationships, the Thematic Map also reveals an important theoretical transition within Game-Based ICT Learning research. The positioning of ICT as a central and highly connected theme indicates that digital technology no longer functions merely as a supporting instructional tool but has evolved into a foundational pedagogical ecosystem shaping contemporary learning environments (Tavares et al., 2024).

This finding aligns with digital pedagogy theory, which emphasises integrating technological infrastructure with learner-centred instructional design to foster meaningful learning experiences. Previous studies have similarly highlighted the transformative role of ICT in enabling personalised and interactive learning environments; however, the present analysis extends these findings by demonstrating how game-based approaches increasingly operate as mediating mechanisms that connect technological innovation with student engagement outcomes (Rivera & Garden, 2021). urthermore, the dominance of themes related to students, e-learning, and learning systems suggests a paradigm shift from technology adoption toward learning experience optimisation. Rather than focusing solely on technological implementation, recent research trends emphasise how game mechanics support motivation, autonomy,

and experiential learning processes consistent with constructivist learning theory and engagement theory (Grab, 2025).

This indicates that Game-Based ICT Learning is transitioning from experimental instructional innovation toward an established framework for designing adaptive digital learning ecosystems. The emergence of educational technology and pedagogy themes in the developing quadrant also signals expanding interdisciplinary collaboration, integrating educational psychology, instructional design, and artificial intelligence-driven learning systems (Battashi et al., 2025). From a broader scholarly perspective, these thematic patterns suggest that future research moves toward immersive technologies, intelligent learning analytics, and personalised, game-based environments that support sustainable digital education. Therefore, the Thematic Map not only visualises research distribution but also provides empirical evidence of a conceptual evolution in which ICT-driven game-based learning becomes a strategic approach for advancing 21st-century education. This reinforces the argument that integrating game-based pedagogy within ICT frameworks represents a critical direction for future educational innovation and theoretical development (Aguilera & de Roock, 2022; Chumari et al., 2024). To visualize this shift in the research landscape, the following Thematic Map illustrates the clustering of related research topics based on document coupling. It highlights key trends, such as the increasing focus on game-based learning, ICT, and educational technologies, while also positioning these themes within broader academic frameworks.

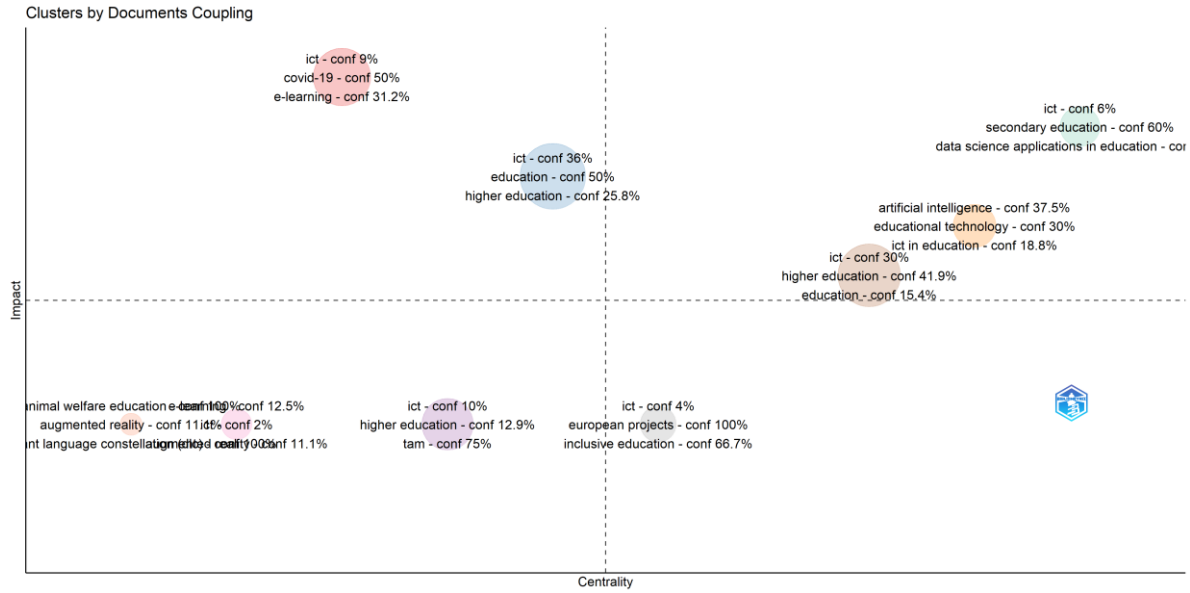

Figure 3. Map of Relationships Between Documents Through Coupling Map

The Coupling Map in Figure 2 shows the interconnections between documents through the document coupling mechanism. This map indicates that game-based learning, ICT in education, educational technology, e-learning, and learning systems are closely connected within the same research network. This finding answers the research question by showing that studies on Game-Based Information and Communication Technology Learning are not developed separately, but are built on shared references and related theoretical foundations. Therefore, the field can be understood as an integrated research area that combines technology, pedagogy, and game-based learning approaches.

The position of dominant themes such as ICT, higher education, e-learning, and educational technology also suggests that broader digital education trends strongly influence the development of game-based ICT learning. Previous studies emphasise that interdisciplinary collaboration is important in creating effective technology-enhanced learning environments that improve student engagement and learning experiences (Oberer & Erkollar, 2024; Haryaka et al., 2025; Huang, 2025). In practice, this finding implies that educators and instructional designers should not view games solely as entertainment tools, but as learning media that can support interaction, motivation, and digital literacy.

In conclusion, the coupling analysis demonstrates that Game-Based Information and Communication Technology (ICT) Learning has evolved into a dynamic and interconnected research domain. A key contribution of this study is the identification of robust thematic links between game-based

learning and ICT-based education, reflecting the growing integration of these fields. While this study offers valuable bibliometric insights, it is limited in scope, as it does not directly assess the impact of game-based ICT learning in classroom settings. Therefore, future research should combine bibliometric analysis with empirical studies to explore how game-based ICT learning influences students' motivation, learning outcomes, and digital competencies in real-world educational environments. To further illuminate these emerging trends, the following figure presents a visualization of Trend Topics in the field. This chart reveals the rise of significant topics such as educational technology, ICT, mobile learning, and online learning, highlighting their growing importance and relevance in the broader educational research landscape.

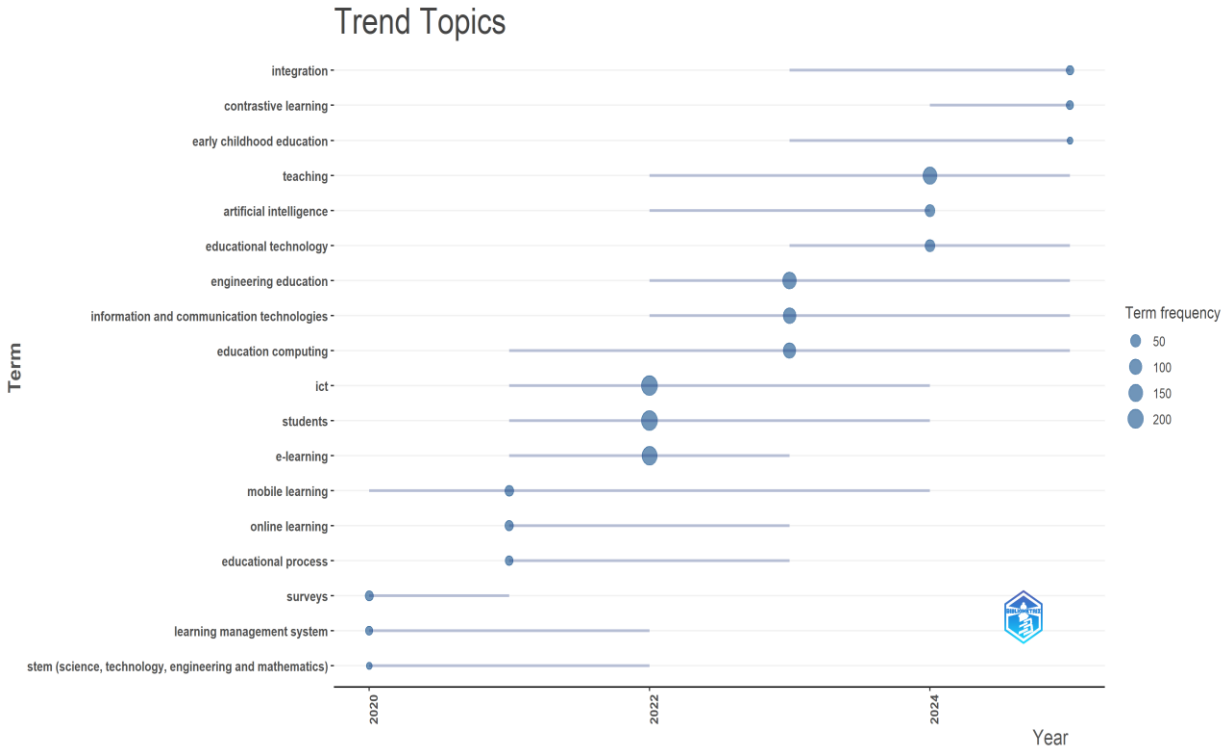

Figure 4. Trend Topics Discussion Through Keywords

Figure 4 shows Trend Topics that exemplify the rising frequency of key themes in scholarly publications on Game-Based ICT Learning from 2020 to 2025. The visualization shows that topics like e-learning, students, and game-based learning have made substantial progress, especially since 2022. This upward trend suggests that game-based learning is gaining recognition within the ICT-enhanced education framework, potentially leading to broader adoption of innovative teaching strategies and changes in curriculum design. It also signals transformation in educational practices across global contexts, potentially impacting policy, teacher training, and student engagement. The subject's prominence in scholarly attention indicates that technology-driven games are seen as an effective and innovative learning approach, highlighting a shift toward experiential and interactive modalities in education.

According to Tuta & Luić (2024), games grounded in learning principles have significant potential to transform how students engage with academic content. This form of gameplay not only increases students' engagement and motivation but also allows them to acquire knowledge in a fun and practical way. The observed increase in the prevalence of terms such as game-based learning and information and communication technology (ICT) in Trending Topics signals a fundamental shift in the educational paradigm, increasingly emphasizing the integration of technology not merely as an additional tool but as an integral component of the educational process itself. By implementing technology-enhanced games, educators can create more dynamic and interactive pedagogical experiences that have proven more effective at capturing student interest than conventional teaching methods.

Furthermore, educational games that utilise Information and Communication Technology (ICT) offer a degree of flexibility and customisation in how learners engage with and understand the subject

matter. This statement aligns with research by Ferreira et al (2024), which asserts that educational games provide immediate feedback, thereby facilitating a faster, more comprehensive understanding of the concepts being taught. The increasing prevalence of game-based learning and ICT in contemporary discourse suggests an urgent need for more interactive, technology-enhanced educational practices in 21st-century pedagogy, which demands an increasingly adaptive and responsive approach to learners' evolving needs in the digital age. To better visualize these evolving trends, the following figure presents Trend Topics in the field, illustrating the growing emphasis on terms such as ICT, educational technology, and game-based learning in recent years.

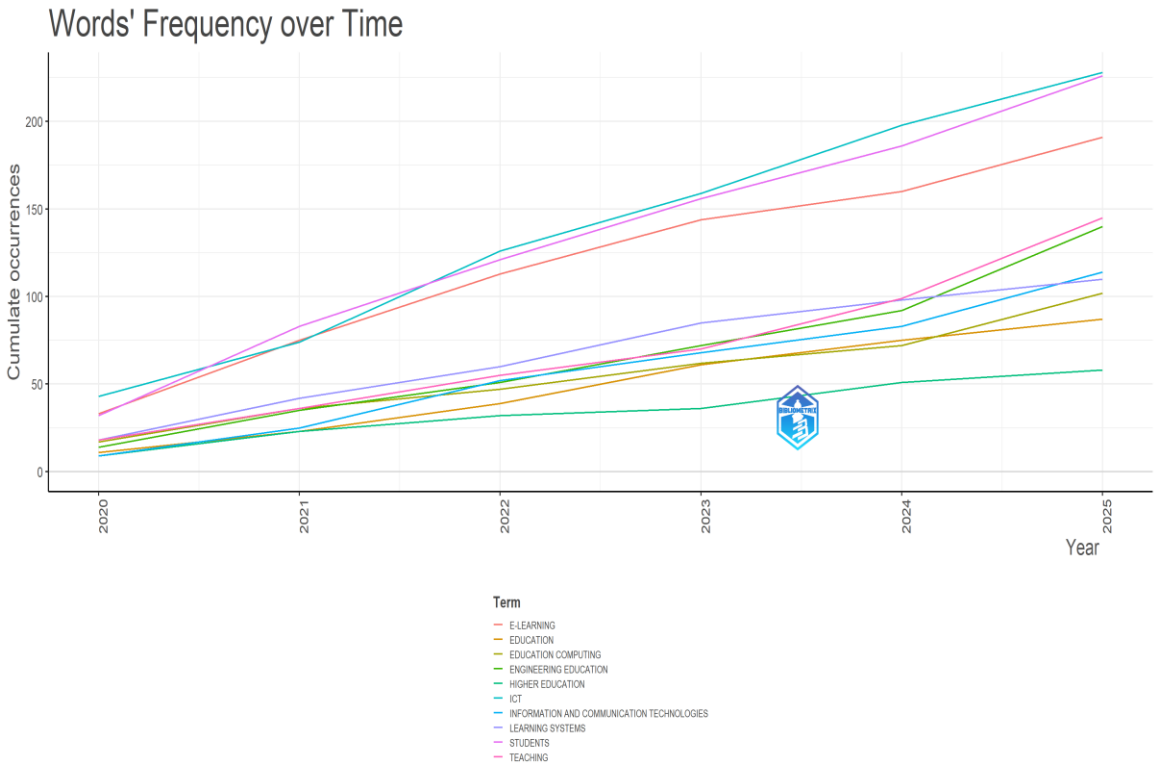

Figure 5. Words' Frequency Over Time

Figure 5 presents a depiction of Term Frequency Over Time, which explains the temporal variation in the prevalence of keywords related to Game-Based ICT Learning. The progressive accumulation of terms such as e-learning, ICT, students, and game-based learning indicates a growing interest in this subject within the realm of ICT-oriented educational research. In particular, the escalation in the occurrence of e-learning terminology signals the increasingly important role of technology in the educational process, in line with the transition towards a more digitally integrated and interconnected pedagogical framework. In this paradigm, technology transcends its role as a mere facilitator, emerging as a fundamental component of a more engaging and dynamic educational experience. Research by Chumari et al. (2024) shows that implementing game-based learning methodologies benefits student engagement, increasing motivation to learn, critical thinking and problem-solving skills. Educational games offer a more interactive learning experience, allowing students to engage with the material more engagingly and enjoyably.

The increased frequency of students' verbal contributions in these visualisations suggests that scientific investigations are increasingly focusing on how game-based technologies can enrich students' learning experiences, providing them with opportunities to interact directly with the subject matter in a more dynamic, applied educational environment. Overall, the developmental trends in word frequency over time indicate that game-based information and communication technology (ICT) learning is increasingly recognised as a powerful approach to transforming the modalities through which learners engage with academic content. By investigating topics such as ICT and game-based pedagogical methods, the research illuminates how technological advancements can shape educational trajectories, fostering more inclusive, needs-centred strategies for students in an ever-evolving digital landscape (Asmayawati

et al., 2024). To provide a visual summary of the most prominent topics in Game-Based ICT Learning, the following word cloud illustrates key terms related to the field. The size of each word represents its relative frequency, emphasizing the growing focus on concepts such as students, ICT, e-learning, and educational technologies.

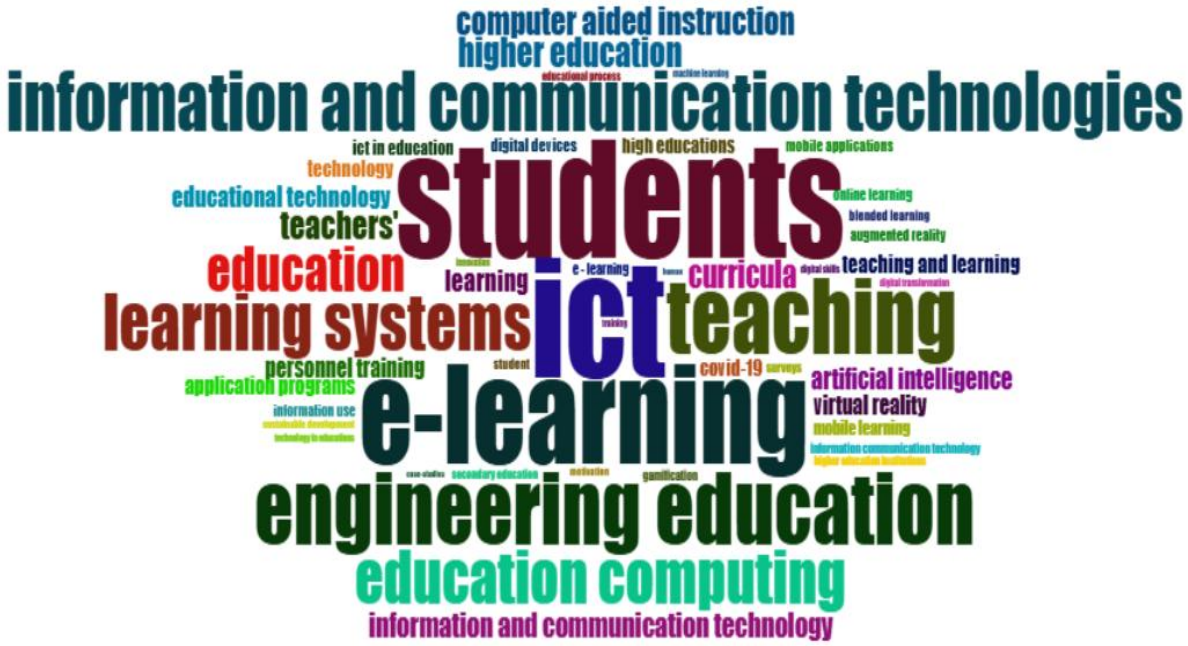

Figure 6. Word Cloud that Appears Based on Time Frequency

The word cloud in Figure 6 exemplifies a lexicon that recurs frequently in the literature on Game-Based ICT Learning. In this representation, terms such as ICT, students, e-learning, teaching, and education are rendered in larger fonts, thus signifying their substantial impact on the evolution of scholarly inquiry in this domain. This word cloud effectively depicts the prevailing topical landscape in academic discourse on integrating Information and Communication Technologies (ICT) with games in educational contexts to enhance student engagement and improve learning outcomes.

The terms prominent in this visual representation indicate that game-based learning, supported by information and communication technologies (ICT), is increasingly gaining prominence in educational discourse. Subjects related to students, for example, illustrate that all these conversations are fundamentally oriented around students' requirements and experiences within the learning continuum. Information and communication technologies, alongside e-learning, exemplify how technological advancements serve as crucial catalysts in the evolution of education. At the same time, pedagogical practices and educational frameworks underscore the crucial role of educators in facilitating learning that combines games and technology. In essence, the integration of games into ICT-enhanced learning environments is increasingly engineered to foster student engagement in interactive, enjoyable ways, thereby advancing the achievement of deeper educational goals (Yu et al., 2022).

Game-based applications such as Wordwall are increasingly relevant within this educational framework. This platform enables educators to design and implement diverse educational games that enhance student engagement with instructional content. Wordwall offers a range of interactive games that can be tailored to specific learning objectives, thereby promoting active student participation through gameplay. The adoption of such platforms enables educators to shift from traditional, passive instructional methods to more participatory and dynamic approaches, thereby improving student comprehension and making the learning process both enjoyable and efficient.

Research by Hasan et al. (2026) corroborates this assertion. Their findings indicate that interactive, feedback-oriented game-based learning enhances comprehension. This methodology improves retention and fosters critical thinking and problem-solving abilities. Such skills are vital for academic advancement. Game-based learning immerses learners in educational experiences, facilitating the application of

knowledge in practical contexts. In this scholarly framework, platforms like Wordwall are instrumental in redefining traditional educational models. By fostering direct engagement with content through creative and dynamic methods, these tools effectively mitigate prevalent issues in conventional education, including low motivation and inadequate student engagement (Rao Sangarsu, 2023). According to Wahyuni et al (2023), educational games enable learners to acquire knowledge through discovery and experimentation, fostering an active learning approach and the development of practical skills.

The figure below encapsulates the state of the art in Game-Based ICT Learning. It visually represents the complex, growing network of interrelated concepts, including "students," "ICT," "artificial intelligence," and "digital transformation." This advanced network visualization reflects the latest trends in the field, marking a significant shift towards more integrated, technology-enhanced educational strategies. As such, it not only illustrates the direction of current research but also highlights the transformative potential of game-based ICT learning in shaping the future of education.

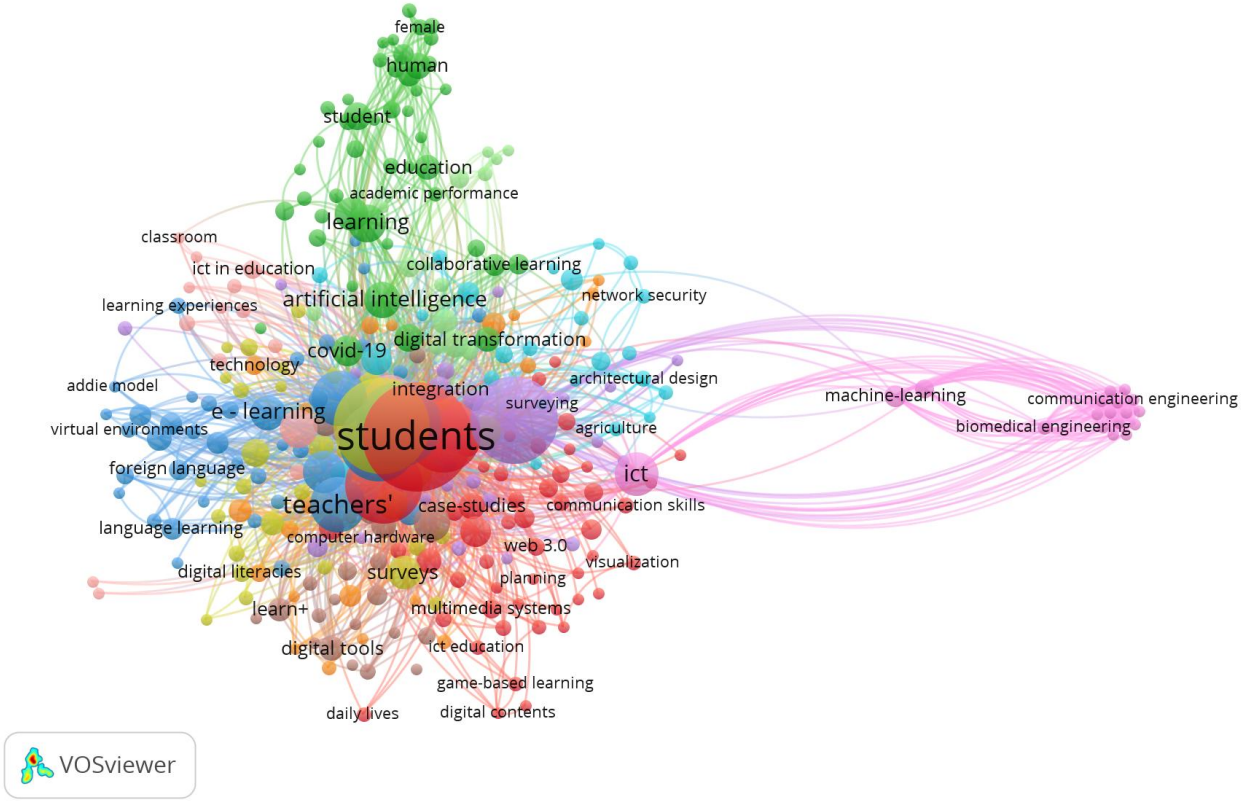

Figure 7. The Emerging Network Visualization

Figure 7 presents a Network Visualisation, an illustrative cartography of the intricate interconnections among themes, authors, and fundamental concepts in the research domain of Game-Based ICT Learning. This cartographic representation clearly elucidates the deep correlations among the dominant subjects in scholarly discourse, including students, ICT, game-based learning, and pedagogical methodologies. This visual representation illuminates how concepts not only exist independently but also engage in dynamic, mutually supportive interactions, thereby establishing a robust framework for advancing more innovative and efficacious game-based learning methodologies.

The interconnectedness of these subjects demonstrates that Game-Based ICT Learning is not an isolated phenomenon, but rather integrated into a broader framework encompassing diverse academic disciplines. For example, the concepts of learnership and pedagogy are fundamental to the learning process. In contrast, ICT and game-based learning serve as instrumental methodologies that enhance and intensify the educational experience. This interconnected network reinforces the notion that collaboration between scholars and education professionals across domains is increasingly crucial for developing game-

based applications that are not only engaging but also pedagogically sound and aligned with the requirements and attributes of contemporary learners (Pratama et al., 2025).

The mapping also highlights the importance of interdisciplinary collaboration in developing educational games that are not only enjoyable but also effective in meeting comprehensive educational goals. Scholars from various domains, including computer science, education, and educational psychology, have come together to develop pedagogically rich, interactive applications. As articulated by Palos-Sánchez et al. (2022), this collaborative effort fosters the development of educational games enriched with educational content and centred on relevant learning dimensions, such as critical thinking, problem-solving, and digital literacy.

Moving forward, this Network Visualisation suggests that interactions across academic disciplines will significantly shape game-based learning trajectories. Educational practices that integrate game components with information and communication technologies (ICT) must evolve through cross-sector collaboration to ensure that the resulting games not only adhere to rigorous pedagogical standards but also remain aligned with evolving educational requirements and technological advancements (Gkintoni et al., 2025). Consequently, game-based learning serves not merely as a tool for entertainment but as an influential mechanism for cultivating 21st-century competencies in learners, which, in turn, has the potential to improve educational practices globally (Khalid et al., 2021; Jain et al., 2022).

As a result, this network visualisation not only illustrates the interconnectedness between subject matter and researchers but also exemplifies the ongoing evolution of Game-Based Information and Communication Technology Learning, driven by the dynamic interactions occurring across multiple disciplines. In the future, this increasingly robust collaboration is poised to lay the foundation for more innovative, inclusive, and relevant educational methodologies that address the challenges facing the field.

CONCLUSION

This study maps the research trends in Game-Based ICT Learning, focusing on its role in interactive educational applications. The bibliometric analysis reveals a growing body of research emphasizing the integration of Information and Communication Technology (ICT) with game-based learning approaches. This trend highlights the increasing recognition of gamification as a powerful tool to enhance student engagement, motivation, and learning outcomes through interactive, adaptive, and contextual learning experiences. The key contribution of this study to the literature is its identification of the central research themes, including interactive learning, ICT integration, and the innovative use of gamification in educational contexts. These findings suggest that game-based ICT learning not only transforms the way students engage with content but also fosters deeper conceptual understanding by creating dynamic and personalized learning environments. From a practical perspective, the study underscores the challenges in implementing game-based ICT learning, particularly regarding educator preparedness, the alignment of pedagogical design with game-based learning, and the effective use of technology to meet educational goals. The policy implications of these findings suggest that educational institutions must prioritize teacher training and curriculum design to integrate game-based learning tools effectively into classrooms. In conclusion, this study positions Game-Based ICT Learning as a promising solution for modernizing education. To further advance the field, future research should focus on developing sustainable, contextually relevant game-based learning models that not only support interactive learning but also address the practical barriers in educational settings, ensuring these innovations can be effectively applied in diverse learning environments.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Universitas Negeri Padang, Indonesia, for academic support in completing this research as part of the graduation requirements, as well as all parties who contributed to this study.

AUTHOR CONTRIBUTIONS

Epi Suryani conceived the research idea, designed the study framework, conducted data collection and bibliometric analysis, and prepared the draft manuscript. Alwen Bentri supervised the research process and contributed to concept development and methodology refinement. Nofri

Hendri assisted in data validation, visualisation using bibliometric tools, and interpretation of the research findings. Rayendra contributed to manuscript review and critical revision. Anggi Prasetia contributed to the final editing of the article and added arguments to each justification of the findings. All authors read and approved the final version of the manuscript.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

REFERENCES

Aguilera, E., & de Roock, R. (2022). Digital Game-Based Learning: Foundations, Applications, and Critical Issues. In K. Hytten (Ed.), *Oxford Research Encyclopedia of Education* (p. 0). Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.1438.

A/P Ong Long, O. A. H., Abd Halim, N. D., & Abdul Hanid, M. F. (2025). Global Trends and Research Frontiers in Game-Based Learning: A 2009 – 2025 Bibliometric Perspective. *International Journal of Academic Research in Progressive Education and Development*, *14*(4), Pages 726-747. https://doi.org/10.6007/IJARPED/v14-i4/26740.

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.

Asmayawati, Yufiarti, & Yetti, E. (2024). Pedagogical innovation and curricular adaptation in enhancing digital literacy: A local wisdom approach for sustainable development in Indonesia context. *Journal of Open Innovation: Technology, Market, and Complexity*, *10*(1), 100233. https://doi.org/10.1016/j.joitmc.2024.100233.

Balaban, I., Rienties, B., & Winne, P. H. (2023). Information Communication Technology (ICT) and Education. *Applied Sciences*, *13*(22), 12318. https://doi.org/10.3390/app132212318.

Battashi, M. A. A., Adnan, M. A. M., Jamil, A. I., & Al-Battashi, M. A. (2025). Mapping Research Trends in AI-Driven Personalized Learning Pathways. *Advances in Computational Intelligence and Robotics Book Series*, 1–30. https://doi.org/10.4018/979-8-3373-0847-0.ch001.

Brito Júnior, J. J. R. T. D., Rodrigues, R. L., & Amorim, A. N. G. F. (2023). An overview of Game-based learning studies and their relationship to student engagement. *RENOTE*, *21*(1), 210–220. https://doi.org/10.22456/1679-1916.134348.

Chen, H., Tsang, Y., & Wu, C. (2023). When text mining meets science mapping in the bibliometric analysis: A review and future opportunities. *International Journal of Engineering Business Management*, *15*, 18479790231222349. https://doi.org/10.1177/18479790231222349.

Chen, X., Zhu, K., & Dai, J. (2023). Research Hotspots and Development Trends of Education Digital Transformation: A Bibliometric Study. *Journal of Innovation and Social Science Research*, *10*(5). https://doi.org/10.53469/jissr.2023.10(05).06.

Chumari, M. Z., Zabidin, N., Nordin, N. A., Kamaludin, P. N. H., & Md Sharif, N. F. (2024). The Educational Impact of Game-Based Learning: Analyzing Benefits Across Disciplines. *International Journal of Modern Education*, *6*(21), 525–530. https://doi.org/10.35631/IJMOE.621037.

D. B. Abdullah & B. Mahmood. (2020). Network-Based Bibliometric Method for Analyzing Collaboration and Publishing Tendencies. *2020 6th International Engineering Conference "Sustainable Technology and Development" (IEC)*, 174–178. https://doi.org/10.1109/IEC49899.2020.9122866.

De Sousa, M. N. A., Almeida, E. P. D. O., & Bezerra, A. L. D. (2024). Bibliometrics: What is it? What is it used for? And how to do it? *Cuadernos de Educación y Desarrollo*, *16*(2), e3042. https://doi.org/10.55905/cuadv16n2-021.

Demir, G., Chatterjee, P., Saha, A., & Kadry, S. (2025). Introduction to Bibliometric Analysis and Methodologies. In *Bibliometric Analyses in Data-Driven Decision-Making* (pp. 1–44). https://doi.org/10.1002/9781394302581.ch1.

Do, M. T., Nguyen, T. N. M., & Pham, T. T. H. (2025). Bibliometric Mapping of Gamification in Education: Evidence from Taylor and Francis Online Using VOSviewer. *Engineering and Technology For Sustainable Development*, *35*(5), 078–090. https://doi.org/10.51316/jst.186.etsd.2025.35.5.10.

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.

Durak, G., Öncü, S., Çankaya, S., Esinbay, E., Levent, G., Yavuz, Z., & Yaman, H. E. (2026). Mapping the evolution of learning analytics in education: Unveiling trends and insights. *Quality & Quantity*, *60*(2), 7115–7144. https://doi.org/10.1007/s11135-025-02552-6.

Ekin, C. C., Polat, E., & Hopcan, S. (2023). Drawing the big picture of games in education: A topic modeling-based review of past 55 years. *Computers & Education*, *194*, 104700. https://doi.org/10.1016/j.compedu.2022.104700.

Elmi, H., Ambiyar, A., Huda, Y., & Novaliendry, D. (2024). The Role of Information and Communication Technology in Interactive Learning. *Jurnal SAINTIKOM (Jurnal Sains Manajemen Informatika Dan Komputer)*, *23*(1), 193. https://doi.org/10.53513/jis.v23i1.9549.

Fan, L., Li, L., Ma, Z., Lee, S., Yu, H., & Hemphill, L. (2024). A Bibliometric Review of Large Language Models Research from 2017 to 2023. *ACM Transactions on Intelligent Systems and Technology*, *15*(5), 1–25. https://doi.org/10.1145/3664930.

Ferreira, G. R. S., Marques, F. R. V., Silva, A. P. D. S. E., Marinho, M. P. R., Silva, A. A. D., Pimenta, T. D. B., Marques, L. H. D. S. D. C., Neves, C. M. D., Oliveira, S. X., Guida, J. D. L. S., Nery, I. D. O., & Morais, H. S. E. S. (2024). The contributions of playful games and digital technologies to education. In *Focus on Education: Academic Research* (1st ed.). Seven Editora. https://doi.org/10.56238/sevened2024.009-006.

Geng, X., & Su, Y.-S. (2025). The effects of different metacognitive patterns on students' self-regulated learning in blended learning. *Computers & Education*, *227*, 105211. https://doi.org/10.1016/j.compedu.2024.105211.

Gkintoni, E., Magriplis, E., Vantaraki, F., Skoulidi, C.-M., Anastassopoulos, P., Cornea, A., Inchaurraga, B., Santurtun, J., Mancha, A. D. L. C., Giorgakis, G., Kouppas, K., Timotheou, S., Moreno Juan, M. J., Muñagorri, M., Harasiuk, M., Lopez, A. G., Skoulidi, E., & Vantarakis, A. (2025). Designing for Engagement in Primary Health Education Through Digital Game-Based Learning: Cross-National Behavioral Evidence from the iLearn4Health Platform. *Behavioral Sciences*, *15*(7), 847. https://doi.org/10.3390/bs15070847.

González-Alcaide, G. (2021). Bibliometric studies outside the information science and library science field: Uncontainable or uncontrollable? *Scientometrics*, *126*(8), 6837–6870. https://doi.org/10.1007/s11192-021-04061-3.

Grab, M. O. (2025). Gamification in ESL Higher Education: A Pathway to Motivation and Engagement. *Shanlax International Journal of Education*, *13*(2), 95–101. https://doi.org/10.34293/education.v13i2.8567.

Graham, M. A., Kruger, G. M., & Van Ryneveld, L. (2024). Developing a Novel Model for ICT Integration in South African Education: Insights from TIMSS. *Education Sciences*, *14*(8), 865. https://doi.org/10.3390/educsci14080865.

Gris, G., & Bengtson, C. (2021). Assessment Measures in Game-based Learning Research: A Systematic Review. *International Journal of Serious Games*, *8*(1), 3–26. https://doi.org/10.17083/ijsg.v8i1.383.

Guskov, A., Kosyakov, D., Selivanova, I., & Malysheva, A. (2025). *How systematic are the systematic reviews?*

Hallinger, P., & Chatpinyakoop, C. (2019). A Bibliometric Review of Research on Higher Education for Sustainable Development, 1998–2018. *Sustainability*, *11*(8), 2401. https://doi.org/10.3390/su11082401.

Haryaka, U., Razak, N. K., Rachman, F., Tung, K. Y., & Judijanto, L. (2025). Integrating Digital Literacy, Critical Thinking, and Collaborative Learning: Addressing Contemporary Challenges in 21st Century Education. *Natural Sciences*, *52*(3).

Hasan, S., Mulyati, Y., Winarni, N. D. A., Larasati, D., Yuanvanelli, Y. D., Hamimi, E., Roini, C., & Istiqomah, I. (2026). Joyful problem-based learning with traditional games to foster 21st century skills and science achievement. *Multidisciplinary Science Journal*, *8*(7), 2026453. https://doi.org/10.31893/multiscience.2026453.

Hassan, W., & Duarte, A. E. (2024). Bibliometric analysis: A few suggestions. *Current Problems in Cardiology*, *49*(8), 102640. https://doi.org/10.1016/j.cpcardiol.2024.102640.

Hsu, T.-C., & Hsu, T.-P. (2025). Teaching AI with games: The impact of generative AI drawing on computational thinking skills. *Education and Information Technologies*, *30*(15), 21499–21518. https://doi.org/10.1007/s10639-025-13624-3.

Huang, H. (2025). Interdisciplinary Collaboration in Educational Informatization Innovation: Importance and Practice. *Research and Advances in Education*, *4*(1), 38–46. https://doi.org/10.56397/RAE.2025.01.05.

Jain, S. A., Hussaini, N., John, S., Alexander, D., & Sarkar, B. (2022). *Game-Based Learning in Higher Education* (pp. 138–163). https://doi.org/10.4018/978-1-7998-7271-9.ch008.

Karagöz, B., & Ateş, H. (2022). Trends in digital game-based learning research: Bibliometric analysis (2001-2021). *Revista on Line de Política e Gestão Educacional*, e022168. https://doi.org/10.22633/rpge.v26i00.17726.

Khalid, A. A., Sarea, A. M., Hannoon, A., & Al-Sartawi, A. M. A. M. (2021). Game-Based Learning: Recommendations Driven from Literature. In A. M. A. Musleh Al-Sartawi (Ed.), *The Big Data-Driven Digital Economy: Artificial and Computational Intelligence* (pp. 119–124). Springer International Publishing. https://doi.org/10.1007/978-3-030-73057-4_10.

Koul, S. K., Praveen, M., & G. S., K. (2025). Future Scopes and Research Gaps. In S. K. Koul, M. Praveen, & K. G. S. (Eds.), *Microwave Absorbers: Materials Engineering* (pp. 247–262). Springer Nature Singapore. https://doi.org/10.1007/978-981-96-9596-6_9.

Kumar, R. (2025). Bibliometric Analysis: Comprehensive Insights into Tools, Techniques, Applications, and Solutions for Research Excellence. *Spectrum of Engineering and Management Sciences*, *3*(1), 45–62. https://doi.org/10.31181/sems31202535k.

Lamb, S. (2024). *Systematic review: PRISMA checklist and flow diagram*. https://doi.org/10.5281/zenodo.12793753.

Lampropoulos, G. (2023). Educational benefits of digital game-based learning: K-12 teachers' perspectives and attitudes. *Advances in Mobile Learning Educational Research*, *3*(2), 805–817. https://doi.org/10.25082/AMLER.2023.02.008.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & for the PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ*, *339*(jul21 1), b2535–b2535. https://doi.org/10.1136/bmj.b2535.

Moral-Muñoz, J. A., Herrera-Viedma, E., Santisteban-Espejo, A., & Cobo, M. J. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. *El Profesional de La Información*, *29*(1). https://doi.org/10.3145/epi.2020.ene.03.

N. S. Sulaiman, N. S. A. Zulkifli, & T. A. A. Kadir. (2025). Enhancing Education Through Game-Based Learning: Benefits and Future Directions. *2025 IEEE International Conference on Industrial*

Technology & Computer Engineering (ICITCE), 99–104. https://doi.org/10.1109/ICITCE65255.2025.11210766.

Nadolny, L., Valai, A., Cherrez, N. J., Elrick, D., Lovett, A., & Nowatzke, M. (2020). Examining the characteristics of game-based learning: A content analysis and design framework. *Computers & Education*, *156*, 103936. https://doi.org/10.1016/j.compedu.2020.103936.

Nakunsong, T. (2024). Evolving K-12 Digital Education: Enhancing Flexibility and Access through Online Learning and Virtual Programs. *Journal of Education and Learning Reviews*, *1*(5), 1–12. https://doi.org/10.60027/jelr.2024.791.

Ng, J. Y., Liu, H., Masood, M., Syed, N., Stephen, D., Ayala, A. P., Sabé, M., Solmi, M., Waltman, L., Haustein, S., & Moher, D. (2024). *Guidance for the Reporting of Bibliometric Analyses: A Scoping Review*. https://doi.org/10.1101/2024.08.26.24312538,

Oberer, B., & Erkollar, A. (2024). Digital Games in Education: An Interdisciplinary View. *Journal of Systemics, Cybernetics and Informatics*, *22*(1), 211–230. https://doi.org/10.54808/JSCI.22.01.211.

Oliveira, O. J. de, Silva, F. F. da, Juliani, F., Barbosa, L. C. F. M., & Nunhes, T. V. (2019). *Bibliometric Method for Mapping the State-of-the-Art and Identifying Research Gaps and Trends in Literature: An Essential Instrument to Support the Development of Scientific Projects*. Intech Open. https://doi.org/10.5772/INTECHOPEN.85856.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Systematic Reviews*, *10*(1), 89. https://doi.org/10.1186/s13643-021-01626-4.

Palos-Sánchez, P. R., Baena-Luna, P., Badicu, A., & Infante-Moro, J. C. (2022). Artificial Intelligence and Human Resources Management: A Bibliometric Analysis. *Applied Artificial Intelligence*, *36*(1), 2145631. https://doi.org/10.1080/08839514.2022.2145631.

Prasetia, A. (2023). Kajian Literatur Sistematis Analisa Penerapan Kurikulum Darurat di Sekolah Dasar dalam Konsep Dunia Pendidikan. *Jurnal Kajian Pembelajaran dan Keilmuan*, *7*(2), 205. https://doi.org/10.26418/jurnalkpk.v7i2.69297.

Prasetia, A. (2023). Peran Orang Tua Siswa dalam Menghindari Fenomena Loss Learning to Loss Generation pada Masa Pandemi COVID-19. *Journal of Educational Learning and Innovation (ELIa)*, *3*(1), 107–117. https://doi.org/10.46229/elia.v3i1.548.

Pratama, H., Azman, M. N. A., Othman, M. S., Marmoah, S., & Fajrie, N. (2025). Bibliometric analysis of digital game-based learning research. *Multidisciplinary Reviews*, *9*(2), 2026086. https://doi.org/10.31893/multirev.2026086.

Ramadhan, D. G., Budiyanto, C. W., & Yuana, R. A. (2023). The role of game-based learning in developing students computational thinking skills: A review of the literature. *AIP Conference Proceedings*, *2540*(1), 110019. https://doi.org/10.1063/5.0105705.

Rao Sangarsu, R. (2023). Enhancing Student Engagement in Learning with Modern Web and AI Technologies. *International Journal of Science and Research (IJSR)*, *12*(10), 1439–1442. https://doi.org/10.21275/SR231017100712.

Renteria, J. A., Dorfman, R., & Greer, R. (2025). *Emerging Trends and Future Directions*. 143–150. https://doi.org/10.1201/9781032726397-18.

Rivera, E. S., & Garden, C. L. P. (2021). Gamification for student engagement: A framework. *Journal of Further and Higher Education*, *45*(7), 999–1012. https://doi.org/10.1080/0309877X.2021.1875201.

Rivera, E. S., & Garden, C. L. P. (2021). Gamification for student engagement: A framework. *Journal of Further and Higher Education*, *45*(7), 999–1012. https://doi.org/10.1080/0309877X.2021.1875201.

Sanfo, J.-B. M. B. (2023). Examining student ICT use and learning outcomes: Evidence from Japanese PISA data. *Computers and Education Open*, *4*, 100141. https://doi.org/10.1016/j.caeo.2023.100141.

Shaikh, G., & Kiranli Güngör, S. (2025). Artificial Intelligence in Education: Insights from a Bibliometric Study (2010–2025) Based on Scopus and Web of Science". *International Journal of Modern Education Studies*, *9*(2). https://doi.org/10.51383/ijonmes.2025.428.

Suci Q A, A. A., Ketut Agustini, & I Kadek Suartama. (2025). Project Based Game Learning Effectiveness In 21st Century Classrooms: A Literature Review. *Didaktika: Jurnal Kependidikan*, *14*(3 Agustus), 4043–4056. https://doi.org/10.58230/27454312.2705.

Tavares, P. R., Pereira, D. A. de S., Brito, F. C. D., Sá, G. B. D., Gomes, L. F., Fujiyoshi, M. R. dos S., Modesto, V. T., & Cruz, R. C. das V. D. (2024). The role of digital information and communication technologies in modern education. *Contribuciones a Las Ciencias Sociales*. https://doi.org/10.55905/revconv.17n.2-015.

Timor, A. R., Ganefri, & Dedy Irfan. (2025). Interactive Learning through Mobile GBL: A Decade of Research Insights. *International Journal of Interactive Mobile Technologies (iJIM)*, *19*(21), 163–183. https://doi.org/10.3991/ijim.v19i21.56963.

Tohirin, A. (2026). *Illustrates the screening and selection procedure for research articles (PRISMA approach)*. https://doi.org/10.5281/zenodo.18252962.

Tuta, J., & Luić, L. (2024). D-Learning: An Experimental Approach to Determining Student Learning Outcomes Using Augmented Reality (AR) Technology. *Education Sciences*, *14*(5), 502. https://doi.org/10.3390/educsci14050502.

Vaishya, R., Gupta, B. M., Verma, M. K., & Elangovan, N. (2025). The Pivotal Role of Bibliometric Analysis in Scholarly Communication: A Review. *DESIDOC Journal of Library & Information Technology*, *45*(4), 367–377. https://doi.org/10.14429/djlit.21028.

Wahyuni, E., Tanuso, N. A. E., Waruwu, Y., Mata, Y., & Putro, A. N. S. (2023). The Role of Educational Games in Increasing Student Motivation and Engagement. *Al-Hijr: Journal of Adulearn World*, *2*(4), 366–383. https://doi.org/10.55849/alhijr.v2i4.552.

Xie, Q., & Waltman, L. (2023). A comparison of citation-based clustering and topic modeling for science mapping. *arXiv.Org*, *abs/2309.06160*. https://doi.org/10.48550/arxiv.2309.06160.

Yeung, A. W. K. (2023). A revisit to the specification of sub-datasets and corresponding coverage timespans when using Web of Science Core Collection. *Heliyon*, *9*(11), e21527. https://doi.org/10.1016/j.heliyon.2023.e21527.

Yolviansyah, F., Amin, N. F., Retutas, M., Tuan, N. A., & Peiling, L. (2023). Implementation of Information Technology Algorithms Based on ICT Media to Make Teachers Have 21st Century Skills. *Journal of Educational Technology and Learning Creativity*, *1*(2), 98–105. https://doi.org/10.37251/jetlc.v1i2.1398.

Yu, Z., Sukjairungwattana, P., & Xu, W. (2022). Effects of Serious Games on Student Engagement, Motivation, Learning Strategies, Cognition, and Enjoyment. *International Journal of Adult Education and Technology*, *13*(1), 1–15. https://doi.org/10.4018/ijaet.314607.

Zakaria, N. Z. S., & Mahat, H. (2024). Exploring Gamification Elements in Education: A Bibliometric Study. *International Journal of Modern Education*, *6*(23), 769–784. https://doi.org/10.35631/IJMOE.623052.