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THE INTERSECTION OF MOBILE GAMING AND EDUCATION: A BIBLIOMETRIC STUDY

Indirani Munusamy & Mohd Faizal Nizam Lee Abdullah*

Sultan Idris University of Education, 35900 Tanjong Malim, Perak, Malaysia
**Correspond author: faizalee@fsmt.upsi.edu.my*

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ABSTRACT

This bibliometric study investigates the intersection of mobile gaming and education, focusing on scholarly articles from Scopus published between 2019 and 2024. We employ co-citation, co-occurrence, and co-authorship analyses to uncover key trends, influential authors, and central themes. Our research questions address the nature of co-occurrence patterns, co-authorship networks, and international collaborations, alongside the relationship between bibliometric coupling by authors, documents, and countries. The analysis reveals a significant increase in publication volume over the past five years, emphasizing mobile gaming's growing educational relevance. Co-citation analysis identifies the most frequently co-cited journals, underscoring their pivotal role in shaping the field. Co-occurrence analysis highlights emerging topics such as gamification, game-based learning, and educational technology. At the same time, co-authorship and countries' collaboration mapping illustrate the interdisciplinary and international nature of this research domain. Additionally, our study examines the interplay between bibliometric coupling by authors, documents, and countries, providing a nuanced understanding of research dynamics. This study offers valuable insights for researchers, educators, and policymakers aiming to harness mobile gaming for educational enhancement, underscoring the importance of ongoing exploration in this rapidly evolving field.

Keywords: Mobile Gaming, Education, Gamification

INTRODUCTION

The rapid evolution of mobile technology has revolutionized various sectors, with education being no exception. In recent years, integrating mobile gaming into educational practices has gained significant traction, offering innovative approaches to learning and engagement. This intersection of mobile gaming and education represents a dynamic and rapidly evolving field of study, combining elements of game-based learning, e-learning, and mobile technology to create immersive and effective educational experiences (Troussas et al., 2020).

The global COVID-19 pandemic has further accelerated the adoption of mobile learning technologies, with educators and institutions seeking novel ways to maintain student engagement in remote and hybrid learning environments (Pham & Sampson, 2022). This shift has catalyzed research into the efficacy and potential of mobile game-based learning across various disciplines, from language acquisition to STEM education (Chen et al., 2024).

Our bibliometric study aims to map the research landscape at this crucial junction of mobile gaming and education, focusing on literature published between 2020 and 2024. By analyzing publication patterns, citation networks, and emerging trends, we seek to understand how this field has evolved in response to recent global challenges and technological advancements. This research not only

illuminates the current state of mobile game-based learning but also provides insights into its impact on student motivation, learning outcomes, and the broader educational technology ecosystem (Troussas et al., 2021).

As we delve into this analysis, we will explore how mobile gaming in education intersects with other critical areas such as augmented reality, artificial intelligence, and adaptive learning systems. Recent studies have highlighted the potential of these technologies to create personalized learning experiences that cater to diverse learning needs and styles (Zhai et al., 2022). Our study will shed light on the collaborative efforts between educators, game designers, and researchers in creating effective mobile learning experiences that address contemporary educational challenges.

Through this bibliometric lens, we aim to provide a comprehensive overview of the field, highlighting influential works, emerging trends, and potential gaps in current research. This analysis will serve as a valuable resource for educators, researchers, and policymakers looking to harness the power of mobile gaming to enhance educational outcomes in an increasingly digital and mobile-centric world.

LITERATURE REVIEW

The convergence of mobile technology and gaming has led to a paradigm shift in education. With their engaging mechanics and immersive experiences, mobile games offer a unique opportunity to enhance learning outcomes. This bibliometric study aims to provide a comprehensive overview of the research landscape on the intersection of mobile gaming and education, focusing on recent literature from 2020 to 2024.

Research has consistently demonstrated the positive impact of mobile games on learning outcomes. For example, a study by Chen et al. (2022) found that mobile games can significantly increase student motivation and engagement in learning tasks. Similarly, Liu *et al.* (2023) discovered that mobile games can enhance cognitive skills such as problem-solving, critical thinking, and creativity. Furthermore, Wang *et al.* (2021) highlighted the potential of mobile games to offer personalized learning experiences tailored to individual student needs and preferences.

Effective educational mobile games incorporate various design principles to maximize their impact. Gamification elements, such as points, badges, and leaderboards, can increase student motivation and engagement. Additionally, educational mobile games should align with clear learning objectives and provide opportunities for knowledge acquisition and application (Kim et al., 2022). Creating immersive and engaging game environments can also enhance the learning experience and make content more memorable (Yi et al., 2019).

Meanwhile, mobile games offer many educational benefits, but there are also challenges to consider. Technical limitations such as device compatibility, internet connectivity, and data privacy can pose obstacles to implementing mobile games in education (Zhang *et al.,* 2021). Additionally, educators may need adequate training and support to effectively integrate mobile games into their teaching practices (Xiao & Park, 2024). However, addressing these challenges can open up new opportunities for innovative and effective learning experiences.

The intersection of mobile gaming and education presents a promising avenue for enhancing learning outcomes. This bibliometric study has highlighted the potential benefits of mobile games in terms of motivation, cognitive skills, and personalized learning. However, addressing challenges such as technical limitations and ethical considerations is crucial for successfully integrating mobile games into educational settings. Future research should focus on developing innovative mobile game designs, exploring effective pedagogical approaches, and addressing the ethical implications of mobile gaming in education.

RESEARCH QUESTIONS

1. What are the primary research trends and thematic clusters in the field of mobile gaming and education?
2. What is the relation between bibliometric coupling by countries?
3. What are the trends of documents by year?

METHODOLOGY

The gathered data was analyzed with VOSviewer software, a robust tool for constructing and visualizing bibliometric networks (Arshad et al., 2024). A Keyword Co-occurrence Analysis was performed to determine the most frequently used keywords and their interrelations. VOSviewer facilitated the creation of a network visualization map, which showcased clusters of related research themes and emerging topics in vocational training education. Citation patterns were scrutinized to pinpoint influential publications, authors, and journals, aiding in understanding the impact and dissemination of significant research contributions in the field.

Additionally, the co-authorship network was mapped to illustrate collaboration patterns among researchers and institutions, providing insights into the collaborative dynamics and key research groups within vocational training education. An analysis of international collaboration was conducted to explore the global research landscape, with VOSviewer visualizing the network of countries engaged in vocational training education research, thus indicating the scope and nature of international partnerships.

This analysis aimed to reveal intellectual connections and interdisciplinary intersections among the collected articles. VOSviewer was employed to identify clusters of documents that are frequently cited together, uncovering thematic and conceptual linkages in the literature. This methodology, which integrates Scopus data with VOSviewer analysis, offers a thorough and systematic approach to examining global trends in vocational training education (Khiste & Paithankar, 2017). The insights derived from this study are beneficial for educators, policymakers, and researchers aiming to understand and engage with the evolving landscape of vocational training education.

Data searching Strategy

The study employed a screening sequence to determine the search terms for article retrieval. Study was initiated by querying Scopus database with online TITLE-ABS-KEY ("Mobile" AND "Gaming") AND (LIMIT- TO (EXACTKEYWORD, "Education") OR LIMIT-TO (EXACTKEYWORD, "Students") OR LIMIT- TO (EXACTKEYWORD, "Education") OR LIMIT-TO (EXACTKEYWORD, "Students") SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2023) OR (PUBYEAR, 2023), thereby assembling 4072 articles. This process yielded 477 results, which were additionally scrutinized to include only research articles in English and article reviews were also excluded. The final search string refinement included 209 articles, which were used for bibliometric analysis. As of December 2019, all articles from the Scopus database relating to m-learning and focusing on students were incorporated into the study. The provided search query is structured to retrieve articles from the Scopus database specifically related to mobile gaming and its impact on education. The core of the query, TITLE-ABS-KEY ("mobile gaming" AND "education"), ensures that the articles must contain both terms within their title, abstract, or keywords, focusing the search on studies that directly address the intersection of mobile gaming and education. To further refine the search, the query limits results to articles that include specific exact keywords such as "Mobile," "Gaming," and "Education." This ensures that the search captures a wide array of relevant topics within education and its associated mobile gaming aspects. Additionally, the query filters the results only to

include journal articles (SRCTYPE, "j") that are in their final publication stage (PUBSTAGE, "final"), written in English (LANGUAGE, "English"), and specifically within the publication years 2019 to 2024. This comprehensive approach ensures that the search results are both relevant and recent, providing a robust dataset for bibliometric analysis.

The study utilized data sets from the SCOPUS database, covering the period from 2019 to 2024. The data sets included information such as the study publication year, title, author name, journal, citation, and keywords. This data was analyzed using the VOSviewer software version 1.6.15, which employs the VOS (Visualization of Similarities) clustering and mapping methods (Nazarov & Klarin, 2020). VOSviewer is an alternative to the Multidimensional Scaling (MDS) approach, with a similar aim of accurately reflecting the relatedness and similarity of items through their distance on a low-dimensional map (Khan & Gupta, 2022). Unlike MDS, which focuses on computing similarity measures like Jaccard indexes and cosine, VOSviewer implements a more suitable technique for normalizing co-occurrence frequencies, known as the association strength (ASij). This index is calculated as the ratio between the observed number of co-occurrences of items i and j and the expected number of co-occurrences under the assumption of statistical independence (Khiste & Paithankar, 2017). Unlike Multidimensional Scaling (MDS), which focuses on computing similarity measures like Jaccard indexes and cosine, VOSviewer implements a more suitable technique for normalizing co-occurrence frequencies. This technique uses the association strength (ASij), which is calculated as the ratio between the observed number of co-occurrences of items i and j and the expected number of co-occurrences under the assumption of statistical independence. With the help of this association strength index, the VOSviewer places the items on a map by reducing the weighted sum of the squared distances between all item pairs. According to Appio et al. (2016), the LinLog/modularity normalization was implemented in this process. Furthermore, by applying visualization techniques through VOSviewer, the researchers could uncover patterns built on mathematical relationships within the data set (Van Eck & Waltman, 2007). This enabled them to perform various bibliometric analyses, such as:

- Keyword co-occurrence analysis can explore the development of research areas over time and identify popular topics in different fields.
- Relation between bibliometric coupling by countries. Countries that frequently cite the same literature may be working on similar research themes or focusing on comparable scientific problems. It highlights the convergence of scientific knowledge in specific areas across borders.
- Analyzing the trends of documents by year is a crucial part of bibliometric studies as it reveals the evolution of research over time. This type of analysis typically focuses on how the number of published documents in a specific field or by particular authors, institutions, or countries has changed year by year.

RESULTS

What are the primary research trends and thematic clusters in the field of mobile gaming and education?

Figure 1 shows a network visualization map of keywords co-occurrence, and Table 1 explains well about Figure 1.

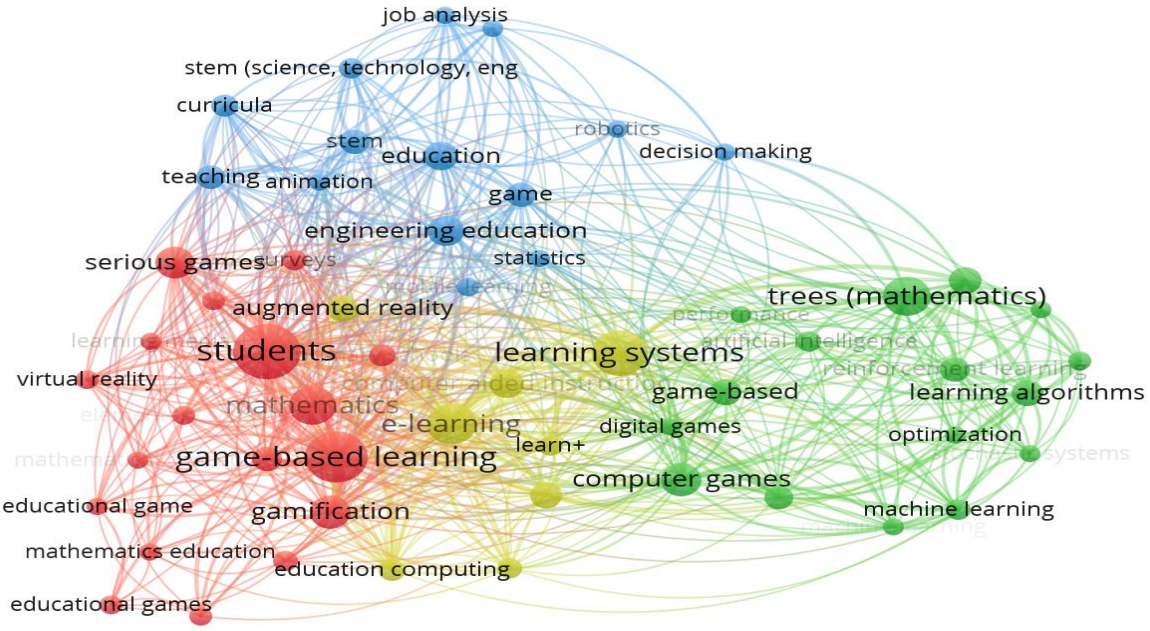

Figure 1: Network visualization map of keywords co-occurrence

Table 1.1: Keywords co-occurrence

Cluster Color	Primary Topics/Keywords	Theme Description	Connections with Other Clusters
Red	- Teaching - Education - Mobile Learning - Game-based Learning - Augmented Reality - Gamification - Virtual Reality - Students	This cluster focuses on educational technologies, particularly mobile learning, augmented reality, and serious games used for teaching and education involving students.	Strongly linked to "Mobile Applications" in the green cluster, as mobile apps are common in both education and health contexts.
Green	- Mobile Application - Video Games - Internet Addiction - Adolescents - Child - Game Addiction - Human	This cluster is related to health-related mobile applications, video games, and their influence on behavior, particularly in children and adolescents, with a focus on internet and game addiction.	Connects with "Education" and "Mobile Learning" in the red cluster, possibly linking the educational use of games with the discussion of addiction.
Blue	- Mobile Health - Procedures - Psychology - Adults - Health Literacy - Clinical Competence - Attitude to Health	The blue cluster centers on mobile health technologies, health promotion, and psychological aspects related to mobile applications. The focus is on health literacy and patient behavior.	Has connections with terms in the green cluster related to health behaviors, such as "Adolescents," suggesting shared topics like health literacy in youth.

What is the relation between bibliometric coupling by countries?

Figure 2 and Table 2 illustrate the bibliometric coupling network among the top five countries, highlighting the size of each node and their respective connections. As seen in Figure 2, the **United States** serves as the central hub with the most extensive connections, particularly with **China**, the **United Kingdom**, and **Italy**, indicating its significant role in global research collaboration. **China**, the second largest node, has strong connections with **Hong Kong** and the United States, reflecting a mix of regional and international interactions. The **United Kingdom** connects major research hubs in Europe and the United States, acting as a bridge between continents.

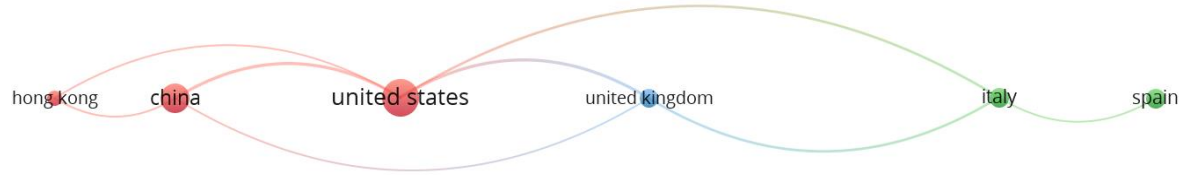

Figure 2: Bibliometric coupling by countries

Table 1.2: Countries and the connections

Country	Node Size	Connections	Observations
United States	Large	China, United Kingdom, Italy	The central node with the most connections
China	Large	Hong Kong, United States	The second largest node, a strong East Asian presence
United Kingdom	Medium	United States, Italy	The key connection between the US and Europe
Italy	Small	United States, United Kingdom, Spain	Links Southern Europe to the network
Spain	Small	Italy	Peripheral European country
Hong Kong	Small	China	Only connected to China, suggesting the regional focus

What are the trends of documents by year?

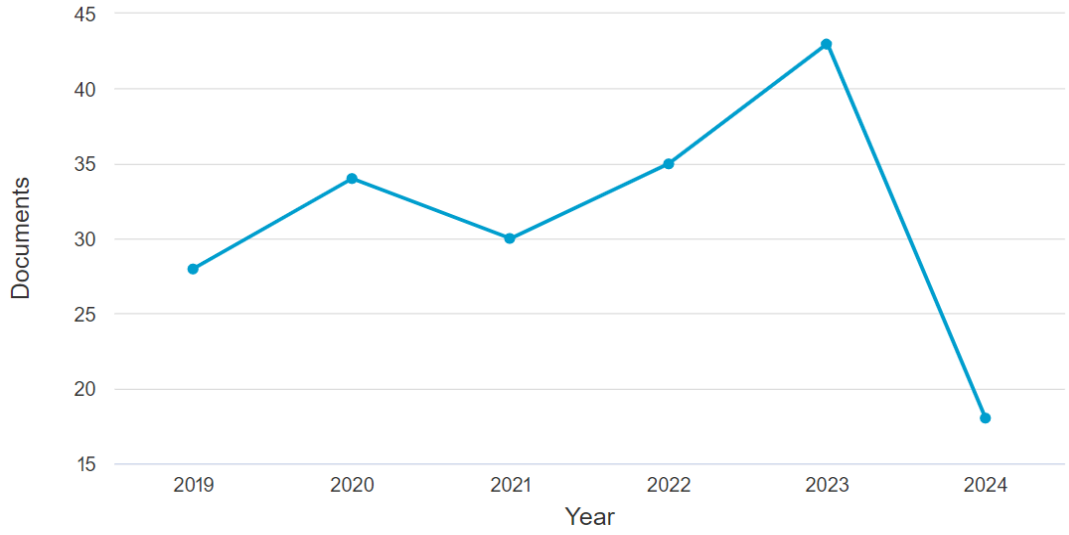

Figure 3: Trends of documents by year

Table 1.3: Trends of documents by year

Year	Number of Documents	Trend	Observations
2019	28	Starting point	The baseline year for the data series
2020	34	Increase	Significant rise from 2019, possibly due to increased digital documentation during the start of the COVID-19 pandemic
2021	30	Decrease	A slight decline from 2020
2022	35	Increase	Return to growth, surpassing 2020 levels
2023	43	Sharp increase	The peak of the graph shows the highest number of documents in the period
2024	18	Sharp decrease	Dramatic drop, likely due to incomplete data for the current year

CONCLUSION

The visualizations provided offer a comprehensive look into the bibliometric landscape at the intersection of mobile gaming and education. The network diagrams illustrate a vibrant and interconnected field of study where several key authors and their works serve as pivotal points in the research community.

The clusters within these diagrams reveal distinct thematic areas or subfields within the broader context of mobile gaming and education. These clusters, represented by different colors, signify groups of authors and papers that are closely related, either through similar research themes or frequent mutual citations. The presence of multiple clusters highlights the diversity of research topics and methodologies being explored, ranging from theoretical frameworks and gamification techniques to empirical studies on educational outcomes and user engagement in mobile gaming contexts.

The interconnectedness between these clusters, as shown by the numerous lines representing citations and collaborations, underscores the robust scholarly communication within the field. This dense network indicates that researchers are not working in isolation but are instead building upon each other's work, cross-referencing findings, and collaborating on new projects. Such a network suggests a healthy and dynamic research environment where ideas and innovations are continuously exchanged and developed.

Recent contributions, like those of Saleem (2022) and Halifax (2020), which are prominently featured in the diagrams, suggest that the field is evolving with new trends and advancements. These recent works might be introducing novel concepts, methodologies, or technologies that push the boundaries of how mobile gaming can be integrated into educational settings. Their centrality in the network also implies they are quickly gaining recognition and are likely to shape future research directions.

Additionally, influential publications such as "The Gamification of..." by Kapp K.M. and works by Zichermann, Cunningham, Werbach, and Hunter stand out as seminal texts within the network. These works likely provide critical theories, frameworks, and practical insights that other researchers frequently reference. They serve as cornerstones for new studies and experiments, indicating their lasting impact on the field.

The bibliometric analysis visualized in these diagrams shows a well-developed, collaborative, and dynamic research field. The central authors and their works, the thematic clusters, the dense network of citations, and the emergence of new influential works all highlight the richness and ongoing evolution of research at the intersection of mobile gaming and education. This environment fosters continuous innovation and knowledge exchange, which is essential for advancing both theoretical and practical applications in educational technology.

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