



Game Based Learning-Enabled 21st Century Skills: A Bibliometric Analysis

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Abstract. To improve 21st century skills, a learning approach is needed that can improve 21st century skills well. One of the learning approaches that can be used is game-based learning. This study aims to analyze the application of game-based learning in improving 21st century skills. Methods: This paper uses scopus and crossref databases year 2018 to 2023 as data sources and employs bibliometric methods and knowledge graphs to visualize the distribution of research power, keyword co-occurrence networks, and research performance to demonstrate the current research prospects and future research directions of game-based learning. There are 5 clusters of classification through vosviewer software. The results of the study obtained articles used with the keywords "21st century skills" and "game-based learning" concentrate in 2020 and 2021. The results show that (1) the game, digital game, learning, strategy and 21st century skills are the main occurrence keywords that shows their power of distribution research, (2) game-based learning initially start the trends and then overlaid to gamification, as 21st century skills re-emerged as content developed in game-based learning. (3) hot spot research leads to educators and individuals who are starting to develop their own game-based learning to meet the demands of the digital age where 21st century skills emergence. This study will contribute to the educational technology future research.

Keywords: 21st century skills; game-based learning; bibliometrics; research prospects; knowledge graph.

1 Introduction

In the 21st century, the world is becoming increasingly complex and interconnected. As a result, the skills that are needed to be successful in the workplace are also changing. The advancements in technology during the 21st century have resulted in notable transformations, particularly in the realm of higher education, which has become closely intertwined with technology[1]. In addition to traditional academic skills, such as reading, writing, and math, employers are increasingly looking for employees with 21st century skills, such as critical thinking, problem solving, creativity, collaboration, and communication. The 21st century is a time of rapid change, and the skills

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that are needed to be successful in this new era are constantly evolving. "21st-century skills" have transformed education around the world. The concept of "21st-century skills" has had a transformative impact on education worldwide, as it plays a crucial role in enhancing the potential of younger generations [2]. To prepare students to become successful global citizens [3]. It is vital for them to develop 21st-century skills such as critical thinking, problem solving, creativity, collaboration, and communication. Acquiring these skills has become increasingly urgent for young students to thrive in the contemporary context [4]. The learning process requires the right learning model and the right method [5]. Game-based learning has been shown to be an effective way to develop 21st century skills. Games can engage students and motivate them to learn, and they can also provide opportunities for students to practice and apply these skills in a safe and supportive environment. Recognizing the significance of game-based learning, many countries have adopted this approach to enhance student engagement and foster meaning-making abilities [6]. Game-based learning involves utilizing games as educational tools to facilitate teaching and assessment. The idea that digital games can effectively support learning and teaching has gained momentum among educational theorists and researchers, with empirical studies highlighting the potential benefits of games for skill and knowledge development [7]. Games provide an effective avenue for student engagement and motivation, while also offering opportunities for the development of 21st-century skills in an interactive and enjoyable manner. Learning is an effort to facilitate deliberate study to achieve a predetermined learning goal/achievement [8].

Today's learners, who are more accustomed to advanced technologies compared to previous generations, are particularly receptive to game-based approaches [7]. While game-based learning can be an effective way to develop 21st century skills, there are also some challenges that need to be considered. One challenge is that not all games are created equal. Some games are better designed than others for promoting learning. Another challenge is that game-based learning can be expensive to develop and implement. Despite the challenges, game-based learning is a promising approach to developing 21st century skills. As technology continues to evolve, we can expect to see more and more high-quality games that are designed to promote learning. As a result, game-based learning is likely to become an increasingly important part of the educational landscape in the years to come. In this study, bibliometric analysis is employed to explore the current state of research on game-based learning and 21st-century skills. The analysis focuses on articles published between 2018 and 2023, sourced from Scopus and CrossRef databases. By conducting this analysis, the study aims to gain insights into the existing research landscape, identify key trends, and contribute to the advancement of knowledge in the field of game-based learning and its relationship with 21st-century skills.

2 Method

This study employed bibliometric methods, researchers propose a new methodology to conduct text analytics-driven topic analysis following a bibliometrics and text analyt-

ics-driven approach from collected metadata [9]. Bibliometrics encompasses the gathering, examination, and understanding of bibliographic data obtained from bibliographic databases. This data is subsequently utilized to assess the productivity, influence, and impact of scientific and research endeavors within a specific field. The application of bibliometric analysis methods enables researchers to delve into bibliographic content and analyze citations extracted from articles available in Harzing's Publish or Perish database [10]. Next, the data was categorized based on the occurrence keywords, publication year, and publication density. This classification was done using the VOSviewer software for co-occurrence analysis [11]. Complemented by VOSviewer visualization software, to analyze the application of game-based learning in improving 21st century skills. The following steps outline the methodology employed.

Data Analysis, Bibliometric analysis was conducted to investigate the distribution of research influence, analyze keyword co-occurrence networks, and assess research performance. To accomplish this, the powerful bibliometric visualization tool, VOSviewer, was utilized. VOSviewer facilitated the creation of knowledge graphs and the identification of classification clusters, enabling the exploration of relationships between keywords, authors, publications, and citations. Visualization and Clustering, VOSviewer generated visual representations based on the bibliographic data, highlighting connections between keywords and their occurrences. Keyword co-occurrence networks were constructed to identify the most influential keywords and their associations. This software aided in the identification of clusters within the data, grouping articles based on thematic similarities. Research Prospects and Directions, Through the analysis conducted with VOSviewer, this study uncovered trends, hotspots, and emerging research prospects in the realm of game-based learning. The focus of analysis encompassed the development of game-based learning, the integration of 21st century skills, and the growing utilization of gamification. Insights derived from bibliometric analysis guided the identification of future research directions and opportunities in the field of educational technology. Research Performance, the bibliometric analysis also evaluated research performance by examining publication trends and identifying influential articles within the field. Metrics such as citation counts, and author collaborations were considered to assess the impact and patterns of collaboration in the research domain.

By employing bibliometric methods and leveraging the visualization capabilities of VOSviewer, this study presented a comprehensive analysis of the application of game-based learning in enhancing 21st century skills. The methodology employed facilitated the identification of key research themes, trends, and future directions, contributing to the advancement of educational technology and the effective integration of game-based learning approaches.

3 Results and discussion

The analysis of the bibliometric data using VOSviewer software yielded several key findings regarding the application of game-based learning in improving 21st century skills. Game-based learning has emerged as one of the most beneficial instructional approaches because it emphasizes "hands-on" and "minds-on" activities in classrooms.[12] The analysis identified the main occurrence keywords as "game," "digital game," "learning," "strategy," and "21st century skills." These keywords demonstrated significant research power and distribution within literature. For research data retrieval, researchers utilized the publish or perish software with two keywords: game-based learning and 21st century skills. Using the publish or perish software, the researchers specified a maximum of 200 articles from Scopus and Crossref databases, and 1000 articles from the Google Scholar database. The search was limited to the past five years (2019-2023). Once the relevant articles were obtained, the researchers saved them in RIS format for further data processing in VOSViewer. The VOS viewer software was chosen by many for visualizing bibliometric networks to detect burst keywords.[13] After filtering and processing the search results within the Publish or Perish application, the researchers proceeded with the analysis using the VOSViewer software. Employing the full counting method, the analysis focused on the relationship between game-based learning and 21st century skills. This analysis yielded a total of 19245 items, with a minimum occurrence threshold of 30 times for each word. From this pool, 133 words were selected and further refined to 65 words, which were then organized into six distinct clusters.

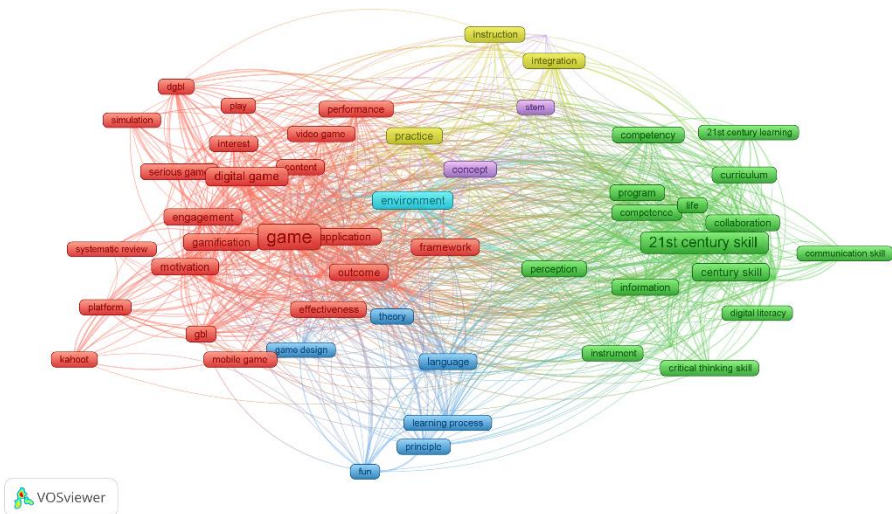


Fig. 1. Network Visualization of 89 Items with Six Cluster

The analysis using the full counting method showed a more distributed grouping. Cluster 1 is marked in red (25 items), and the words included in this cluster are about game, gamification, digital game, and so on. To indicate that games have been used as a learning tool for long time.[14] Cluster 2 is marked in green (24 items), and the words included in this cluster are mobile 21st century skills, 21st century learning, and so on. Cluster 3 is marked in blue (7 items), and the words included in this cluster are game design, learning process, and so on. Cluster 4 is marked in yellow (3 items), and the words included in this cluster are instruction, integration, and practice. Cluster 5 is marked in purple (3 items), and the words included in this cluster are computational thinking, concept, and stem. The notion of teaching experts' habits of mind (e.g., computational thinking and scientific thinking; stem included) to novices seems to have inspired many educators and researchers worldwide.[15] The 6th cluster is marked in cyan (1 item), and the words included in this cluster is environment. The analysis highlighted an evolutionary trend within the field, wherein game-based learning initially laid the foundation for subsequent developments in game. Moreover, the integration of 21st century skills emerged as a prominent content focus in game-based learning research.

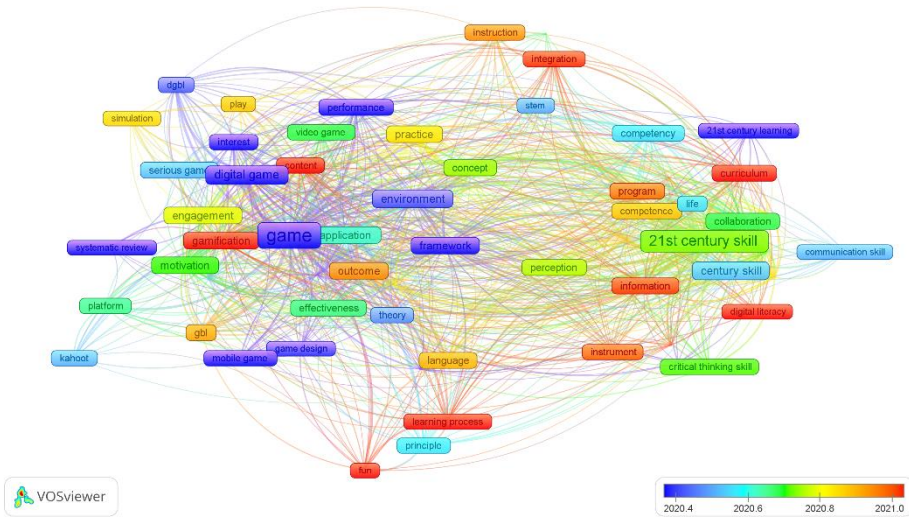


Fig. 2. Overlay Visualization of 65 Items with Six Cluster

Figure 2 of VOSviewer showcases the latest research related period. The findings indicated a notable concentration of articles focusing on "game-based learning" during the early period of 2020, while the research on "21st century skills" began to increase in late 2020. As we know education worldwide has emphasized 21st-century competencies, including language competence, computer competence, and thinking skills.[16] This trend suggests a rising interest in the field during that period.

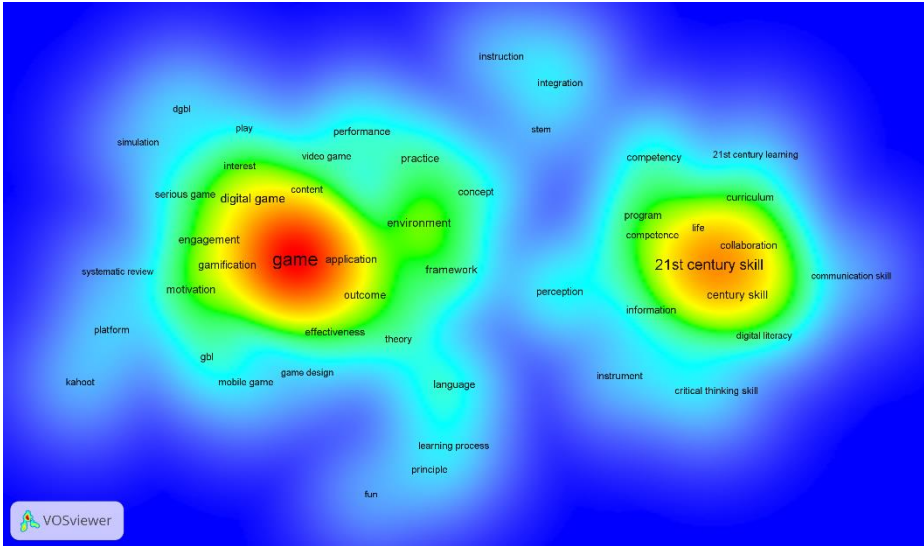


Fig. 3. Density Visualization of 65 items with Six Cluster

Figure 3 of the VOSViewer results show that items included in the cluster will be displayed on the density visualization screen. The application of VOSviewer software facilitated the identification of six distinct clusters within the research landscape. These clusters represented different aspects and dimensions of game-based learning, providing valuable insights into the diversity of approaches and themes within the field. Each color has its meaning according to the item's density. The light color that appears indicates that a lot of research has been done. In contrast, the dark color indicates that much research has not been done in the specified analysis period; the results appeared in 2020 to 2021. From the image analysis on the VOSViewer display, the word *game* often appears, meaning that there has been a lot of research on game-based learning related terms. But it becomes a novelty (the quality of being new, different and interesting[17]) when associated with 21st century skills both from the instruction and integration into learning process seems not very much connected to game-based learning.

The analysis revealed that the main occurrence keywords in the literature were "game," "digital game," "learning," "strategy," and "21st century skills." These keywords demonstrated significant research power and distribution. This indicates the prominence of these keywords in the context of game-based learning and their influence on research outcomes. Researchers utilized the Publish or Perish software with specific keywords to retrieve relevant articles from databases such as Scopus, Crossref, and Google Scholar. The search was limited to the past five years (2018-2023). Once the articles were obtained, they were saved in RIS format for further data processing in VOSViewer. This approach ensured the inclusion of recent research and enabled efficient analysis. The analysis using VOSViewer resulted in the identification of six distinct clusters within the research landscape. These clusters represented different aspects and dimensions of game-based learning. The visualizations provided

valuable insights into the diversity of approaches and themes within the field. The density visualization demonstrated the distribution of research, with light colors indicating extensive research and dark colors suggesting areas with fewer studies. The analysis indicated an evolutionary trend within the field, with game-based learning initially laying the foundation for subsequent developments in game. The integration of 21st century skills emerged as a prominent content focus in game-based learning research. This trend highlights the evolving nature of game-based learning and its adaptation to incorporate essential skills for the 21st century.

The concentration of articles related to game-based learning in the early period of 2020, followed by an increase in research on 21st century skills in late 2020, indicates a rising interest in the field during that period. This concentration of research suggests a growing recognition of the importance of integrating game-based learning approaches and 21st century skills in educational contexts. The analysis of the VOSViewer display showed that the term "game" appeared frequently, indicating extensive research in the field of game-based learning. However, the association between game-based learning and 21st century skills, particularly in terms of instruction and integration into the learning process, seemed to be less explored. This finding highlights the potential for further research to explore the effective integration of game-based learning to enhance 21st century skills acquisition.

These insights provide valuable information for researchers, educators, and policymakers. They offer a comprehensive understanding of the current state of game-based learning research, highlight areas of focus, and identify potential gaps for future investigations. The findings can inform the design of effective game-based learning interventions and contribute to the advancement of educational practices that foster 21st century skills.

4 Conclusion

Game-based learning is a rapidly growing field of research, with a significant number of recent and relevant articles published in recent years. The field is characterized by a diverse range of perspectives and approaches, with researchers investigating a variety of topics related to game-based learning, including its effectiveness in improving 21st century skills, its potential to enhance motivation and engagement, and its impact on learning outcomes. The integration of 21st century skills into game-based learning is a relatively new area of research, with much still to be learned about how to effectively integrate these skills into game-based learning experiences. Game-based learning has the potential to be a powerful tool for promoting the development of 21st century skills, such as critical thinking, problem solving, creativity, and collaboration.

Further research is needed to explore the implementation and effectiveness of game-based learning in diverse educational contexts. Overall, the bibliometric data on game-based learning suggests that this is a promising area of research with the potential to make a significant contribution to education. Of course, there are also some challenges associated with using games for learning. For example, it can be difficult to ensure that games are aligned with learning objectives and that they are effective in

promoting student learning. Additionally, some games can be addictive or violent, which can be a concern for parents and educators.

Despite these challenges, I believe that game-based learning has the potential to be a valuable tool for promoting the development of 21st century skills. As the field of game-based learning continues to evolve, I am confident that we will see the development of more effective and engaging games that can help learners acquire the skills they need to succeed in the 21st century.

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