Bibliometric Analysis of Game-Based Researches in Educational Research

Cansu Cigdem Ekin
Atilim University, Turkey

Abdulmenaf Gul
Hakkari University, Turkey

www.ijte.net

To cite this article:

Ekin, C.G., & Gul, A. (2022). Bibliometric analysis of game-based researches in educational research. *International Journal of Technology in Education (IJTE), 5*(3), 499-517. https://doi.org/10.46328/ijte.341

International Journal of Technology in Education
2022, Vol. 5, No. 3, 499-517 https://doi.org/10.46328/ijte.341

Bibliometric Analysis of Game-Based Researches in Educational Research

Cansu Cigdem Ekin, Abdulmenaf Gul

Article Info

Article History

Received:
07 January 2022
Accepted:
14 June 2022

Keywords

Bibliometric analysis Games in education
Game researches

Abstract

This research aims to conduct a bibliometric study to describe how game-based educational research is structured and how it has evolved over time. For this purpose, bibliometric analysis has been used to analyze 4980 publications indexed by the Elsevier SCOPUS database between 1967 and May 2021. The related publications were evaluated by analyzing co-authorship, co-occurrence, and citation by considering author, keyword, country, journal, university, and publication variables. As a result of the bibliometric analysis, it was concluded that the United States was leading the field and significantly publishing more studies. Top performing organizations were in Taiwan and the United States. According to the keyword co-occurrence analysis, “game-based learning” was the most used keyword followed by “serious games” and “gamification”. Co-authorship status results show that collaboration between researchers in the field was not high and the number of researchers in co-author groups was small. It was found that the most influential research was related to literature review on games and the effectiveness of games on motivation or learning and Computers & Education was the most published and cited journal in game-based educational research.

Introduction

Gaming has been criticized for having a negative impact on players as harmful in terms of violence and addiction (Granic et al., 2014). Despite the native publicity of games, the latest research has begun to reveal cognitive, emotional, and social benefits of playing games due to significant changes in game design and types (Granic et al., 2014). Educational games are increasingly becoming essential tools in education due to their affordances for fostering learning. Previous research revealed that games are effective in terms of fostering motivation, learner engagement, and problem-solving (De Sousa Borges et al., 2014; Dickey, 2007; Domínguez et al., 2013; Grünewald et al., 2019; Su & Cheng, 2015; Kapp, 2012).

In educational research, various terms, such as gamification, serious games, and educational games, have been used to define the game genre and used method. While these definitions overlap to a certain degree, they differ in terms of game features and their application in educational settings. The first method of game-based learning is the gamification method, which is a way of utilizing various game elements and mechanics in a non-gaming context (Deterding et al., 2011; Werbach & Hunter, 2012). Kapp (2012) defined gamification as "using game-

based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (p. 10). A wide range of game components can be integrated into education settings via gamification. Bunchball (2010) proposed a framework that divides these gamification elements into two main categories: mechanics and dynamics. Game mechanics are concrete and technical features. Some of the most commonly implemented mechanics are badges, rewards, points, leader boards, and levels. On the other hand, game dynamics are rather abstract features that emerge from a player's interaction with game mechanics. Competition, achievement, and reward are some examples of game dynamics. A distinct feature of gamification compared to digital games is that it is not limited to a specific tool or technology. It can be integrated into instructional processes using traditional tools without using any digital tools. A substantial body of literature has explored the affordances of gamification in education. It is found to be an effective method in terms of fostering motivation (Hakulinen et al., 2013; Hoogveld & Paas, 2002; Neeli, 2012; Su & Cheng, 2015), engagement (Çakıroğlu et al., 2017; Da Rocha Seixas et al., 2016; Leaning, 2015), achievement (Çakıroğlu et al., 2017; De-Marcos et al., 2016; Su & Cheng, 2015), learner participation and collaboration in online learning environments (Knutas et al., 2014; Moccozet et al., 2013; Uz Bilgin & Gul, 2019; Lui, 2022), and extrinsic motivation (Dewi,& Verawati, 2022; Mekler et al., 2017).

Serious games are another type of game that is extensively used in education. The main difference between serious games and entertainment games is that serious games have well-planned instructional goals and entertainment is not the primary concern (Ulrich & Helms, 2017). Usually, these games are designed as immersive 2D or 3D environments allowing users to interact and manipulate the objects in the environment. Depending on the purpose of the game it might have multiplayer features, and it can be designed to be played on various platforms such as laptops and smartphones. Simulation-based serious games are a well-known type of serious games that have been used extensively in education.

Although, in some studies, gamification, serious games, and game-based learning (GBL) are used interchangeably, we prefer to use the term game-based learning as an umbrella term to cover all types of game use in education. Therefore, in this study, we covered all these types of research to provide a broader perspective. In a game-based learning review study, researchers reported that using games for educational purposes has positive cognitive, behavioral, affective, and motivational outcomes (Connolly et al., 2012). They further reported that the most frequently reported outcome of educational games was knowledge acquisition, while affective and motivational factors were the main focus areas for entertainment games.

In parallel with the increasing popularity of game-based research, substantial research has already been conducted to review the role of games and game-based research. The number of review studies has been increasing as these articles are essential information resources for synthesizing existing literature and guiding researchers and practitioners in decision-making (Paré et al., 2015). In a review, Mayer (2019) categorizes game-based educational research into three categories; value-added research, cognitive consequences research, and media comparison research. The first category of research focuses on the effectiveness of various game features and components. The second category of research focuses on comparing the cognitive aspects of game players and non-players. The last category focuses on comparing learning outcomes of game-based instruction with conventional media.

Various research methods can be employed depending on the purpose of a review study. Some of the most common approaches to review studies are theoretical reviews, narrative reviews, systematic literature reviews, and meta-analyses (Paré et al., 2015). These approaches have already been applied in game-based research (Connolly et al., 2012; Gul & Uz Bilgin, 2020; Mayer, 2019; Papastergiou, 2009a; Tsekleves et al., 2016; Young et al., 2012). Although these studies are valuable, they cover a specific field, such as health education and adult education, or a specific type of game-based learning methods, such as gamification and video games. Another popular quantitative method of the literature review is the bibliometric analysis which aims to measure the performance and collaboration of researchers and institutions and map the historical development of a research field (Ellegaard & Wallin, 2015). Using text-mining and visualization methods, this approach allows researchers to use a large set of citation and co-citation data to draw out common research patterns.

In recent years there has been an enormous increase in the number of studies using bibliometric analysis partly due to large volumes of data and computer software to analyze these data automatically. This method has been used in various research fields such as computer science (Y. Li et al., 2020), economics (Bonilla et al., 2015), and marketing (Martínez-López et al., 2018), and healthcare (Gu et al., 2017). Our extensive search of available bibliometric analysis studies in game-based educational research revealed some studies. The first study conducted by Trinidad and colleagues (2021) used bibliometrics analysis covering gamification research. The main difference between their study and ours was that their search criteria were gamification, excluding other types and methods of game use and all research fields. Two other studies (Çiftci, 2018; Irmade et al., 2021) analyzed serious games while excluding methods such as gamification.

Similarly, these studies included research papers from other fields such as engineering and economics. The last study we found was conducted by Chen et al. (2021) and their study covered only mathematics and science education research. Our extensive literature search showed that game-based educational research had not been analyzed over a long period of time using bibliometric analysis. Furthermore, the studies mentioned above covered a shorter period than ours. For example, in their study, Trinidad and colleagues (2021) analyzed publications from 2011. Considering the long history of game-based educational research we have strived to include studies since 1967. To the best of our knowledge, this study is the first effort to provide an up-to-date game-based educational research review and aims to fill a critical gap.

Given the use of a wide range of terms in game-based educational research and various focus areas, it is vital to present an overview of the current literature to help researchers and practitioners in the field. Thus, this paper presents a bibliometric analysis of game-based educational research. The findings of this paper will be invaluable for junior and senior researchers in terms of; gaining insight into game-based educational research, identifying the most relevant literature and topics in the field, and providing evidence of potential research gaps. In addition, this paper will provide insights for practitioners in terms of historical trends in the educational use of games and the latest trending topics.

Based on the aim of the paper, the following research questions were investigated;

- RQ 1. What bibliometric characteristics of game-based research in educational journals between 1967 and 2021?

- RQ1.1 Who are the most influential authors?
- RQ1.2 Which are the most influential researches and sources?

- RQ 2. What are the scientific collaborations among major contributors like?
- RQ 3. What is the trend and distribution of author keywords in the game-based research in educational journals in the period between 1967 and 2021?

Method

To analyze bibliometric characteristics and research trends of game-based research in the field of education, research methodology was designed considering the main steps of bibliometric analysis. The research has mainly consisted of 2 sub-processes: (1) data retrieval (2) and bibliometric analysis. A detail of these sub-processes is given in Figure 1.

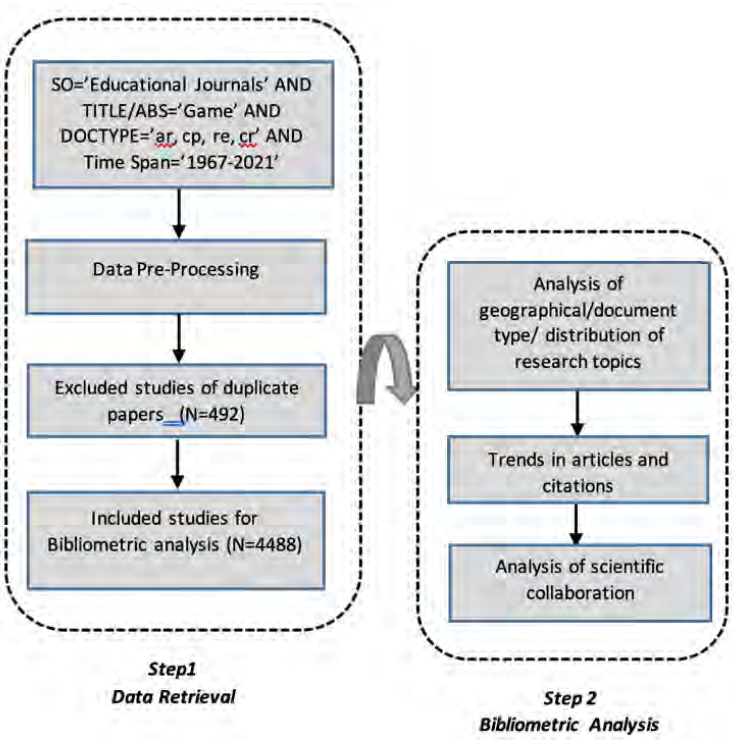

Figure 1. Steps of the Research

Bibliometric Analysis

The bibliometric analysis examines the bibliometric data in studies published by individuals or institutions in a specific period and region, and the relations between these publications (Small, 1999; Thelwall, 2008). With bibliometric analysis, research articles are examined within the framework of different characteristics such as subject, year, contributors, keywords, citations, and co-citations. Most influential authors, publications, or journals can be found in this analysis. In this bibliometric analysis, the aim was to examine the publications about game-based educational research by revealing the status of the scientific collaboration in means of co-authorship, trends in articles in terms of the keyword co-occurrence and citation, and yearly distribution. VOSviewer software was

used to analyze and visualize the co-authorship, keyword co-occurrence, and citation metrics. The threshold (cutoff value) required for each relevant analysis was used to create more meaningful maps.

Data Retrieval

In the first stage of the analysis, the Web of Science and Elsevier Scopus database, the two most critical electronic sources in bibliometric analysis, were selected as primary data sources and the same search queries were used for both of these databases. When the search results of two databases were compared, the number of retrieved articles based on the relevant search query was significantly higher in Elsevier Scopus because it covers more journals (Mongeon & Paul-Hus, 2016). Thus, Elsevier Scopus was preferred as the final data source.

In bibliometric analysis, an article's title, abstract, and keyword section are the primary sections used as input for the analysis. In order to cover a wide range of publications, we searched for studies containing the term "game" in these sections. Furthermore, the target field was educational research based on the research questions. Thus, the subject area was restricted to education to cover only studies published in this category. The search was limited to journal articles, journal reviews, conference papers, and conference reviews. Publication language was limited to English only and the publication period was between 1967-and 2021.

In total, 4980 journal publications were retrieved as an experimental dataset. In the data preprocessing step, a total of 492 publications were removed due to missing data. Among these studies, 352 did not have an abstract text and 140 had the same abstract. Then, the affiliation section in the dataset was converted into a format suitable for bibliometric analysis. The final dataset ready for bibliometric analysis included 4488 publications.

Results

Co-authorship Analysis Results of Countries

Results of country co-authorship comprised 65 countries out of 115 with at least five publications on games in education. When the co-authorship status is examined in Figure 2, there were 12 different clusters in different colors. Each cluster shows the countries where they collaborate more in co-authorship. The size of the nodes shows countries in which they have more collaborations. The links between countries indicate the number of co-authorships of a given country with other countries. The United States is the most prominent country in terms of collaborations with other countries, with co-authored works comprising 41 different countries. This superiority in collaboration is followed by the United Kingdom with 38, Australia with 28, and Canada with 22 countries. The most prominent countries in terms of the number of publications in order (see Figure 3) are the United States (n=1283 papers), Taiwan (n=400), United Kingdom (n=338), Spain (n=240), Australia (n=235), and Brazil (n=180). Remarkably, the United States and Spain are in the same cluster. From this relationship, it seems that the United States and Spain are the countries that publish together the most. On the other hand, Taiwan and China are also in the same cluster, again in the category of the two countries that publish the most together. The red cluster with a network of 18 countries is the largest co-authorship network. Among the clusters, it is noteworthy that Morocco and Slovenia do not have any co-authorship with any other country.

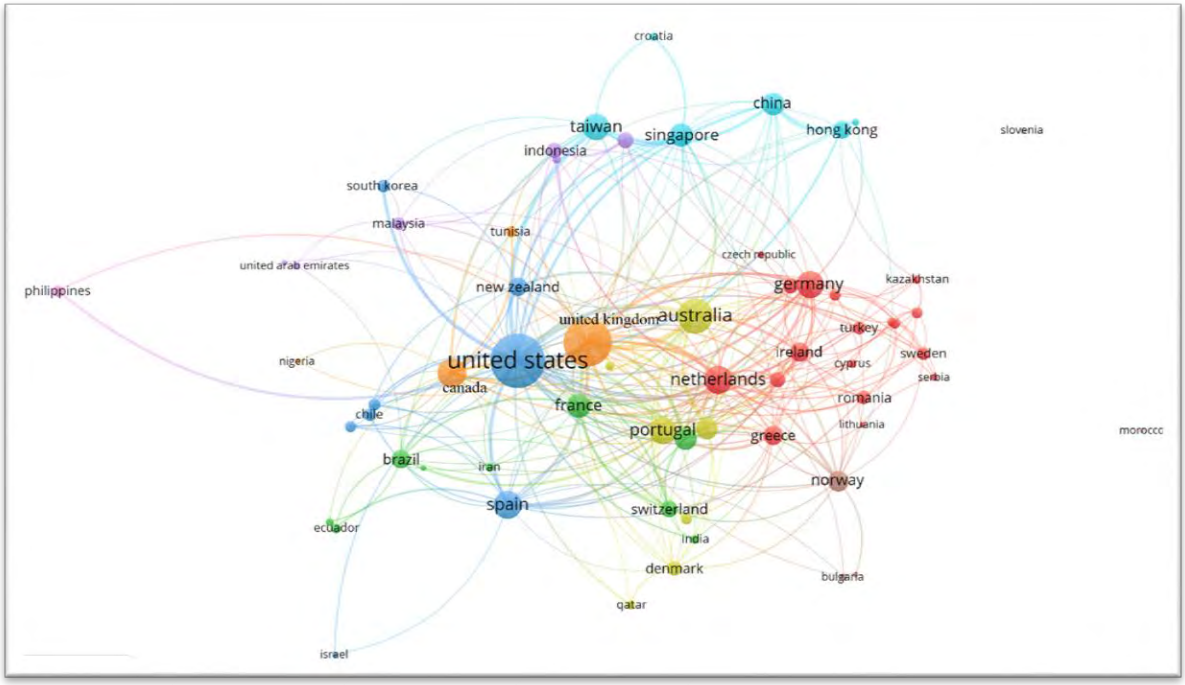

Figure 2. The Country Co-authorship Network Map on Games in Educational Publications

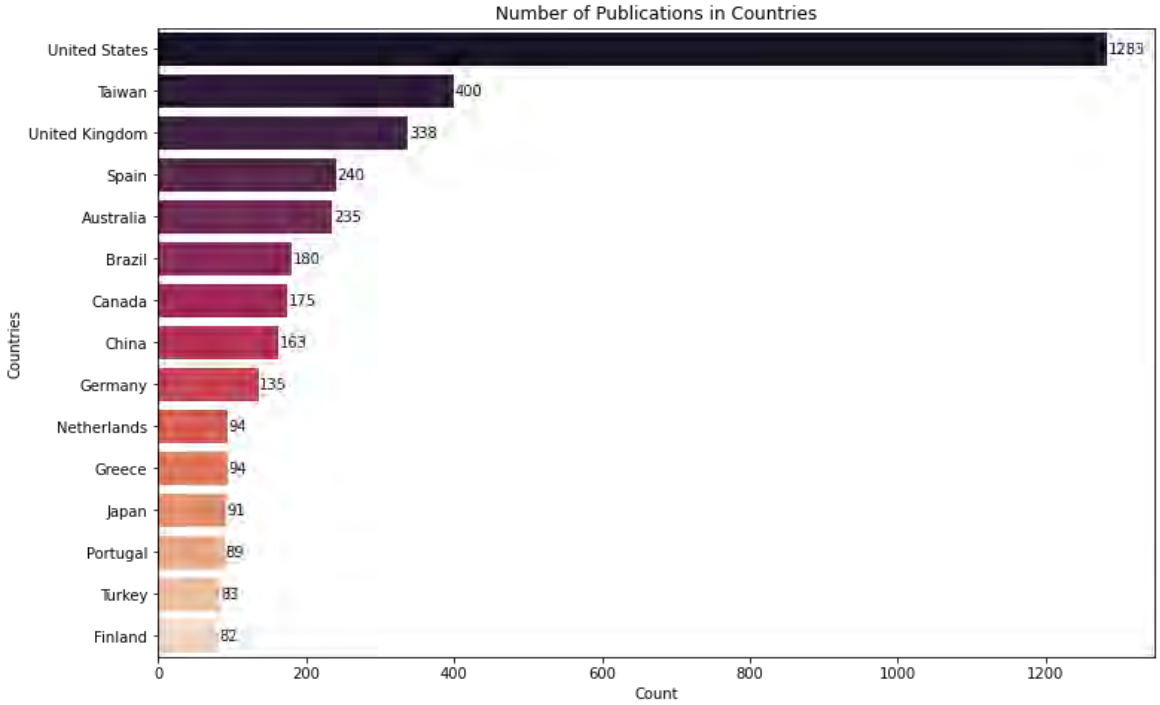

Figure 3. Number of Publications by Countries

Co-authorship Analysis Results for Organizations

Organizations with at least 15 publications were included in the organization co-authorship analysis. According to the result, 2833 institutions have published in the field, and 40 organizations met this threshold. The co-authorship status of publications is presented in Figure 4. In the analysis, 40 organizations were classified with 22

different colored clusters. The links between two circles represent the linked organizations having publications together. The size of the circle represents the number of publications of the organization. As seen in Figure 4, only 7 clusters (containing 21 organizations) surrounded by lines were interconnected, while the other 15 clusters were not connected. In other words, they had no co-authorship. To make it more precise, the top 15 most cited institutions that are cited more than 490 times and related information are listed in Table 1.

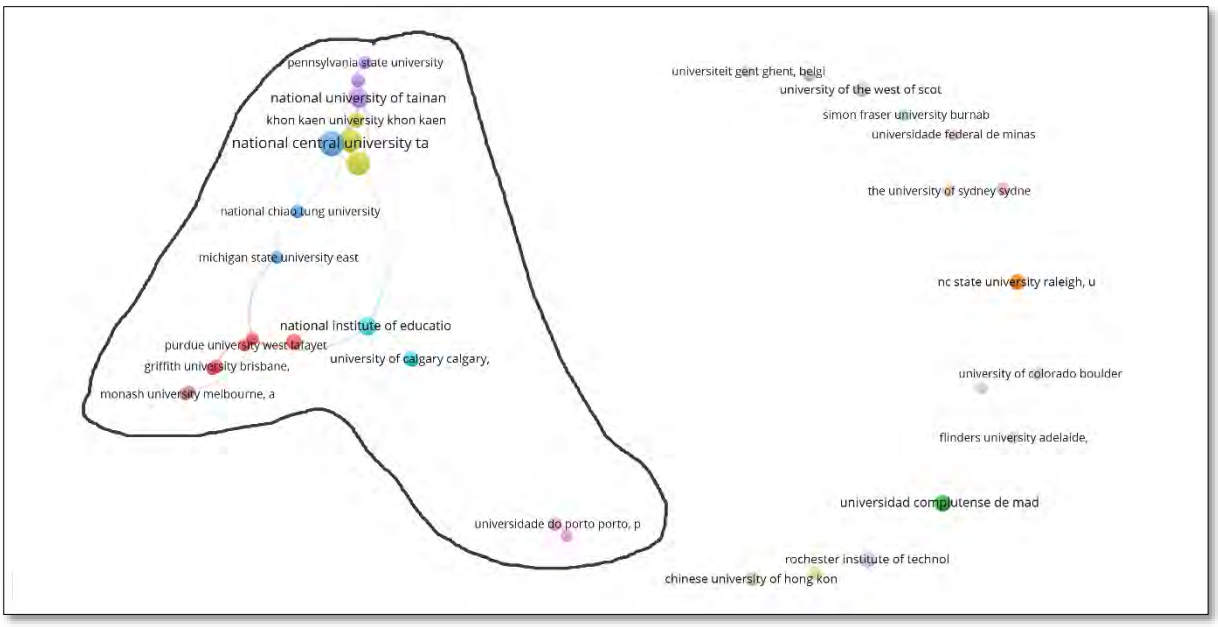

Figure 4. Organization Co-authorship Network Map on Game in Education

When Table 1 is examined, a significant portion of the 15 organizations is from Taiwan (5 organizations) and the United States (4 organizations). The University of The West of Scotland Ayr has published just 22 papers in the area but has gained the highest citation score. *National Taiwan University of Science and Technology Taipei* and *Nc State University Raleigh* have published 56 and 28 papers respectively and have been cited 1760 and 1062 times. Total link strength value shows the number of collaborations of the organization with other organizations. As seen in Table 1, it is noteworthy that the *University of The West of Scotland Ayr* has the highest citation score but has no co-authorship with other organizations. *National Taiwan University of Science and Technology Taipei* has the highest collaboration value. It has collaborated 14 times with other organizations. National Taiwan Normal University Taipei has the next highest collaboration value with 13 and is again a Taiwan university.

Table 1. The Top 15 Most Influential Organizations

Rank	Organization	Country	# of Publications	Citations	Total link strength
1	The University of The West of Scotland Ayr	United Kingdom	22	2341	0
2	National Taiwan University of Science and Technology Taipei	Taiwan	56	1760	14

Rank	Organization	Country	# of Publications	Citations	Total link strength
3	Nc State University Raleigh	United States	28	1062	5
4	National Taiwan Normal University Taipei	Taiwan	63	809	13
5	Universiteit Gent Ghen	Belgium	15	806	0
6	University of Central Florida Orlando	United States	15	734	3
7	National Cheng Kung University Tainan	Taiwan	21	605	8
8	National İnstitute Of Education Singapore City	Singapore	34	592	9
9	National Chiao Tung University Taiwan Hsinchu	Taiwan	19	581	3
10	Norges Teknisk-Naturvitenskapelige Universitet Trondheim	Norway	20	575	0
11	University of Jyvaskyla Jyvaskyla	Finland	24	532	3
12	University of Colorado Boulder Boulder	United States	16	506	0
13	National Central University Taiwan Chung-Li	Taiwan	68	501	8
14	Queensland University of Technology Brisbane	Australia	16	497	10
15	Michigan State University East Lansing	United States	17	496	3

Co-occurrence Analysis Results for Keywords

Between 8500 unique keywords, the threshold value was set as 20 in means of the minimum number of occurrences of a keyword; 86 keywords meet this threshold value. Figure 5 shows the network map of the most used keywords between 1967 to May 2021. There are five different colored clusters. As shown in the same cluster, relevant keywords are commonly given together. The links between two circles represent the linked keywords used together. The size of the circle represents the frequency of the occurrence. The green cluster in Figure 5 shows that game-based learning, serious games, educational games, game design, e-learning, active learning, game theory, and mobile learning are closely related and frequently co-occur. For the red cluster, games, motivation, engagement, self-efficacy, children, and collaboration are closely related and frequently co-occur. To make it more straightforward, the top 15 most used keywords and related information are listed in Table 2.

As seen in Table 2, game-based learning, serious games, games, gamification, and educational games are the core keywords. The total link strength (TLS) value in Table 2 represents the number of links of a keyword with other keywords. Game-based learning and serious games are the most occurring and used keywords together with other

keywords. The interactive learning environment keyword is in rank 9 in the occurrence, but in rank 3 in the TLS score. It is the third keyword most used together with other keywords.

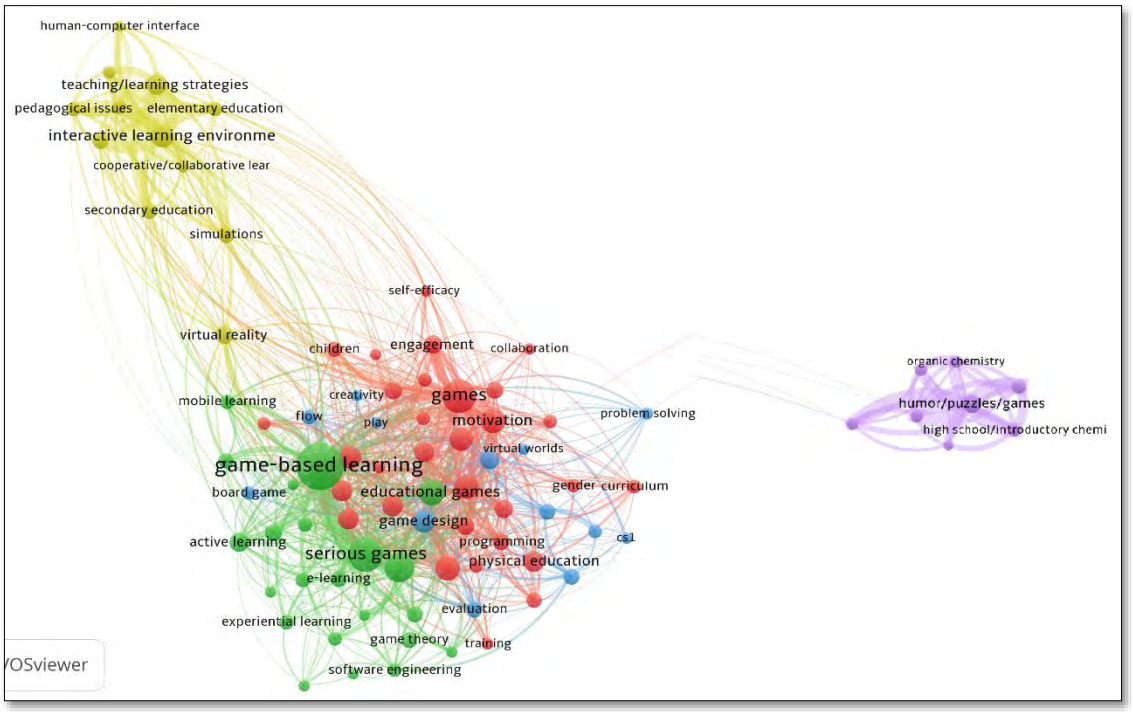

Figure 5. Author Keywords Co-occurrence Network Map

Table 2. Top 15 Most Used Keywords

Keyword	Occurrences	Total Link strength	Rank in the TLS	Rank in the Occurrence
game-based learning	483	452	1	1
serious games	240	269	2	2
games	231	250	4	3
gamification	172	246	5	4
educational games	125	120	12	5
education	123	190	7	6
motivation	119	181	9	7
learning	115	159	10	8
interactive learning environments	108	251	3	9
video games	105	93	25	10
game design	98	128	11	11
educational game	94	88	28	12
simulation	84	112	15	13
game	84	86	30	14
serious game	83	81	34	15

Co-authorship Analysis Results

In the co-authorship analysis, the authors with at least five publications on games were included out of 10471 authors (f = 184, N = 10471). 187 authors meet the thresholds. As a result, 69 different clusters emerged. As seen in Figure 6, only 4 clusters surrounded by lines were connected (f = 40), and this network includes a small number of researchers. When the network map is analyzed, it becomes clear that the collaboration among the clusters the researchers constructed is weak.

In most of the clusters, there are also not a lot of researchers. According to several authors (f=15), the red cluster is the biggest cluster. Surprisingly, given the quantity of publications, none of the authors in this cluster are well-known. Although there are no notable authors in this cluster, N. Srisawasdi is the author with the most publications, 20 documents total. The green cluster is another noteworthy cluster. With 23 publications, H.T. Hou stands out among the group of ten authors. The light blue cluster contains the most notable authors. With 33 and 27 documents, respectively, on games in the educational field, T.W. Chan and Z.H. Chen are the authors with the most publications. The number of publications is indicated by the size of the circles. The circles' close proximity to one another suggests collaboration.

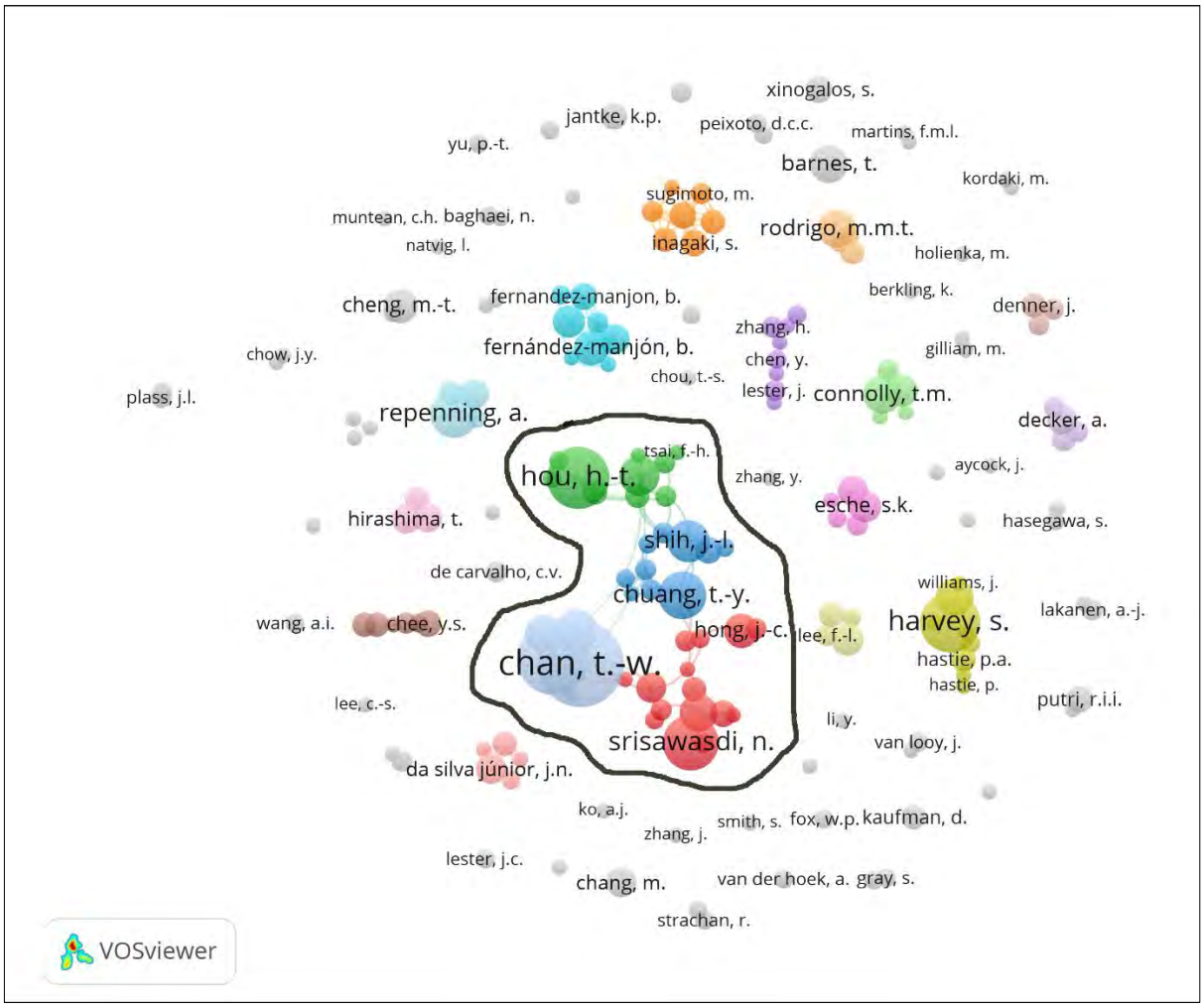

Figure 6. Co-authorship Network Map

Most Influential Researches

Citation analysis was used to determine the most influential researchers from 1967 to 2021 in the field of game research in education. Only 98 of these articles received 100 or more citations. Table 3 lists the top 15 studies with the most impact. The Connolly et al. study is the piece of writing that has garnered the most citations (2012). He conducted research on computer games and serious games and published it in the Computers & Education Journal. When the related studies are examined in Table 3, it is seen that the most cited studies are in the Computers & Education journal. In addition, it is noteworthy that the related studies were conducted mainly between 2009 and 2016. Most of the highly cited studies include research literature reviews on games and the effectiveness of games on motivation or learning.

Table 3. The Most Cited 15 Publications

Authors	Title	Pub. Year	Source Title	# of Citation
Connolly et al. (2012)	A systematic literature review of empirical evidence on computer games and serious games	2012	Computers and Education	1294
Papastergiou (2009b)	Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation	2009	Computers and Education	926
Kiili (2005)	Digital game-based learning: Towards an experiential gaming model	2005	Internet and Higher Education	808
Domínguez et al. (2013)	Gamifying learning experiences: Practical implications and outcomes	2013	Computers and Education	754
Merchant et al. (2014)	Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis	2014	Computers and Education	537
De Freitas and Oliver (2006)	How can the curriculum's exploratory learning with games and simulations be most effectively evaluated?	2006	Computers and Education	447
Ebner and Holzinger (2007)	Successful implementation of user-centered game-based learning in higher education: An example from civil engineering	2007	Computers and Education	419

Authors	Title	Pub. Year	Source Title	# of Citation
Rosas et al. (2003)	Beyond Nintendo: Design and assessment of educational video games for first and second-grade students	2003	Computers and Education	406
Boyle et al. (2016)	An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games	2016	Computers and Education	387
Annetta et al. (2009)	Investigating the impact of video games on high school students' engagement and learning about genetics	2009	Computers and Education	363
Papastergiou (2009a)	Exploring the potential of computer and video games for health and physical education: A literature review	2009	Computers and Education	350
Kebritchi et al. (2010)	The effects of modern mathematics computer games on mathematics achievement and class motivation	2010	Computers and Education	335
Fu et al. (2009)	EGameFlow: A scale to measure learners' enjoyment of e-learning games	2009	Computers and Education	333
Tüzün et al. (2009)	The effects of computer games on primary school students' achievement and motivation in geography learning	2009	Computers and Education	332
Li and Kirkup (2007)	Gender and cultural differences in Internet use: A study of China and the UK	2007	Computers and Education	325

Most Influential Sources

The most influential sources from 1967 to 2021 were determined according to the citation analysis. The top 15 most influential sources are given in Table 4. The source that received the highest number of citations is Computers and Education. While the related journal is the first in the citation score, it is also in the first rank regarding the total number of publications. While the Journal of Science Education and Technology is in 2nd place with its citation score, it is in 11th place with the number of publications it has. In addition, it is noteworthy

that 4 of the top 10 most cited journals are related to physical education and sport.

Table 4. The Most cited 15 Sources from 1967 to 2021

Journal	# of Publications	# of Citations	Rank in the Total Number of Publications
Computers and Education	317	23193	1
Journal of Science Education and Technology	44	1367	11
Journal of Teaching in Physical Education	32	1110	16
Physical Education and Sport Pedagogy	44	1065	12
European Physical Education Review	45	939	9
Journal of Chemical Education	92	906	5
Proceedings - Frontiers in Education Conference, Fie	216	775	2
International Journal of Artificial Intelligence İn Education	25	607	20
Sport, Education and Society	33	563	15
Journal of Research on Technology in Education	13	541	69
IEEE Global Engineering Education Conference, EduCon	118	512	4
IEEE Transactions on Education	24	503	24
Journal of Physical Education and Sport	125	494	3
Interactive Technology and Smart Education	31	480	17
Since Bulletin (Association for Computing Machinery, Special Interest Group on Computer Science Education)	17	478	46

Discussion and Conclusion

In this study, we proposed an approach based on bibliometric analysis, text-mining and visualization techniques to assess the most up-to-date review of the game-based educational research. Performance analysis of the studies revealed useful information regarding the performance of countries, institutions, authors, journals, citations, and co-citations. The first finding was countries' performance analysis which revealed that the United States was leading the field and significantly publishing more studies. Following this country, Taiwan, the United Kingdom, Spain, and Australia were the other high-performing countries. Furthermore, country collaboration was investigated using clustering methods. Results revealed four main clusters, mainly based on geographical region and the country's official language. For instance, South Asian countries formed a cluster which means those countries collaborated more.

Similarly, the United Kingdom and Canada counties with the same official language were grouped under the same

cluster. Similar to publication performance results, the United States had the highest collaboration score and collaborated with more than 40 countries. Based on these findings, it can be argued that countries' geographical regions and socio-cultural similarities played an essential role in countries' collaboration in game-based educational research. Another important finding was that the United States was significantly out-performing other countries in terms of productivity and collaboration (Wang& Tian, 2021; Dehghanbanadaki et al., 2020).

Analyzing the organizations' publication performance revealed that top-performing organizations were in Taiwan and the United States. When the correlation between organizations' publications count and citation scores was considered, the results revealed mixed findings. For example, the University of The West of Scotland Ayr had an average publication count. However, it was the most influential organization as it had quite a high citation score. Another investigated organization performance factor was the collaboration score measured based on the number of publications co-authored with other organizations. The result revealed a weak degree of collaboration among organizations. Thus, it can be argued that collaboration among organizations could be improved in game-based educational research.

Another factor that we analyzed was the co-occurrence of keywords used for publications. Using text-mining and clustering methods, we analyzed keywords to investigate the research areas in game-based research. Analysis results revealed four main clusters. The biggest cluster was game-based learning and included more broad terms. This cluster included keywords such as "game-based learning", "serious games", and "educational games". The second cluster was studies related to affective aspects of game-based research and some of the main keywords were "motivation", "engagement", and "problem-solving". The third emerged cluster was related to game-based learning methods and strategies. Cluster keywords showed that these studies were focused on "interactive learning environments" and the research focus was "pedagogical issues", "teaching/learning strategies", and "collaborative learning". The third cluster was related to game design and evaluation methods. This cluster mostly included the research-focused game design elements such as flow, creativity and methods to evaluate games. The final cluster was domain-specific which included education games related to chemistry education. Keyword co-occurrences results revealed that "game-based learning" was the most used keyword followed by "serious games" and "gamification". A similar result was found in the study of Schöbel and his colleagues (2021). As discussed in the introduction section, although sometimes these terms are used interchangeably, there are specific differences. While game-based learning is a broad term and can be used as an umbrella term, serious games and gamification are specific types of games designed for specific instructional goals.

Besides, this study analyzed the co-authorship status of the game-based educational research to find the existence of groups of authors collaborating more. It was determined that only 67 researchers among 187 with at least five publications collaborated with different researchers. Among these 67 researchers, it was observed that only four different groups collaborated. Related results show that there is not much collaboration between researchers in the field and the number of researchers in co-author groups is small. Thus, it can be argued that in game-based educational research collaboration among researchers could be improved.

This study also used citation analysis to investigate the most influential research in the field. The publication that

received the highest number of citations is the study by Connolly et al. (2012). His research was a literature review on computer games and serious. The results showed that the most cited studies are in the Computers& Education Journal. It was concluded that the most influential research was related to the literature reviews on games and the effectiveness of games on motivation or learning. It was noteworthy that studies were mostly conducted between 2009 and 2016.

According to the journal analysis, Computers & Education was the most published and cited journal in game-based educational research. Journal of Science Education and Technology, Journal of Teaching in Physical Education, and Physical Education and Sport Pedagogy were also influential. In addition, 4 of the top 10 most cited journals are related to physical education and sport.

References

Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M.-T. (2009). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers & Education*, *53*(1), 74–85. https://doi.org/10.1016/j.compedu.2008.12.020

Bonilla, C. A., Merigó, J. M., & Torres-Abad, C. (2015). Economics in Latin America: a bibliometric analysis. *Scientometrics*, *105*(2), 1239–1252. https://doi.org/10.1007/s11192-015-1747-7

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

Bunchball. (2010). *Gamification 101: An introduction to game dynamics [White paper]*. http://jndglobal.com/wp-content/uploads/2011/05/gamification1011.pdf

Çakıroğlu, Ü., Başıbüyük, B., Güler, M., Atabay, M., & Yılmaz Memiş, B. (2017). Gamifying an ICT course: Influences on engagement and academic performance. *Computers in Human Behavior*, *69*, 98–107. https://doi.org/10.1016/j.chb.2016.12.018

Chen, P. Y., Hwang, G. J., Yeh, S. Y., Chen, Y. T., Chen, T. W., & Chien, C. H. (2021). Three decades of game-based learning in science and mathematics education: an integrated bibliometric analysis and systematic review. *Journal of Computers in Education*, *0123456789*. https://doi.org/10.1007/s40692-021-00210-y

Çiftci, S. (2018). Trends of serious games research from 2007 to 2017: a bibliometric analysis. *Journal of Education and Training Studies*, *6*(2), 18. https://doi.org/10.11114/jets.v6i2.2840

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers and Education*, *59*(2), 661–686. https://doi.org/10.1016/j.compedu.2012.03.004

Da Rocha Seixas, L., Gomes, A. S., & De Melo Filho, I. J. (2016). Effectiveness of gamification in the engagement of students. *Computers in Human Behavior*, *58*, 48–63. https://doi.org/10.1016/j.chb.2015.11.021

De-Marcos, L., Garcia-Lopez, E., & Garcia-Cabot, A. (2016). On the effectiveness of game-like and social approaches in learning: Comparing educational gaming, gamification & social networking. *Computers and Education*, *95*, 99–113. https://doi.org/10.1016/j.compedu.2015.12.008

De Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers and Education*, *46*, 249–264. https://doi.org/10.1016/j.compedu.2005.11.007

Dehghanbanadaki, H., Seif, F., Vahidi, Y., Razi, F., Hashemi, E., Khoshmirsafa, M., & Aazami, H. (2020). Bibliometric analysis of global scientific research on Coronavirus (COVID-19*). Medical journal of the Islamic Republic of Iran*, *34*, 51.

De Sousa Borges, S., Durelli, V. H. S., Reis, H. M., & Isotani, S. (2014). A systematic mapping on gamification applied to education. *29th Annual ACM Symposium on Applied Computing - SAC '14*, *60*(1), 216–222. https://doi.org/10.1145/2554850.2554956

Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification: Using game-design elements in non-gaming contexts. *Proc. CHI EA '11*, 2425–2428.

Dewi, R., & Verawati, I. (2022). The Effect of Manipulative Games to Improve Fundamental Motor Skills in Elementary School Students. *International Journal of Education in Mathematics, Science, and Technology (IJEMST), 10*(1), 24-37. https://doi.org/10.46328/ijemst.2163

Dickey, M. D. (2007). Game design and learning: a conjectural analysis of how massively multiple online role-playing games (MMORPGs) foster intrinsic motivation. *Educational Technology Research and Development*, *55*(3), 253–273. https://doi.org/10.1007/s11423-006-9004-7

Domínguez, A., Saenz-De-Navarrete, J., De-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers and Education*, *63*, 380–392. https://doi.org/10.1016/j.compedu.2012.12.020

Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: An example from civil engineering. *Computers & Education*, *49*(3), 873–890. https://doi.org/10.1016/j.compedu.2005.11.026

Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, *105*(3), 1809–1831. https://doi.org/10.1007/s11192-015-1645-z

Fu, F.-L., Su, R.-C., & Yu, S.-C. (2009). EGameFlow: A scale to measure learners' enjoyment of e-learning games. *Computers & Education*, *52*(1), 101–112. https://doi.org/10.1016/j.compedu.2008.07.004

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. *American Psychologist*, *69*(1), 66–78. https://doi.org/10.1037/a0034857

Grünewald, H., Kneip, P., & Kozica, A. (2019). The use of gamification in workplace learning to encourage employee motivation and engagement. In *The Wiley Handbook of Global Workplace Learning* (pp. 557–575). Wiley. https://doi.org/10.1002/9781119227793.ch29

Gu, D., Li, J., Li, X., & Liang, C. (2017). Visualizing the knowledge structure and evolution of big data research in healthcare informatics. *International Journal of Medical Informatics*, *98*, 22–32. https://doi.org/10.1016/j.ijmedinf.2016.11.006

Gul, A., & Uz Bilgin, C. (2020). Gamification in adult learning. In *Handbook of Research on Adult Learning in Higher Education* (pp. 570–597). https://doi.org/10.4018/978-1-7998-1306-4.ch022

Hakulinen, L., Auvinen, T., & Korhonen, A. (2013). Empirical study on the effect of achievement badges in TRAKLA2 online learning environment. *Proceedings of Learning and Teaching in Computing and Engineering (LaTiCE) Conference*, 47–54. https://doi.org/10.1109/LaTiCE.2013.34

Hoogveld, A., & Paas, F. (2002). Exploring teachers' instructional design practices from a systems design perspective. *Instructional Science*, *30*(43), 291–305.

Irmade, O., Suwarno, & Anisa, N. (2021). Research trends of serious games: Bibliometric analysis. *Journal of Physics: Conference Series*, *1842*(1). https://doi.org/10.1088/1742-6596/1842/1/012036

Kapp, K. M. (2012). *The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education*. Pfeiffer.

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education*, *55*(2), 427–443. https://doi.org/10.1016/j.compedu.2010.02.007

Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. *The Internet and Higher Education*, *8*(1), 13–24. https://doi.org/10.1016/j.iheduc.2004.12.001

Knutas, A., Ikonen, J., Nikula, U., & Porras, J. (2014). Increasing collaborative communications in a programming course with gamification. *15th International Conference on Computer Systems and Technologies - CompSysTech '14*, 370–377. https://doi.org/10.1145/2659532.2659620

Leaning, M. (2015). A study of the use of games and gamification to enhance student engagement, experience and achievement on a theory-based course of an undergraduate media degree. *Journal of Media Practice*, *16*(2), 155–170. https://doi.org/10.1080/14682753.2015.1041807

Li, C., Dong, Z., Untch, R. H., & Chasteen, M. (2013). Engaging computer science students through gamification in an online social network based collaborative learning environment. *International Journal of Information and Education Technology*, *3*(1), 72–77. https://doi.org/10.7763/ijiet.2013.v3.237

Li, N., & Kirkup, G. (2007). Gender and cultural differences in Internet use: A study of China and the UK. *Computers & Education*, *48*(2), 301–317. https://doi.org/10.1016/j.compedu.2005.01.007

Li, Y., Xu, Z., Wang, X., & Wang, X. (2020). A bibliometric analysis on deep learning during 2007–2019. *International Journal of Machine Learning and Cybernetics*, *11*(12), 2807–2826. https://doi.org/10.1007/s13042-020-01152-0

Liu, X., Wachira, P., Koc, S., & Pourdavood, R. (2022). An Exploratory Study of Predictors of Pre-Service Teachers' Intention to Integrate Computer Games in Mathematics Education. *International Journal of Education in Mathematics, Science, and Technology (IJEMST), 10*(1), 145-161. https://doi.org/10.46328/ijemst.1827

Martínez-López, F. J., Merigó, J. M., Valenzuela-Fernández, L., & Nicolás, C. (2018). Fifty years of the European Journal of Marketing : A bibliometric analysis. *European Journal of Marketing*, *52*(1/2), 439–468. https://doi.org/10.1108/EJM-11-2017-0853

Mayer, R. E. (2019). Computer games in education. *Annual Review of Psychology*, *70*(September 2018), 531–549. https://doi.org/10.1146/annurev-psych-010418-102744

Mekler, E. D., Brühlmann, F., Tuch, A. N., & Opwis, K. (2017). Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. *Computers in Human Behavior*, *71*, 525–534. https://doi.org/10.1016/j.chb.2015.08.048

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers and Education*, *70*, 29–40. https://doi.org/10.1016/j.compedu.2013.07.033

Moccozet, L., Tardy, C., Opprecht, W., & Leonard, M. (2013). Gamification-based assessment of group work. *International Conference on Interactive Collaborative Learning (ICL)*, 171–179. https://doi.org/10.1109/ICL.2013.6644565

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: a comparative analysis. *Scientometrics*, *106*(1), 213–228. https://doi.org/10.1007/s11192-015-1765-5

Neeli, B. K. (2012). A method to engage employees using gamification in BPO Industry. *3rd International Conference on Services in Emerging Markets*, 142–146.

Papastergiou, M. (2009a). Exploring the potential of computer and video games for health and physical education: A literature review. *Computers and Education*, *53*(3), 603–622. https://doi.org/10.1016/j.compedu.2009.04.001

Papastergiou, M. (2009b). Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation. *Computers & Education*, *52*(1), 1–12. https://doi.org/10.1016/j.compedu.2008.06.004

Paré, G., Trudel, M. C., Jaana, M., & Kitsiou, S. (2015). Synthesizing information systems knowledge: A typology of literature reviews. *Information and Management*, *52*(2), 183–199. https://doi.org/10.1016/j.im.2014.08.008

Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., Grau, V., Lagos, F., López, X., López, V., Rodriguez, P., & Salinas, M. (2003). Beyond Nintendo: design and assessment of educational video games for first and second grade students. *Computers & Education*, *40*(1), 71–94. https://doi.org/10.1016/S0360-1315(02)00099-4

Small, H. (1999). Visualizing science by citation mapping. *Journal of the American Society for Information Science*, *50*(9), 799–813.

Schöbel, S., Saqr, M., & Janson, A. (2021). Two decades of game concepts in digital learning environments–A bibliometric study and research agenda. *Computers & Education*, *173*, 104296.

Su, C.-H., & Cheng, C.-H. (2015). A mobile gamification learning system for improving the learning motivation and achievements. *Journal of Computer Assisted Learning*, *31*(3), 268–286. https://doi.org/10.1111/jcal.12088

Thelwall, M. (2008). Bibliometrics to webometrics. *Journal of Information Science*, *34*(4), 605–621. https://doi.org/10.1177/0165551507087238

Trinidad, M., Ruiz, M., & Calderon, A. (2021). A bibliometric analysis of gamification research. *IEEE Access*, *9*, 46505–46544. https://doi.org/10.1109/ACCESS.2021.3063986

Tsekleves, E., Cosmas, J., & Aggoun, A. (2016). Benefits, barriers and guideline recommendations for the implementation of serious games in education for stakeholders and policymakers. *British Journal of Educational Technology*, *47*(1), 164–183. https://doi.org/10.1111/bjet.12223

Tüzün, H., Yılmaz-Soylu, M., Karakuş, T., İnal, Y., & Kızılkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computers & Education*, *52*(1), 68–77. https://doi.org/10.1016/j.compedu.2008.06.008

Uz Bilgin, C., & Gul, A. (2019). Investigating the effectiveness of gamification in collaborative learning environments. *TechTrends*. https://doi.org/10.1007/s11528-019-00442-x

Wang, P., & Tian, D. (2021). Bibliometric analysis of global scientific research on COVID-19. *Journal of*

Biosafety and Biosecurity, *3*(1), 4-9.

Werbach, K., & Hunter, D. (2012). For the win: How game thinking can revolutionize your business. In *Wharton Digital Press*. Wharton Digital Press. https://doi.org/10.1017/CBO9781107415324.004

Yildirim, I. (2017). The effects of gamification-based teaching practices on student achievement and students' attitudes toward lessons. *Internet and Higher Education*, *33*(2016), 86–92. https://doi.org/10.1016/j.iheduc.2017.02.002

Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., Simeoni, Z., Tran, M., & Yukhymenko, M. (2012). Our princess is in another castle: A review of trends in serious gaming for education. *Review of Educational Research*, *82*(1), 61–89. https://doi.org/10.3102/0034654312436980

Author Information

Cansu Cigdem Ekin
https://orcid.org/0000-0003-4838-9708
Atilim University
Turkey
Contact e-mail: *cansu82@gmail.com*

Abdulmenaf Gul
https://orcid.org/0000-0002-3683-8441
Hakkari University
Turkey