Gamification in Inclusive Education for Children with Disabilities: Global Trends and Approaches - A Bibliometric Review

Janio Jadán-Guerrero[1], Fátima Avilés-Castillo[2], Jorge Buele[3(✉)], and Guillermo Palacios-Navarro[4]

[1] Research Center of Mechatronics and Interactive Systems-MIST, Universidad Indoamérica, Quito 170103, Ecuador
janiojadan@uti.edu.ec

[2] Centro de Investigaciones de Ciencias Humanas y de la Educación-CICHE, Universidad Indoamérica, Ambato 180103, Ecuador
faviles@indoamerica.edu.ec

[3] SISAu Research Group, Facultad de Ingeniería, Industria y Producción, Universidad Indoamérica, Ambato 180103, Ecuador
jorgebuele@indoamerica.edu.ec

[4] Department of Electronic Engineering and Communications, University of Zaragoza, 44003 Teruel, Spain
guillermo.palacios@unizar.es

Abstract. Given the growing attention to the intersection between technology and education, gamification has emerged as a strategy with great benefits. This bibliometric review addresses gamification's current and future relevance in the educational field, focusing on its use as a pedagogical strategy to improve the learning and engagement of children with disabilities. Sixty-six studies published between 2001 and 2023 were analyzed, evaluating the most influential articles, main keywords, prominent authors, collaborating institutions, and funding sources. The literature suggests that gamification offers inclusive and personalized learning opportunities covering various disabilities. Methodologies and approaches to implement gamification were identified, including game elements, user-centered design techniques, and emerging technologies such as virtual reality, artificial intelligence, and educational robotics. However, challenges and areas for improvement were also found, such as the need for more long-term empirical evidence and the importance of considering individual differences and specific needs when designing gamification strategies. The review highlights the importance of strengthening collaborative networks between researchers and education professionals to disseminate best practices and promote more effective gamification approaches adapted to the needs of children with disabilities. Collaboration between educators, game developers, researchers, and parents are crucial to ensure that gamification efforts are inclusive and meet the diverse needs of students.

Keywords: Gamification · Inclusive Education · Disabilities · Children

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2023 2023
O. Gervasi et al. (Eds.): ICCSA 2023 Workshops, LNCS 14104, pp. 461–477, 2023.
https://doi.org/10.1007/978-3-031-37105-9_31

1 Introduction

Inclusive education is a pedagogical approach that seeks to meet the needs of all students, including those with disabilities and special needs [1, 2]. This approach considers diversity an opportunity to enrich learning and promote equity and equal opportunities in the education system [3, 4]. Attention to diversity involves developing strategies and resources that allow children with disabilities to achieve their educational goals and fully develop in their school and social environment [5].

The scientific literature has reported numerous studies on gamification in education, both in general contexts and those specific to children with disabilities. Studies have addressed various disabilities that affect children, including autism spectrum disorder (ASD) [6], attention deficit hyperactivity disorder (ADHD) [7], learning disabilities, intellectual disabilities, speech and language disorders, and sensory disabilities [8]. In the case of autism spectrum disorder, serious games and video games have been explored to improve social skills, communication, and emotional regulation. Studies have shown promising results, especially in increasing social interaction and effective communication between infants and adults [9]. For attention deficit hyperactivity disorder, gamification has been used to help children improve attention, concentration, and self-control. Educational games that include reward elements and immediate feedback effectively keep these students engaged and motivated in their tasks [10].

Children with learning disabilities, such as dyslexia or dyscalculia, have experienced improvements in their reading, writing, and math skills thanks to gamification-based pedagogical approaches, which offer a playful and personalized approach to teaching [11]. In the context of intellectual disabilities, serious games, and game-based learning environments have been used to teach cognitive and social-emotional skills. Results have shown improvements in cognitive development, adaptability, and problem-solving skills in these students [12]. Gamification has also been applied in speech and language therapies, using specific games and applications to improve articulation, fluency, and language understanding in children with speech and language disorders. Finally, for children with sensory disabilities, such as visual or hearing impairments, gamification has been adapted through assistive technologies, such as devices [13].

In this context, it is essential to explore pedagogical strategies facilitating the active participation and meaningful learning of children with disabilities. Gamification understood as the application of game elements and mechanics in non-game environments, has emerged as an effective tool to improve student motivation, commitment, and learning [14]. This pedagogical approach is beneficial in general education, but its potential in the education of children with disabilities still needs to be fully investigated [15, 16].

This article aims to review the state of the art in applying gamification in the education of children with disabilities and provide an overview of the research carried out in this field through a bibliometric analysis. In addition, it will seek to identify gaps in the existing literature, highlight future research opportunities, and provide recommendations for the effective implementation of gamification in inclusive education. Hopefully, this work will contribute to developing innovative and effective pedagogical practices that promote the learning and well-being of children with disabilities in their educational contexts.

This article consists of four sections, including the introduction in Sect. 1. The methodology is in Sect. 2, and the results are in Sect. 3. The conclusions are presented in Sect. 4.

2 Methodology

2.1 Data Extraction

Before starting to search for relevant articles, a careful selection of the search engine that best suited the needs of the study was carried out. It was decided to use Scopus as a source of information for articles published in the area of interest. The decision was based on several reasons, such as that Scopus is one of the most important and internationally recognized scientific citation indexes and has a rigorous selection process that guarantees the inclusion of high-quality and influential research. This database extensively covers prestigious journals, conference proceedings, and books in many countries. It provides useful analytical tools to comprehensively process the information, making it easy to find and select relevant documents.

2.2 Search

In inclusive education, it is essential to explore different teaching methods that can benefit children with disabilities. One of the emerging areas in this field is gamification, which refers to using game design elements in non-game contexts, such as education. This approach effectively increases student motivation and engagement and can be particularly beneficial for children with disabilities. To better understand how gamification has been applied in inclusive education, we have designed a search equation to identify scientific papers addressing this topic. This equation is divided into three main groups of terms: i) gamification and educational games, ii) children with disabilities and inclusive education, and iii) pedagogical approaches and strategies. These terms represent different approaches and applications of games in educational contexts, the most common disabilities and special needs in children, and concepts related to inclusive education and the practices and strategies used in teaching and learning.

TITLE-ABS-KEY((gamification OR “game-based learning” OR “serious games” OR “digital games” OR “video games” OR “educational games”) AND (“children with disabilities” OR “special needs” OR “special education” OR “inclusive education” OR “autism spectrum disorder” OR ASD OR ADHD OR “attention deficit hyperactivity disorder” OR “learning disabilities” OR “intellectual disabilities” OR “speech and language disorders” OR “hearing impairments” OR “visual impairments” OR “physical disabilities” OR “motor disabilities”) AND (pedagogical OR pedagogy OR “teaching strategies” OR “learning strategies” OR “instructional methods” OR “educational approaches”)).

2.3 Research Questions

Considering the above, the main purpose of this study is to analyze the generation of scientific knowledge related to gamification as a pedagogical strategy to enhance

learning and participation in children with disabilities by reviewing documents accessible in Scopus databases. To achieve this objective, several research questions have been formulated:

RQ1: How have the scientific production and citations of gamification for children with disabilities evolved over the years?

This question aims to discover the evolution of scientific production and citations related to using gamification in education for children with disabilities over time. The information obtained will allow the number of publications per year and citation trends to be determined, which will be valuable in anticipating future patterns in this area of research.

RQ2: Which are the countries with the largest number of publications on gamification for children with disabilities?

This question focuses on determining the countries that have generated the largest number of publications to identify the leaders in producing scientific knowledge in this area. In this way, it will be possible to obtain a global perspective of the geographical distribution of the research and determine its importance in different parts of the world.

RQ3: What are the most influential articles in gamification for children with disabilities?

This question seeks to identify which documents have received the highest number of citations on using gamification in education for children with disabilities. By knowing the most influential articles, valuable information can be obtained about the research methods and studies that have been successful, which will make it easier for researchers and professionals to produce high-quality work.

RQ4: What main keywords can be identified in this topic?

This question seeks to identify the most relevant key terms in the topic. This information will be helpful for researchers when searching scientific databases, allowing them to select the most appropriate terms to find relevant documents for their research.

RQ5: Which are the journals/books/proceedings with the highest number of publications and citations?

This question aims to identify the sources that researchers mostly used. This will allow them to make informed decisions about where to publish their research results.

RQ6: Who are the authors with the most publications on this topic?

This question seeks to identify authors who have published many papers. This information will allow researchers to identify the leading experts in the field and make informed decisions about whom they can collaborate with or learn from.

RQ7: Which are the institutions that carried out the most research on gamification for children with disabilities?

This question aims to discover the institutions that have carried out the greatest number of investigations on using gamification in education for children with disabilities. This way, it will be possible to know the leading institutions in researching and producing scientific knowledge in this area.

RQ8: What are the main funding agencies for gamification documents for children with disabilities?

This question offers valuable information for researchers seeking funding for their projects. It will allow them to determine which agencies have funded previous studies in this area and direct their funding search toward these institutions.

2.4 Sample Selection

To carry out this research, scientific articles that are indexed in Scopus and that contain the terms shown in Sect. 2.2 will be used. These articles will be considered the unit of analysis. For the sample selection, inclusion criteria will be applied, including the peer review of the articles, the year of publication, and the appearance of the search terms in the title, abstract, or keywords. Exclusion criteria will also apply for documents not subject to peer review, such as theses or technical reports, review papers, editorials, notes, errata, and retracted, as well as for publications in languages other than English. After applying these criteria, a sample of 66 documents was obtained for analysis. Significantly, the search was last updated on April 4, 2023, which are accessible at the following link https://github.com/faviles7/gamification.

3 Results

RQ1: How have the scientific production and citations of gamification for children with disabilities evolved over the years?

Figure 1 shows the evolution of scientific production over the last 23 years since 2001. According to the data, the number of publications has increased significantly, from three in 2009 to nine in 2020. A decrease is observed after that year, with only one publication in 2023. However, more articles on the subject may continue to be published so that the final figure could be higher.

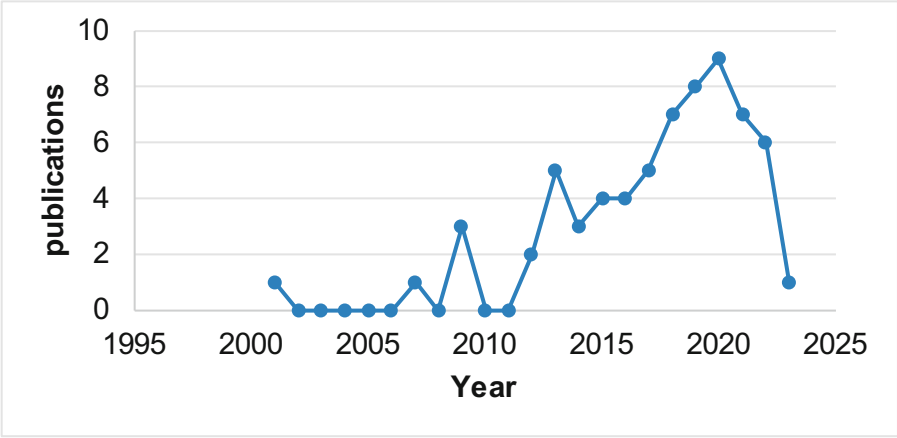


Fig. 1. Annual distribution of articles indexed by Scopus.

Citations are an important measure of the influence and impact of a scientific article in the field of research. In the case of Fig. 2, the citations have varied over the years,

with a peak in 2017 (97 citations) and a constant decrease. This pattern could be due to several reasons, such as the topic's popularity at a given time, the quality of the articles published each year, or the impact of the authors and institutions in the research field. It is important to note that citations may continue to increase, as recent articles may take some time to be recognized and cited by other researchers. Therefore, although a decrease has been observed since 2020, there is still potential for the citations of these articles to continue to increase.

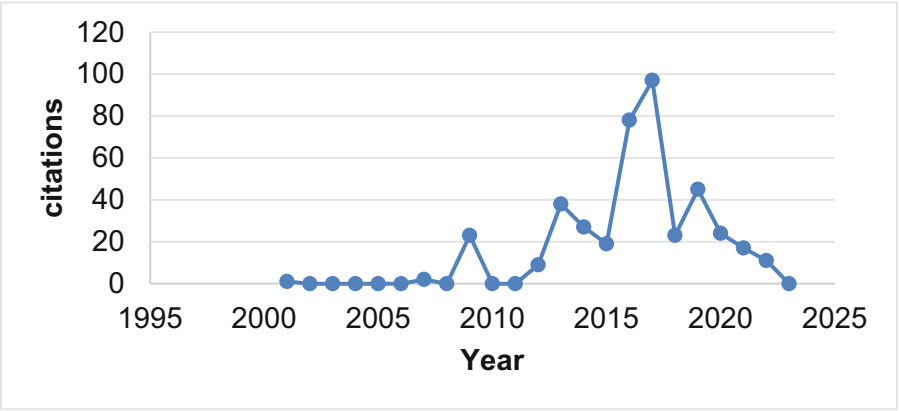


Fig. 2. Annual distribution of citations on this topic.

RQ2: Which are the countries with the largest number of publications on gamification for children with disabilities?

Figure 3 shows the countries with the largest number of publications on this topic: the United Kingdom, Spain, and Greece, with 10, 9, and 8 publications, respectively. Brazil and the United States follow closely with six publications each, and other countries such as Canada, Ecuador, France, India, and Portugal also contribute three publications each.

This geographical distribution of the publications suggests that gamification in the education of children with disabilities has been of interest in different regions, with a notable concentration in Europe. The UK and Spain have shown strong interest in this area of research, which could be related to their respective education systems and the attention they pay to the inclusion of students with disabilities in the educational process.

The bibliometric review also highlights the diversity of approaches. This wide geographical scope indicates that gamification is a pedagogical strategy with the potential to be applied in different cultural and educational contexts. This enriches its knowledge base and facilitates the exchange of experiences and good practices between researchers and education professionals worldwide.

RQ3: What are the most influential articles in gamification for children with disabilities?

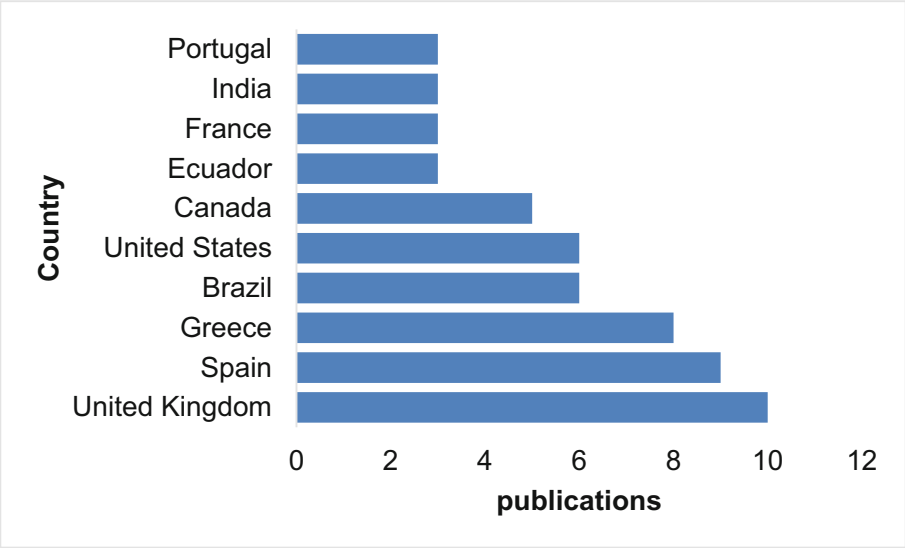


Fig. 3. Summary of the ten countries with the highest number of publications.

Table 1 presents a selection of outstanding research carried out in different countries and years and received a variable number of citations, indicating its impact on the scientific community. Notably, the two most cited studies come from the UK and focus on digital game-based learning for children with dyslexia. The study by Vasalou et al. [17] ranks first in average annual citations, with 8.32, while the study by Gooch et al. [18] ranks second, with 4.97. These works address the importance of the social constructivist approach and the motivation of students with dyslexia in the context of game-based learning.

Studies next on the list address a wide range of topics and populations, from Serious Game Design for Children with Hearing Impairments in Chile, de Cano et al. [19],

Table 1. Summary of the most influential articles.

No.	Authors	Title	Main Findings	Source	Country	Year	Citations	Average
1	Vasalou, A. et al. [17]	Digital games-based learning for children with dyslexia: A social constructivist perspective on engagement and learning during group gameplay	'Words Matter' improves social engagement, provides additional learning opportunities, and boosts self-esteem in children with dyslexia	Computers and Education	United Kingdom	2017	52	8.32 (#1)

(*continued*)

Table 1. (*continued*)

No.	Authors	Title	Main Findings	Source	Country	Year	Citations	Average
2	Gooch, D. et al. [18]	Using gamification to motivate students with dyslexia	Gamification, through ClassDojo, improves the motivation of students with dyslexia, thanks to the pedagogical personalization of teachers	Conference on Human Factors in Computing Systems - Proceedings	United Kingdom	2016	36	4.97 (#2)
3	Cano, S. et al. [19]	Toward a methodology for serious games design for children with auditory impairments	The MECONESIS methodology for designing serious games is effective for hearing impaired children, enhancing the learning, and gaming experience	IEEE Latin America Transactions	Chile	2016	26	3.59 (#4)
4	Serret, S. et al. [20]	Teaching literacy skills to French minimally verbal school-aged children with autism spectrum disorders with the serious game SEMA-TIC: An exploratory study	The SEMA-TIC serious game significantly improves literacy skills in French children with minimally verbal ASD	Frontiers in Psychology	France	2017	21	3.36 (#5)
5	Díaz-Lauzurica, B., Moreno-Salinas, D. [21]	Computational thinking and robotics: A teaching experience in compulsory secondary education with students with high degree of apathy and demotivation	Increase in student motivation, meaningful learning, better behavior, development of programming and robotics skills	Sustainability	Spain	2019	19	4.47 (#3)

(*continued*)

Table 1. (*continued*)

No.	Authors	Title	Main Findings	Source	Country	Year	Citations	Average
6	Bertacchini, F. et al. [22]	An emotional learning environment for subjects with autism spectrum disorder	Face3D, a 3D modeling system, improves the understanding of emotions and social behaviors in individuals with autism	International Conference on Interactive Collaborative Learning	Italy	2013	19	1.85 (#6)
7	Saridaki, M. et al. [23]	Digital games-based learning for students with intellectual disabilities	Digital games can be an effective educational tool for students with intellectual disabilities under certain conditions and limitations	Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces: Techniques and Effective Practices	Greece	2009	19	1.33 (#10)
8	Balan, O. et al. [24]	Navigational 3D audio-based game-training towards rich auditory spatial representation of the environment	Training with a 3D audio game improves mental spatial representation and orientation skills	Applications in Software Engineering - Proceedings of the 9th International Conference on Software Process Improvement	Romania	2014	16	1.73 (#7)
9	Leask, M., Pachler, N. [25]	Learning to Teach Using ICT in the Secondary School: A Companion to School Experience: A companion to school experience	ICT possibilities to improve teaching and learning in various subjects	Proceedings - 9th International Conference on Measuring Technology and Mechatronics Automation	United Kingdom	2013	15	1.46 (#9)
10	King, A. et al. [26]	The routledge companion to music, technology, and education	Theoretical and empirical perspectives on technology in music education and its impact on learning	Journal of Intelligent and Fuzzy Systems	United Kingdom	2017	10	1.60 (#8)

to teaching literacy skills in children with autism spectrum disorder using the SEMATIC game, Serret et al. [20]. The analysis of this information is crucial to understand

the current trends in gamification research applied to the education of children with disabilities.

RQ4: What main keywords can be identified in this topic?

In this section, an analysis was carried out to identify the most relevant topics using the VOSviewer tool to analyze the frequency of keywords in the retrieved documents. To do this, a minimum threshold of 5 occurrences was established to preselect the relevant keywords, resulting in a total of 22 keywords. Table 2 presents a summary of the selected keywords and their frequency and link strength.

Table 2. Summary of the selected keywords.

Keywords	Occurrences	TLS	Keywords	Occurrences	TLS
Serious games	18	61	Diseases	6	28
Education	13	67	Game design	6	3.4
Autism	11	59	Game-based learning	6	18
Gamification	10	56	Learning disabilities	6	19
Learning systems	10	46	Computer aided instruction	5	20
Special education	10	56	Educational computing	5	24
Teaching	10	51	Educational technology	5	24
Computer games	8	48	Human computer interaction	5	27
E-learning	8	34	Including education	5	14
Students	7	38	Intellectual disability	5	20

Examining the data carefully, in Fig. 4 it was possible to identify several important keywords that are relevant to the field of gamification as a pedagogical approach aimed at improving the learning and active participation of children with disabilities. Two sets of main keywords are highlighted: i) those linked to specific disabilities and conditions, such as “adhd”, “asd” (autism spectrum disorder), “attention deficit hyperactivity disorder” and “learning disabilities”, which demonstrate a trend towards more recent publications, with an average number of years of publication ranging from 2012 to 2017; ii) those related to pedagogical and educational approaches, such as “game-based learning”, “educational games”, “e-learning”, “education”, “educational technology”, “engagement” and “inclusive education”, reflecting a wide range of publications over time, with average publication years ranging from 2011 to 2020.

In addition, terms such as “gamification”, “serious games” and “special education” have a greater number of occurrences and links, which suggests that these topics could be

of particular interest in the scientific literature related to the application of gamification in the education of children with disabilities.

In addition, there is a diversity of keywords associated with the use of specific technologies, such as "augmented reality", "computer aided instruction", "computer games", "digital games" and "video games".

RQ5: Which are the journals/conferences with the highest number of publications and citations?

Choosing the right publication to share your findings is essential in research, as this decision can affect how often the article will be cited after publication. Therefore, it is essential to identify the most appropriate places of publication to disseminate the research. Table 3 is presented below with the journals and proceedings with the most publications and citations in this field of study.

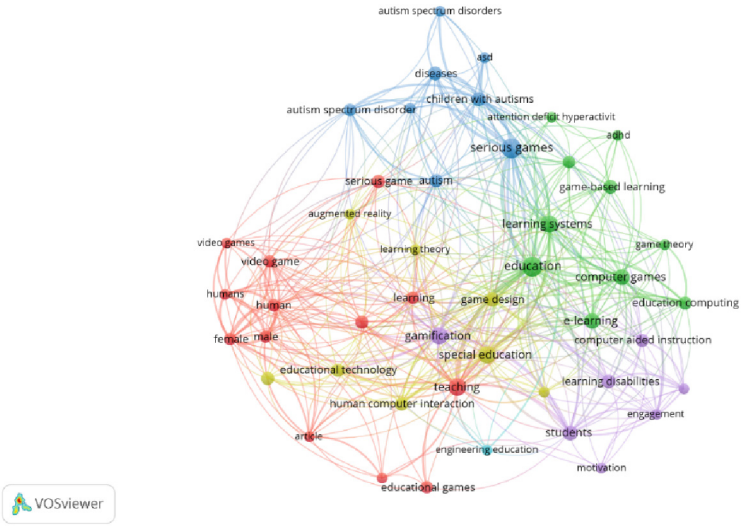


Fig. 4. Cloud of frequent keywords in this subject.

These journals and proceedings allow researchers and practitioners to access up-to-date information, share experiences, and discuss scientific and technological advances in the field. Elsevier's Computers and Education stands out for its high number of citations, suggesting that studies published in this journal could have a greater influence on the academic community and educational practice.

RQ6: Who are the authors with the most publications on this topic?

Based on the information obtained, 193 authors were identified, of which 16 have at least two publications to their credit and the rest only one. This information makes it possible to know those researchers working on this subject, with whom the exchange of experiences, approaches and good practices could be promoted, which will further enrich the understanding and application of similar proposals. This growth in research will also favor the establishment of collaboration networks between experts, strengthening the scientific community around this topic.

Table 3. Summary of the journals, books and proceedings where most articles were published.

Publisher	Journal/Conference	Publications	Citations
Dechema eV	Proceedings of the European Conference On Games Based Learning	3	9
Brazilian Association of Researchers in Special Education	Brazilian Magazine of Special Education	3	4
Associate Iberica de Sistemas e Tecnologias de Informacao	Risti Iberian Magazine of Information Systems and Technologies	3	3
Association for Computing Machinery	ACM International Conference Proceeding Series	2	1
Elsevier	Computers And Education	2	61
Springer	Education And Information Technologies	2	6

Figure 5 shows the authors who are grouped into different clusters (from 1 to 9), which may indicate that they have addressed various themes or approaches within the field of study. Furthermore, the information from VOSViewer shows that the average publication dates vary from 2006 to 2021. This suggests that although the field of research may be at an early stage, there has been sustained interest in the topic throughout the years. Authors such as "Deliyannis, I.", "Fokides, E.", and "Kaimara, P." have more recent publications, with an average publication year of 2021, indicating that they are still active in this field and might be contributing to the most current research in this area. On the other hand, authors such as "Gifford, KE.", "Ouscos, D.", and "Saridaki, M." have an average year of publication older (2006, 2008 and 2008, respectively), which could suggest that their contributions were more relevant in the early years of the field of study.

RQ7: Which are the institutions that carried out the most research on gamification for children with disabilities?

Table 4 allows us to identify the institutions that have conducted the most research on gamification as a pedagogical strategy to improve the learning and engagement of children with disabilities. Two European institutions lead this field with three published articles each: the UCL Institute of Education in the United Kingdom, with 103 citations, and the National and Kapodistrian University of Athens in Greece, with 21 citations.

In addition, several institutions have published two articles each in this field of research. Among them, the University of South Alabama in the United States and the Autonomous University of Aguascalientes in Mexico stand out, as well as other European institutions such as Nottingham Trent University and The Open University in the United Kingdom, the Ionian University and the University of the Aegean in Greece, and the Universitat Autonomous of Barcelona in Spain. Finally, the Universidade do Vale do Itajai in Brazil contributed two articles.

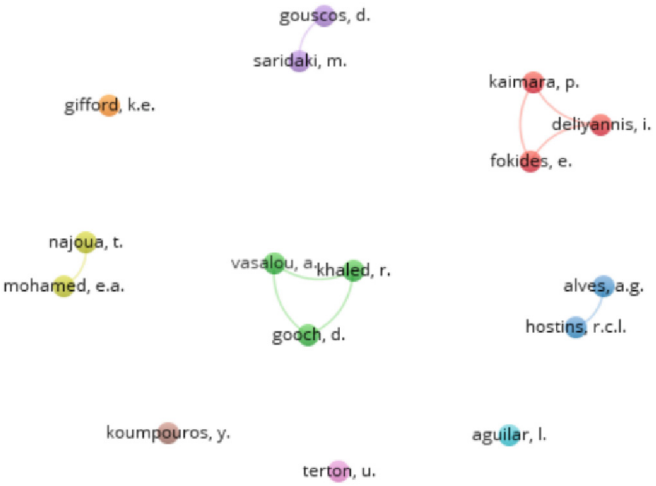


Fig. 5. Co-authors who work in collaborative networks regarding the subject matter.

Table 4. Institutions that have a greater number of publications and citations.

No.	Affiliation	Country	Mainland	Articles	Citations
1	UCL Institute of Education	United Kingdom	Europe	3	103
2	National and Kapodistrian University of Athens	Greece	Europe	3	21
3	University of South Alabama	United States	America	2	1
4	Autonomous University of Aguascalientes	Mexico	America	2	29
5	Nottingham Trent University	United Kingdom	Europe	2	11
6	The Open University	United Kingdom	Europe	2	88
7	Ionian University	Greece	Europe	2	3
8	University of Vale do Itajai	Brazil	America	2	1
9	University of the Aegean	Greece	Europe	2	3
10	University Autonomous of Barcelona	Spain	Europe	2	8

The presence of institutions from different geographical regions, such as Europe and America, indicates a global interest in gamification applied to the education of children with disabilities. The diversity of institutions involved in research also suggests that the field can benefit from a wide range of approaches, perspectives, and methodologies. This information is valuable in the context of the bibliometric review since it helps to

understand the geographical distribution and the impact of research in this field and identify the leading institutions in the production of knowledge in the area. In addition, the analysis of these institutions can provide a basis for future collaborations and research projects in gamification and inclusive education.

RQ8: What are the main funding agencies for gamification documents for children with disabilities?

The main funding agencies that have supported these investigations are the Fundação para a Ciência e Tecnologia with two studies. Other important organizations that have financed a single study include the Ministry of Education of the Junta de Castilla y León in Spain, the Conselho Nacional de Desenvolvimento Científico e Tecnológico in Brazil, the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior also in Brazil and the Deanship of science King Saud Research University in Saudi Arabia, among others. While not all the funding agencies involved are listed, these entities represent some of the main sources of support. It is worth noting that 73% of these studies have not been funded or have not been reported.

4 Conclusions

The results showed a growth in scientific production related to gamification and the education of children with disabilities over the years, although with a decrease in recent years. However, the citations of the articles could continue to increase in the future, which indicates that the field continues to be relevant and of interest to the scientific community. In geographical terms, a notable concentration of publications in Europe was identified, with countries such as the United Kingdom and Spain leading the scientific production in the area. This could be related to their education systems and their attention to including students with disabilities. Furthermore, the wide geographical scope of the publications suggests that gamification is a pedagogical strategy applicable in different cultural and educational contexts.

The diversity of approaches and themes addressed in the most influential articles highlights the richness and complexity of the field. In addition, two main sets of keywords were identified: one related to specific disabilities and conditions, and one related to pedagogical and educational approaches. This suggests that the scientific literature addresses the specific needs of children with disabilities and the most effective educational methodologies and strategies for their learning. Several relevant journals and conferences in the field were identified, with Elsevier's Computers and Education being the one that stands out for its high number of citations. This suggests that the studies published in this journal could have a greater influence on the academic community and educational practice. The authors and institutions identified in this bibliometric study show a diversity of geography and approaches. This could facilitate the exchange of experiences and good practices between researchers and education professionals, enriching the knowledge base in the field and fostering future collaborations and research projects. They could receive support from identified funding agencies, both locally and internationally, to gain greater recognition within this area of knowledge.

Within the analyzed literature, several methodologies, and approaches for implementing gamification in the education of children with disabilities were identified. These

include the use of game elements such as points, badges, leaderboards, and narratives to motivate students; the application of user-centered design techniques to ensure the accessibility and usability of gamification tools; and the integration of emerging technologies such as virtual and augmented reality, artificial intelligence, and educational robotics to offer immersive and adaptive learning experiences. However, challenges and areas for improvement were also found in the literature. One of the challenges identified is the need for more empirical evidence on the effectiveness of gamification in the education of children with disabilities, especially in the long term. In addition, the importance of considering individual differences and the specific needs of children with disabilities when designing and implementing gamification strategies was recognized, to ensure that these are inclusive and adapted to their learning context.

Regarding future directions, it is necessary to continue investigating the potential of gamification and its relationship with disabilities, considering the specific needs of each group and educational context. It is required: (i) to explore the long-term impact of gamification in the education of children with disabilities, including academic results and socio-emotional skills. (ii) Investigate the best practices and the most effective approaches for gamification in different cultural and educational contexts. (iii) Promote international collaboration between researchers and professionals to share experiences and good practices in applying gamification in the education of children with disabilities. (iv) Identify and address the barriers and challenges for implementing gamification in the education of children with disabilities, including the lack of resources and resistance to change in educational systems.

Acknowledgment. To the Universidad Indoamérica for its support for this research in collaboration with the University of Zaragoza.

References

1. Mitchell, D., Sutherland, D.: What Really Works in Special and Inclusive Education: Using Evidence-Based Teaching Strategies (2020).https://doi.org/10.4324/9780429401923
2. Lindner, K.T., Schwab, S.: Differentiation and individualisation in inclusive education: a systematic review and narrative synthesis. Int. J. Incl. Educ. (2020).https://doi.org/10.1080/13603116.2020.1813450
3. Florian, L.: On the necessary co-existence of special and inclusive education. Int. J. Incl. Educ. **23**, 691–704 (2019). https://doi.org/10.1080/13603116.2019.1622801
4. Ainscow, M.: Promoting inclusion and equity in education: lessons from international experiences. Nord. J. Stud. Educ. Policy **6**, 7–16 (2020). https://doi.org/10.1080/20020317.2020.1729587
5. Sandoval, M., Muñoz, Y., Márquez, C.: Supporting schools in their journey to inclusive education: review of guides and tools. Support Learn. **36**, 20–42 (2021). https://doi.org/10.1111/1467-9604.12337
6. Mubin, S.A., Wee Ann Poh, M.: A review on gamification design framework: how they incorporated for autism children. In: 4th Int. Conf. Work. Recent Adv. Innov. Eng. Thriving Technol. (ICRAIE 2019) (2019). https://doi.org/10.1109/ICRAIE47735.2019.9037765
7. Zhang, M., Vallabhajosyula, R., Fung, D.: Emotional bias modification for individuals with attention deficit hyperactivity disorder: protocol for a co-design study. JMIR Res. Protoc. **9**, e24078 (2020). https://doi.org/10.2196/24078

8. Graham, S., Hebert, M., Fishman, E., Ray, A.B., Rouse, A.G.: Do children classified with specific language impairment have a learning disability in writing? A meta-analysis. J. Learn. Disabil. **53**, 292–310 (2020). https://doi.org/10.1177/0022219420917338
9. Tori, A.A., Tori, R., Nunes, F.D.L.D.S.: Serious game design in health education: a systematic review. IEEE Trans. Learn. Technol. **15**, 827–846 (2022). https://doi.org/10.1109/TLT.2022.3200583
10. Saleem, A.N., Noori, N.M., Ozdamli, F.: Gamification applications in e-learning: a literature review. Technol. Knowl. Learn. **27**, 139–159 (2021). https://doi.org/10.1007/s10758-020-09487-x
11. Buele, J., et al.: Interactive system to improve the skills of children with dyslexia: a preliminary study. In: Rocha, Á., Pereira, R.P. (eds.) Developments and Advances in Defense and Security. SIST, vol. 152, pp. 439–449. Springer, Singapore (2020). https://doi.org/10.1007/978-981-13-9155-2_35
12. Vacca, R.A., et al.: Serious games in the new era of digital-health interventions: a narrative review of their therapeutic applications to manage neurobehavior in neurodevelopmental disorders. Neurosci. Biobehav. Rev. **149**, 105156 (2023). https://doi.org/10.1016/j.neubiorev.2023.105156
13. Furini, M., Mirri, S., Montangero, M.: Gamification and accessibility. In: 2019 16th IEEE Annu. Consum. Commun. Netw. Conf. (CCNC 2019), vol. 36, pp. 104–123 (2019). https://doi.org/10.1109/CCNC.2019.8651750
14. Fiuza-Fernández, A., Lomba-Portela, L., Soto-Carballo, J., Pino-Juste, M.R.: Study of the knowledge about gamification of degree in primary education students. PLoS ONE **17**, e0263107 (2022). https://doi.org/10.1371/journal.pone.0263107
15. Agran, M., et al.: Why aren't students with severe disabilities being placed in general education classrooms: examining the relations among classroom placement, learner outcomes, and other factors. Res. Pract. Pers. Sev. Disabil. **45**, 4–13 (2020). https://doi.org/10.1177/1540796919878134
16. Finnerty, M.S., Jackson, L.B., Ostergren, R.: Adaptations in general education classrooms for students with severe disabilities: access, progress assessment, and sustained use. Res. Pract. Pers. Sev. Disabil. **44**, 87–102 (2019). https://doi.org/10.1177/1540796919846424
17. Gooch, D., Vasalou, A., Benton, L., Khaled, R.: Using gamification to motivate students with dyslexia. In: 34th Annual CHI Conference on Human Factors in Computing Systems, (CHI EA 2016), pp. 969–980. Association for Computing Machinery, Open University, Milton Keynes, UK (2016). https://doi.org/10.1145/2858036.2858231
18. Vasalou, A., Khaled, R., Holmes, W., Gooch, D.: Digital games-based learning for children with dyslexia: a social constructivist perspective on engagement and learning during group game-play. Comput. Educ. **114**, 175–192 (2017). https://doi.org/10.1016/j.compedu.2017.06.009
19. Cano, S., Munoz Arteaga, J., Collazos, C.A., Gonzalez, C.S., Zapata, S.: Toward a methodology for serious games design for children with auditory impairments. IEEE Lat. Am. Trans. **14**, 2511–2521 (2016). https://doi.org/10.1109/TLA.2016.7530453
20. Serret, S., et al.: Teaching literacy skills to French minimally verbal school-aged children with autism spectrum disorders with the serious game SEMA-TIC: an exploratory study. Front. Psychol. **8**, 1523 (2017). https://doi.org/10.3389/fpsyg.2017.01523
21. Díaz-Lauzurica, B., Moreno-Salinas, D.: Computational thinking and robotics: a teaching experience in compulsory secondary education with students with high degree of apathy and demotivation. Sustainability **11**(18), 5109 (2019). https://doi.org/10.3390/su11185109
22. Bertacchini, F., et al.: An emotional learning environment for subjects with Autism Spectrum Disorder. In: 2013 16th International Conference on Interactive Collaborative Learning (ICL 2013), pp. 653–659. IEEE Computer Society, Environmental and Territorial Engineering

and Chemical Engineering Department, University of Calabria, Unical Arcavacata di Rende, Cosenza, Italy (2013). https://doi.org/10.1109/ICL.2013.6644675
23. Saridaki, M., Gouscos, D., Meimaris, M.G.: Digital games-based learning for students with intellectual disability. In: Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces: Techniques and Effective Practices, pp. 304–325. IGI Global, National and Kapodistrian University of Athens, Greece (2009). https://doi.org/10.4018/978-1-60566-360-9.ch018
24. Balan, O., Moldoveanu, A., Moldoveanu, F., Dascalu, M.-I.: Navigational 3D audio-based game-training towards rich auditory spatial representation of the environment. In: 2014 18th International Conference on System Theory, Control and Computing (ICSTCC 2014), pp. 682–687. IEEE, Bucharest, Romania (2014). https://doi.org/10.1109/ICSTCC.2014.6982496
25. Leask, M., Pachler, N.: Learing to teach using ICT in the secondary school: a companion to school experience: a companion to school experience. Taylor and Francis, Educational Knowledge Management, University of Bedfordshire, UK (2013)
26. King, A., Himonides, E., Ruthmann, S.A.: The routledge companion to music, technology, and education. Taylor and Francis, University of Hull, UK (2017). https://doi.org/10.4324/9781315686431