Multimodal Technologies and Interaction

MDPI

Review

Impact of Artificial Intelligence on Learning Management Systems: A Bibliometric Review

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Abstract: The field of artificial intelligence is drastically advancing. This study aims to provide an overview of the integration of artificial intelligence into learning management systems. This study followed a bibliometric review approach. Specifically, following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement, 256 documents from the Scopus and Web of Science (WoS) databases over the period of 2004–2023 were identified and examined. Besides an analysis of the documents within the existing literature, emerging themes and topics were identified, and directions and recommendations for future research are provided. Based on the outcomes, the use of artificial intelligence within learning management systems offers adaptive and personalized learning experiences, promotes active learning, and supports self-regulated learning in face-to-face, hybrid, and online learning environments. Additionally, learning management systems enriched with artificial intelligence can improve students' learning outcomes, engagement, and motivation. Their ability to increase accessibility and ensure equal access to education by supporting open educational resources was evident. However, the need to develop effective design approaches, evaluation methods, and methodologies to successfully integrate them within classrooms emerged as an issue to be solved. Finally, the need to further explore education stakeholders' artificial intelligence literacy also arose.

Keywords: artificial intelligence; AI; learning management systems; LMS; university; education; personalized learning; e-learning; challenges; benefits

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1. Introduction

Learning management systems emerged in the early 1990s [1] as rudimentary platforms for content delivery in online educational environments. Since then, they have evolved significantly, integrating a wide range of tools and functionalities designed to enhance the learning experience [2]. According to the Technological Pedagogical Content Knowledge (TPACK) framework, these systems have not only enhanced the administrative and content delivery aspects of education, but they have also transformed pedagogical practices by enabling more interactive and student-centered learning environments [3]. Learning management systems refer to software applications designed to digitally manage aspects of learning programs, including the administration, monitoring and reporting of the teaching–learning process [1,2]. These tools enable educational institutions to offer online learning environments by facilitating course delivery, interactions between students and teachers, as well as progress monitoring and performance evaluations of participants [4]. In addition to hosting educational content, learning management systems offer functionalities such as discussion forums, chats, evaluations, progress monitoring, user and resource management, among others, all of which contribute to enriching the learning experience in virtual environments [5,6].

In addition to their application in traditional educational environments, learning management systems are also considered useful in the corporate environment, where they can be used for employee training and professional development [7,8]. The versatility and adaptability of learning management systems make them ideal for a variety of educational scenarios, from face-to-face teaching with synchronous components to fully virtual and asynchronous learning [9]. Learning management systems have also been proven to improve student engagement [10–12]. In fact, since the COVID-19 pandemic, the application of learning management systems in educational and business environments has become commonplace [13,14]. In this sense, learning management systems have not only transformed the teaching and learning processes and educational environments but has also helped democratize access to education by making it more accessible and flexible to a global audience. In addition, these platforms offer educators tools to personalize teaching, adapt content according to the educational needs of students, and foster inclusion and knowledge sharing in a virtual environment [15]. Despite this, there are studies that have revealed the existence of a gender gap in learning management systems use patterns [16], as well as some innovation resistance to the use of new learning management systems [17].

On the other hand, artificial intelligence has experienced a remarkable progress in recent decades, moving from simple algorithms to complex systems capable of emulating human cognitive abilities [18]. Although its first milestones date back to the 1950s [19], it is only now that artificial intelligence is bringing about a true social revolution, given the applicability of many applications that implement it to facilitate everyday activities in many professions [20], such as writing texts, designing presentations, creating images, performing basic calculations, etc. This evolution has led to a wide range of applications in fields such as health [21], robotics [22], engineering [23], energy efficiency [24], among others. Education is another sector in which the integration of artificial intelligence can yield several benefits, as well as help transform and further advance it [25–27]. The potential of artificial intelligence to transform multiple aspects of society is undeniable, and its continuous evolution promises to open new frontiers in research and technological innovation.

Learning management systems are systems in which the integration of artificial intelligence can drastically change and improve their performance [28,29]. As the field of study is rapidly advancing, it is important to present a detailed representation of the existing literature so that future studies can build upon. This study aims to provide an overview of the existing literature regarding the integration of artificial intelligence in learning management systems through the conduct of a bibliometric review. The main contributions of this study are that it reveals the strengths and weaknesses of recent research in relation to the use of artificial intelligence in learning management systems and that it identifies the most developed lines of research and those that are still incipient. Thus, this study provides a representation and analysis of the current literature, examines and maps the published documents, identifies emerging topics and trends, and provides future research directions.

The remainder of this study is structured as follows: In Section 2, the methods and materials used are presented focusing on the document identification and process. In Section 3, the result analysis of the document collection examined is showcased. The outcomes are further discussed in Section 4 and conclusive remarks and suggestions for future research directions are provided in Section 5.

2. Materials and Methods

Bibliometric analysis and scientific mapping approaches are regarded as suitable approaches to examine and map the current state of the art on a specific topic [30]. Therefore, this study adopted a bibliometric analysis and scientific mapping approach to provide an overview regarding the integration of artificial intelligence into learning management systems. The approach described in [31] was used and the guidelines presented in [32] were followed to meet the requirements of a thorough and valid bibliometric and scientific mapping analysis [33,34]. To identify suitable documents, widely used and highly regarded databases were used. Specifically, Scopus and Web of Science (WoS) were selected as the most appropriate databases due to their highly impactful indexed documents and relevancy

to the topic [35,36] as well as the ability of the extracted information from these sources to be used in the analysis through the specific tool used in this study. To analyze the data, the open-source R package "Bibliometrix" was used [31].

2.1. Document Identification

To examine the role and integration of artificial intelligence into learning management systems thoroughly, the only limitation set in the query was the search for English documents. Additionally, to provide more accurate results, we opted to search for data up to 2023 as the year 2024 was still ongoing. The search for suitable documents was conducted on 3 March 2024. After using different search queries, we opted to use the following query ("artificial intelligence" or "AI") AND ("learning management system*" OR "lms") since it provided a more general representation of the existing literature. By using more keywords, it would be as if we provided a specific direction through the search of document which focused on a specific aspect of artificial intelligence or learning management systems. The search query ran on both Scopus and WoS at the topic level, that is, on the title, abstract, and keywords of each document. To ensure that the results would be accurate and reproducible, we adopted the steps and guidelines presented in the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement [36].

2.2. Document Processing

When searching for relevant documents through the sources and query explained, 677 documents were identified from Scopus and 204 from WoS. Therefore, the initial number of documents was 881. When removing duplicates both automatically and manually, a total of 168 duplicate documents were eliminated. As a result, 713 documents were manually assessed for eligibility. Furthermore, 25 documents were removed as they were proceedings books, 1 document was removed since it was retracted, 1 as it was an erratum, and 1 since it was a note. The inclusion criteria for a study to be included in this analysis was for it to primarily involve and examine artificial intelligence and their role and integration into learning management systems. Hence, studies that simply mentioned artificial intelligence while they focused on other aspects of learning management systems and vice versa were removed. A total of 429 were removed since they did not meet the inclusion criteria. Consequently, the document collection examined in this study contained 256 relevant to the topic documents spanning across the period of 2004–2023. The detailed PRISMA flowchart is presented in Figure 1.

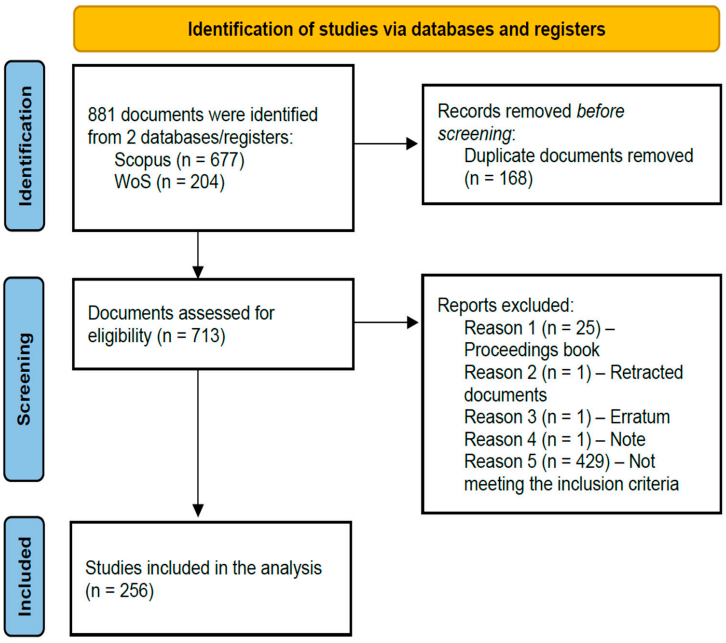

Figure 1. Document processing flowchart.

3. Result Analysis

The result analysis is categorized into: (i) document collection, (ii) citation, (iii) source, (iv) affiliation, (v) country, and (vi) document analysis. Descriptive statistics, diagrams, and figures are used to present the related information.

3.1. Document Collection

The document collection examined in this study is composed of 256 documents which derived from 194 different sources and spanned the period of 2004 to 2023. The documents of this collection have an average age of 4.74 years, received on average 7 citations, and depicted a 25.42% annual growth rate. When further examining the author-related information, it was noticed that authors with the same initials were treated as the same author in some cases; hence, the author full name had to be manually checked and separated appropriately. As a result, a total of 819 authors from 55 countries have contributed to the documents examined. It is noteworthy that although there were 3.45 co-authors per document on average, the international co-authorship rate was only 1.17%. Additionally, there were 21 single-authored documents. Most of the documents examined were conference/proceedings papers (freq.: 141 and perc.: 55.08%), followed by journal articles (freq.: 90 and perc.: 35.16%). Table 1 showcases the descriptive statistics of the document collection.

Table 1. Document collection information.

Description	Results	Description	Results
Main Information about Data		**Document Types**	
Timespan	2004:2023	Keywords plus (ID)	1403
Sources (journals, books, etc.)	194	Author's keywords (DE)	737
Documents	256	**Authors**	
Annual growth rate %	25.42	Authors	819
Document average age	4.74	Authors of single-authored docs	21
Average citations per doc	7.004	**Authors collaboration**	
Document types		Single-authored docs	21
Article	90	Co-authors per doc	3.45
Book chapter	20	International co-authorships %	1.172
Conference/proceedings paper	141		
Review	5		

3.2. Citations

Although artificial intelligence is a long-lasting field of study, its recent advances and integration in educational settings have led to the majority of documents on the topic being published in the last 3 years. More specifically, as it is also shown in Figure 2, although the first relevant study was identified in 2004, most studies were published in 2023 (freq.: 74 and perc.:28.91%), followed by 2022 (freq.: 39 and perc.: 15.23%) and 2021 (freq.: 33 and perc.: 12.89%). The increase in the number of relevant to the topic published documents is in line with the high annual growth rate (25.42%) and highlights the significance of integrating artificial intelligence into learning management systems. Based on the results, it can be inferred that the interest in this topic and in artificial intelligence intervention in educational settings in general will continue to increase in the coming years. The data revealed that 2019 and 2020 were the years in which the interest in the topic started to spark, the following years 2021–2022 were the years in which the topic started to materialize, and 2023 was the breakthrough year. These outcomes are in accordance with the advances in the field of artificial intelligence that have taken place in recent years. Furthermore, the documents published in 2010 (n = 2 and MeanTCperDoc = 33) and 2019 (n = 10 and MeanTCperDoc = 21.5) had the highest mean total citations per document. Documents

published in 2019 (citable years = 6 and mean MeanTCperYear = 3.58) and 2020 (citable years = 5 and mean MeanTCperYear = 13.24) had the largest mean total citations per year. However, it is expected that these outcomes will change in the future given the drastic increase in the number of published documents in recent years and due to the average citable age of the documents within the collection being 4.74 years. The detailed scientific production and citations per year are displayed in Table 2.

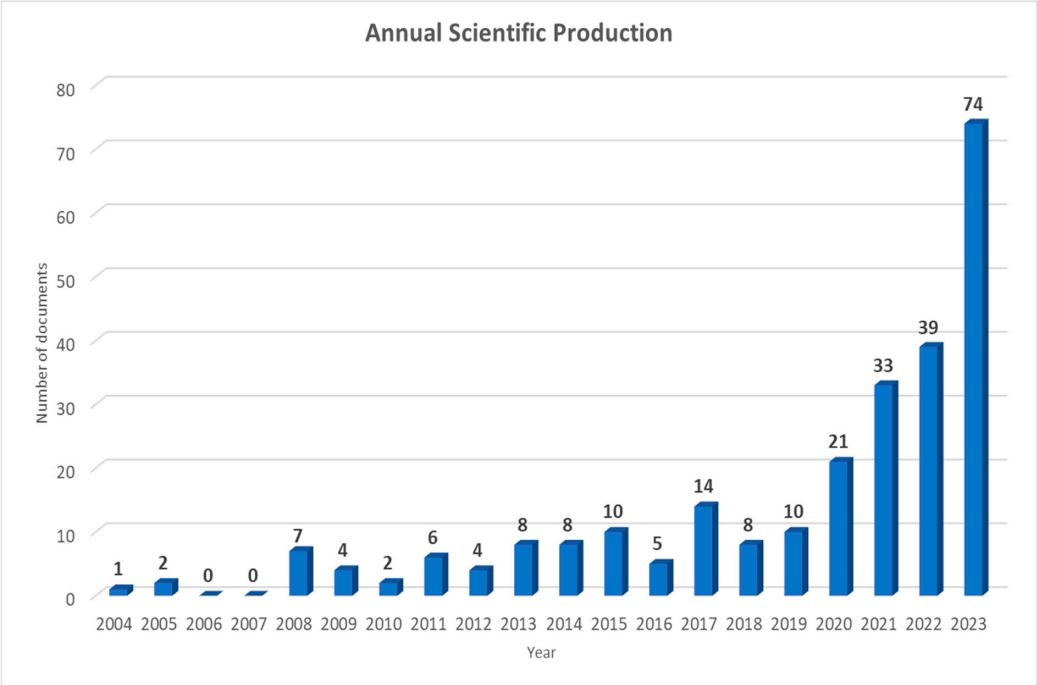

Figure 2. Annual scientific production.

Table 2. Annual scientific production and citations.

Year	MeanTCperDoc	N	MeanTCperYear	Citable Years	Year	MeanTCperDoc	N	MeanTCperYear	Citable Years
2004	3	1	0.14	21	2015	9.6	10	0.96	10
2005	5.5	2	0.28	20	2016	12.4	5	1.38	9
2008	8.71	7	0.51	17	2017	8.86	14	1.11	8
2009	13.5	4	0.84	16	2018	13.25	8	1.89	7
2010	33	2	2.2	15	2019	21.5	10	3.58	6
2011	7.67	6	0.55	14	2020	13.24	21	2.65	5
2012	2.75	4	0.21	13	2021	6.27	33	1.57	4
2013	7.38	8	0.62	12	2022	5.31	39	1.77	3
2014	6	8	0.55	11	2023	1.88	74	0.94	2

3.3. Sources

The documents of the examined collection were published in 194 sources comprising journals, conference/proceedings, and book chapters. Figure 3 displays the details of the top sources according to their number of published documents relevant to the topic. "Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)" (14 documents), "ACM International Conference Proceeding Series (ICPS)" (10 documents), "Advances in Intelligent Systems and Computing" (6 documents), "International Journal of Emerging Technologies in Learning" (5 documents), and "Sustainability (Switzerland)" (5 documents) were the sources in which the most documents were published. Moreover, according to their h-index, which is based on the published documents on this topic, the top-five sources were: "Lecture

Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)" (h-index: 5); "ACM International Conference Proceeding Series (ICPS)" (h-index: 4); "Sustainability (Switzerland)" (h-index: 4); "Applied Sciences (Switzerland)" (h-index: 3); and "International Journal of Emerging Technologies in Learning" (h-index: 3). The details of the most impactful sources in terms of the h-index on the topic are showcased in Table 3.

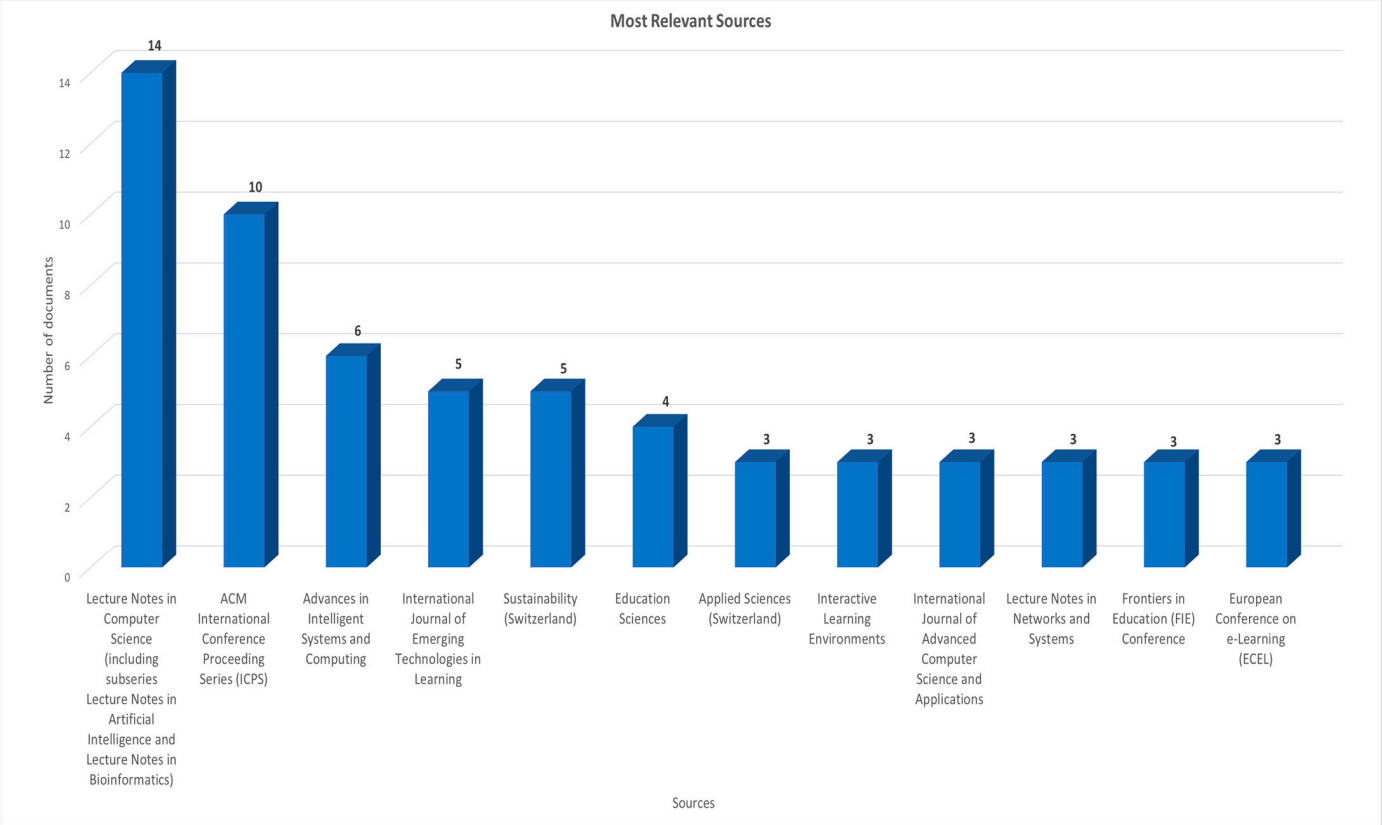

Figure 3. Sources with most documents published.

Table 3. Most impactful sources based on the h-index.

Sources	h-Index	g-Index	m-Index	TC	NP	PY_start
Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	5	8	0.294	68	14	2008
ACM International Conference Proceeding Series (ICPS)	4	4	0.364	27	10	2014
Sustainability (Switzerland)	4	5	0.571	148	5	2018
Applied Sciences (Switzerland)	3	3	0.6	111	3	2020
International Journal of Emerging Technologies in Learning	3	5	0.6	68	5	2020
British Journal of Educational Technology	2	2	1	13	2	2023
Computers and Education	2	2	0.333	167	2	2019
Education Sciences	2	4	0.5	25	4	2021
Expert Systems with Applications	2	2	0.143	66	2	2011
Procedia Computer Science	2	2	0.143	7	2	2011
European Conference on e-Learning (ECEL)	2	2	0.2	8	3	2015

Following Bradford's law, which "*estimates the exponentially diminishing returns of searching for references in science journals*" [31,37], the sources were grouped into three clusters. Cluster 1 represented the most impactful sources and consisted of 24 sources (12.37%) in which 86 documents were published. Cluster 2 was composed of 86 sources (44.33%) in which 86 documents were published. Cluster 3, which contained the least impactful sources, had 84 sources (43.30%) with 84 published documents. The top-five most impactful sources based on Bradford's law were: "Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)"; "ACM International Conference Proceeding Series (ICPS)"; "Advances in Intelligent Systems and Computing"; "International Journal of Emerging Technologies in Learning"; and "Sustainability (Switzerland)". Furthermore, the top sources of Cluster 1 are displayed in Table 4 and their scientific production is depicted in Figure 4. It is worth mentioning that only a few of the top sources have published related to the topic documents throughout the years, whereas some of the sources listed in the top ones based on Bradford's law only published relevant documents in 2023.

Year	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	ACM International Conference Proceeding Series (ICPS)	Advances in Intelligent Systems and Computing	International Journal of Emerging Technologies in Learning	Sustainability (Switzerland)	Education Sciences	Applied Sciences (Switzerland)	Interactive Learning Environments	International Journal of Advanced Computer Science and Applications	Lecture Notes in Networks and Systems	Frontiers in Education (FIE) Conference	European Conference on e-Learning (ECEL)	Total per year
2008	1	0	0	0	0	0	0	0	0	0	0	0	**1**
2009	1	0	0	0	0	0	0	0	0	0	0	0	**1**
2010	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2011	1	0	0	0	0	0	0	0	0	0	0	0	**1**
2012	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2013	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2014	1	1	1	0	0	0	0	0	0	0	0	0	**3**
2015	3	0	0	0	0	0	0	0	0	0	0	1	**4**
2016	1	1	1	0	0	0	0	0	0	0	0	0	**3**
2017	1	1	1	0	0	0	0	0	0	0	0	0	**3**
2018	1	0	1	0	1	0	0	0	0	0	0	0	**3**
2019	0	1	0	0	0	0	0	0	0	0	0	2	**3**
2020	0	2	1	1	1	0	3	0	0	0	0	0	**8**
2021	2	0	1	0	2	1	0	0	0	0	0	0	**6**
2022	1	1	0	3	1	0	0	0	1	0	0	0	**7**
2023	1	3	0	1	0	3	0	3	2	3	3	0	**19**
Total per source	**14**	**10**	**6**	**5**	**5**	**4**	**3**	**3**	**3**	**3**	**3**	**3**	**62**

Figure 4. Top-ten sources production over time based on Bradford's law.

Table 4. Most impactful sources based on Bradford's law.

Source	Rank	Freq	cumFreq	Cluster
Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	1	14	14	Cluster 1
ACM International Conference Proceeding Series (ICPS)	2	10	24	Cluster 1
Advances in Intelligent Systems and Computing	3	6	30	Cluster 1

Table 4. *Cont.*

Source	Rank	Freq	cumFreq	Cluster
International Journal of Emerging Technologies in Learning	4	5	35	Cluster 1
Sustainability (Switzerland)	5	5	40	Cluster 1
Education Sciences	6	4	44	Cluster 1
Applied Sciences (Switzerland)	7	3	47	Cluster 1
Interactive Learning Environments	8	3	50	Cluster 1
International Journal of Advanced Computer Science and Applications	9	3	53	Cluster 1
Lecture Notes in Networks and Systems	10	3	56	Cluster 1
Frontiers in Education (FIE) Conference	11	3	59	Cluster 1
European Conference on e-Learning (ECEL)	12	3	62	Cluster 1

3.4. Affiliations

The affiliations of authors who contributed to most studies relevant to the topic are presented in Figure 5. However, it should be noted that several affiliations were identified having three relevant published documents. Near East University (six documents), Helwan University (five documents), Saudi Electronic University (five documents), and University of Coimbra (five documents) emerged as the top affiliations whose authors contributed the most.

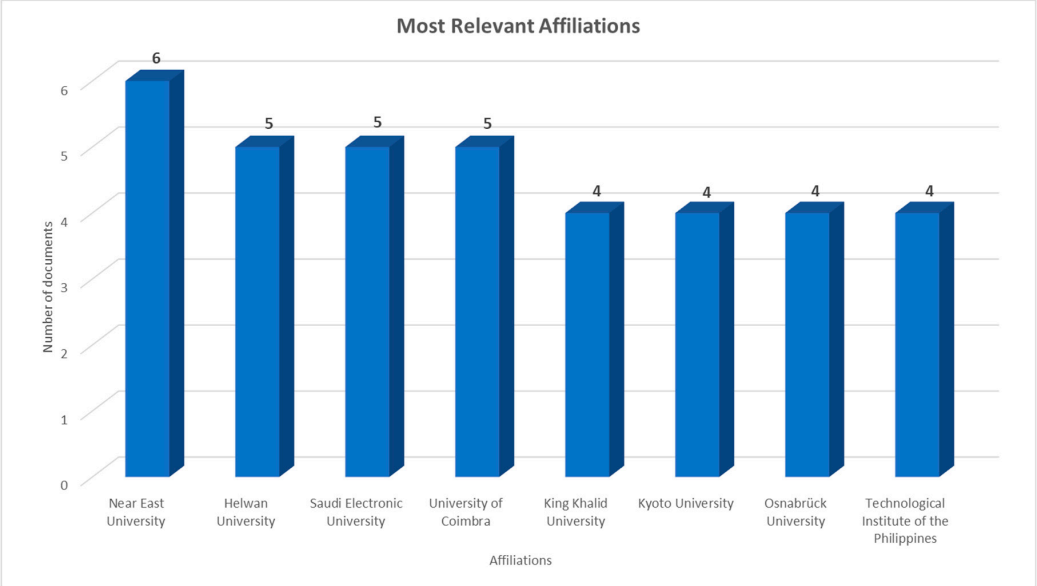

Figure 5. Top affiliations based on the number of documents published.

3.5. Countries

Of the 75 countries whose authors contributed documents to this collection of documents examined, the countries whose authors published the most are depicted in Figure 6 while the countries whose authors received the most citations are presented in Figure 7. More specifically, India (30), Spain (18), the United States (16), and Saudi Arabia (15 documents) arose as the countries with the highest number of published documents. When taking the citations received into account, Spain (175 citations), India (155 citations), China (144 citations), Saudi Arabia (125 citations), and Australia (121 citations) emerged as the countries whose authors received the highest number of citations. Due to the low interna-

tional collaboration rate (1.17%), besides the collaborations among authors from Spain and Italy, no other indications were identified.

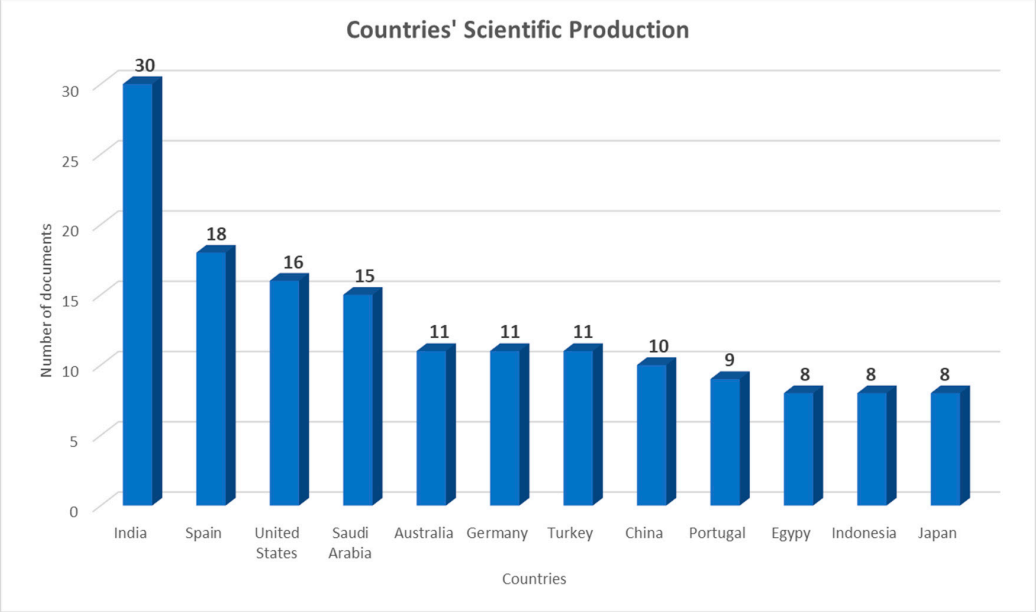

Figure 6. Countries that published the most over time.

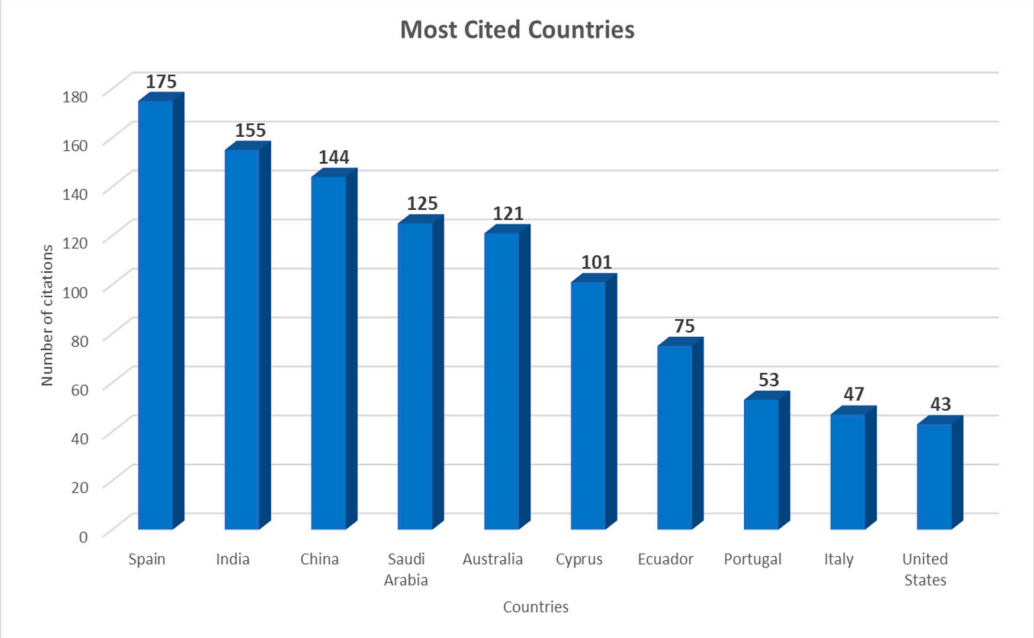

Figure 7. Countries that received the most citations.

3.6. Document Analysis

The related documents were also examined based on their impact, the keywords used as well as the topic trends and thematic evolution were also analyzed. According to the total global citations received, the most impactful documents are displayed in Table 5. Specifically, the studies of [38–42] arose as the top-five most impactful in terms of receiving the highest number of citations.

Table 5. Collection information.

Document	DOI	Total Citations	Total Citations per Year	Normalized Total Citations
[38]	10.1016/j.compedu.2019.103642	122	20.33	5.67
[39]	10.3390/APP10155371	74	14.8	5.59
[40]	10.1186/s40594-021-00323-x	70	23.33	13.19
[41]	10.3390/su10020468	66	9.43	4.98
[42]	10.1016/j.advengsoft.2009.07.009	62	4.13	1.88
[43]	10.3991/IJET.V15I01.11435	56	11.2	4.23
[44]	10.20344/amp.8404	49	6.13	5.53
[45]	10.1016/j.eswa.2015.05.048	46	4.6	4.79
[46]	10.1109/EAEEIE.2009.5335493	46	2.88	3.41
[47]	10.1016/j.compedu.2022.104684	45	22.5	23.96

The documents contained within the document collection examined were published in different sources mainly as conference/proceedings papers (freq.: 141 and perc.: 55.08%) or journal articles (freq.: 90 and perc.: 35.16%), followed by book chapters (freq.: 20 and perc.: 7.81%) or review articles (freq.: 5 and perc.: 1.95%). In the context of this study, keywords plus were used to conduct keywords analysis due to their higher accuracy and representative depiction in comparison to author keywords [48]. In Figure 8, the most frequently used keywords are displayed and Figure 9 presents their co-occurrence network. The top-five most common keywords were: "e-learning" (n = 121), "learning management systems" (n = 117), "learning systems" (n = 117), "artificial intelligence" (n = 116), and "students" (n = 90). Keywords such as "computer aided instruction" (n = 46), "education computing" (n = 42), "teaching" (n = 39), "education" (n = 31), and "information management" (n = 30) were also frequently used. Additionally, Figure 10 presents the relationships among the top authors, keywords, and sources.

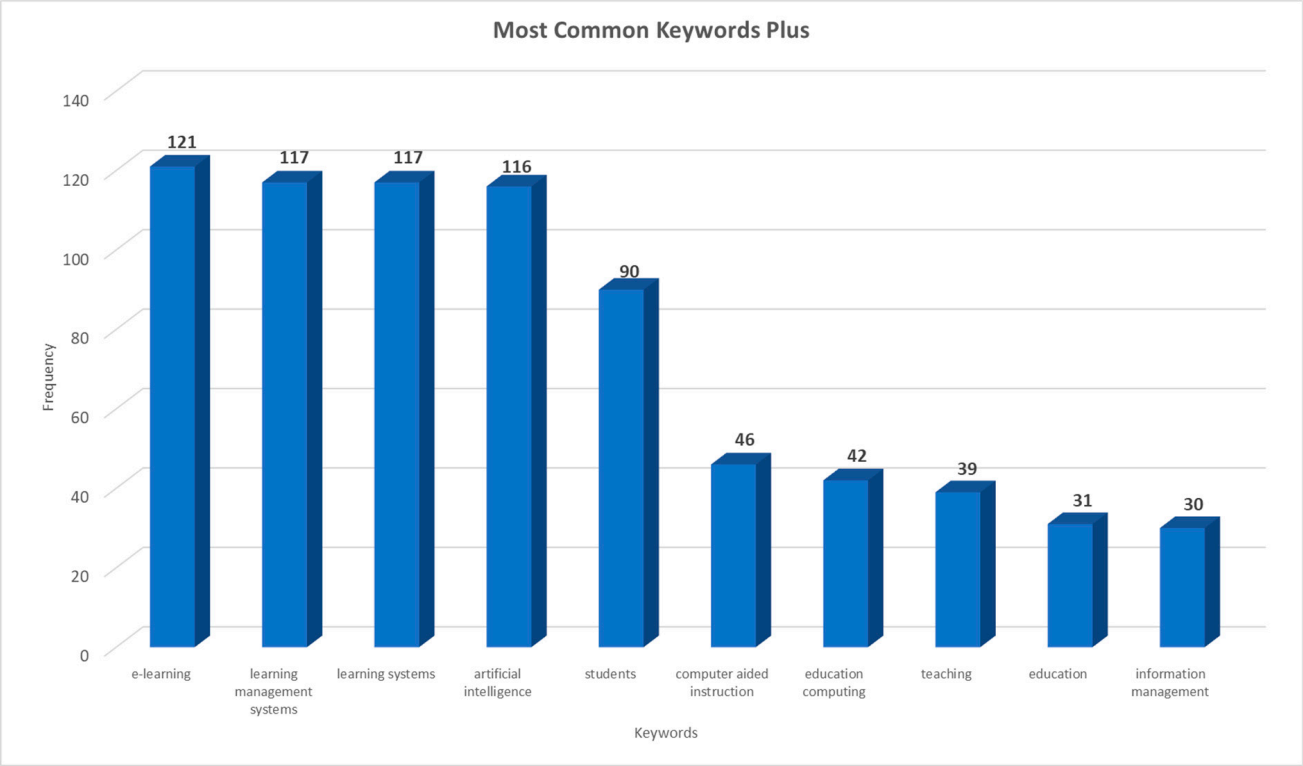

Figure 8. Most frequent keywords plus.

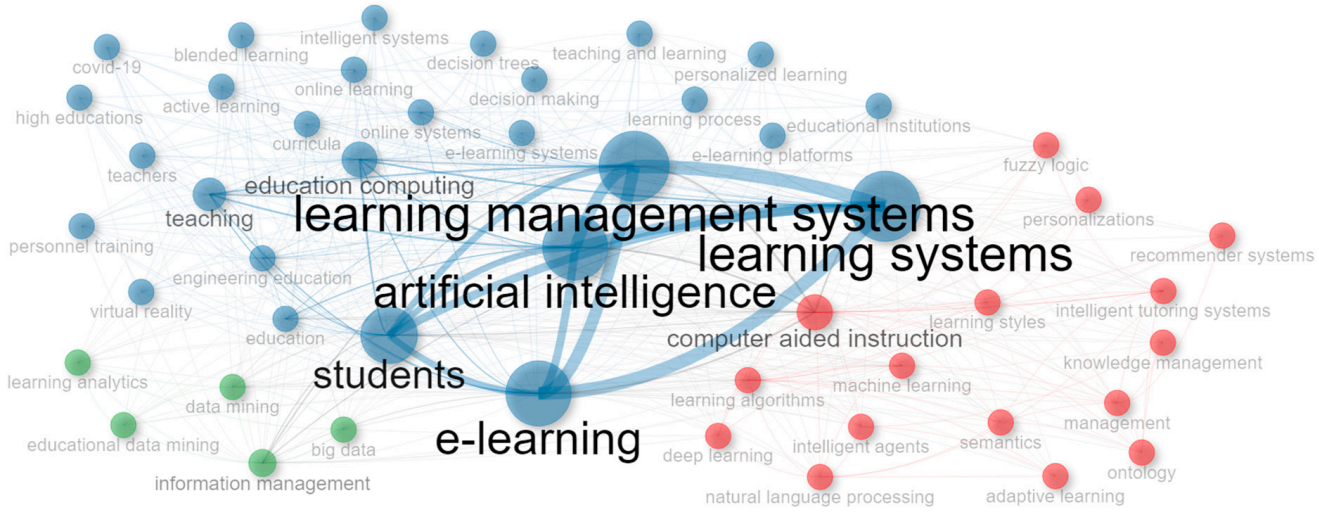

Figure 9. Keywords plus co-occurrence network.

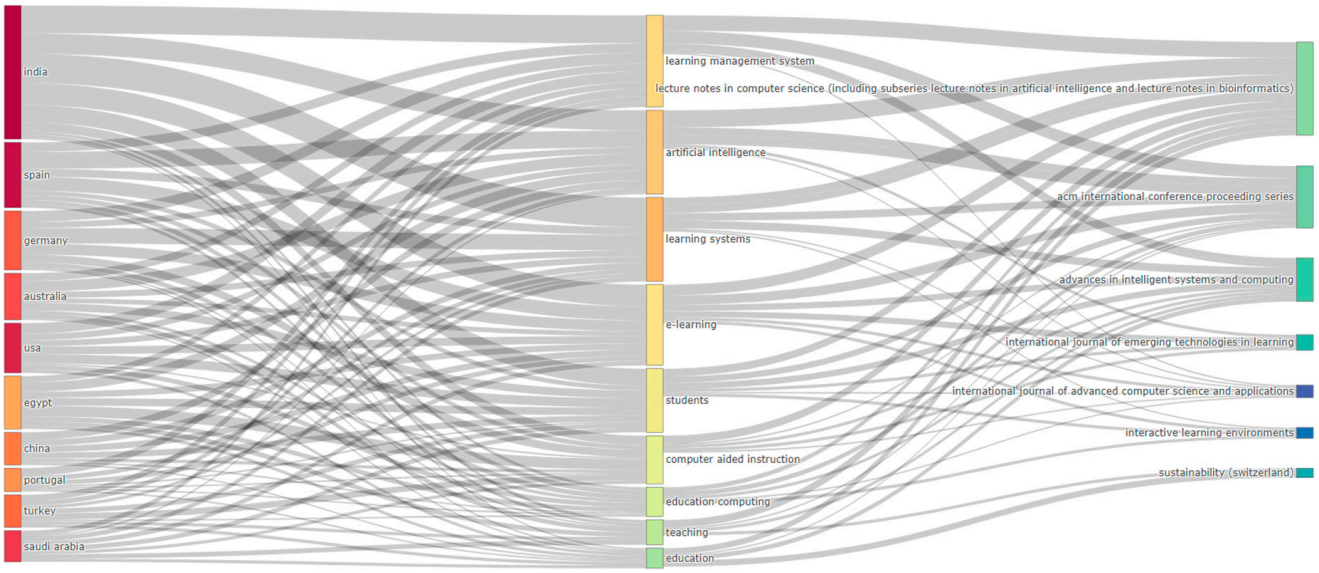

Figure 10. Countries, keywords, and sources relationships.

To obtain a better understanding of the existing literature, the thematic map of the topic using keywords plus was examined. As it can be seen in Figure 11, a total of 12 themes emerged. The themes were separated into basic themes, motor themes, niche themes, and emerging or declining themes. The themes of the basic themes were: (1) learning systems, learning management systems, and artificial intelligence; (2) computer-aided instructions, intelligent tutoring systems, and natural language processing; and (3) information management, data mining, and machine learning. The themes of the motor themes were: (1) learning contents, mathematical models, and e-learning environments; (2) blended learning, fuzzy logic, and fuzzy systems; and (3) application programs, educational process, and C (programming language). The themes of the niche themes were: (1) Bayesian networks, optimization, and algorithms; (2) commerce, education and training, and educational platforms; and (3) broad application, computational thinking, and course modules. The themes of the emerging or declining themes were: (1) learning, artificial neural networks, and prediction; (2) digital devices, digital platforms, and ecosystems; and (3) curriculum.

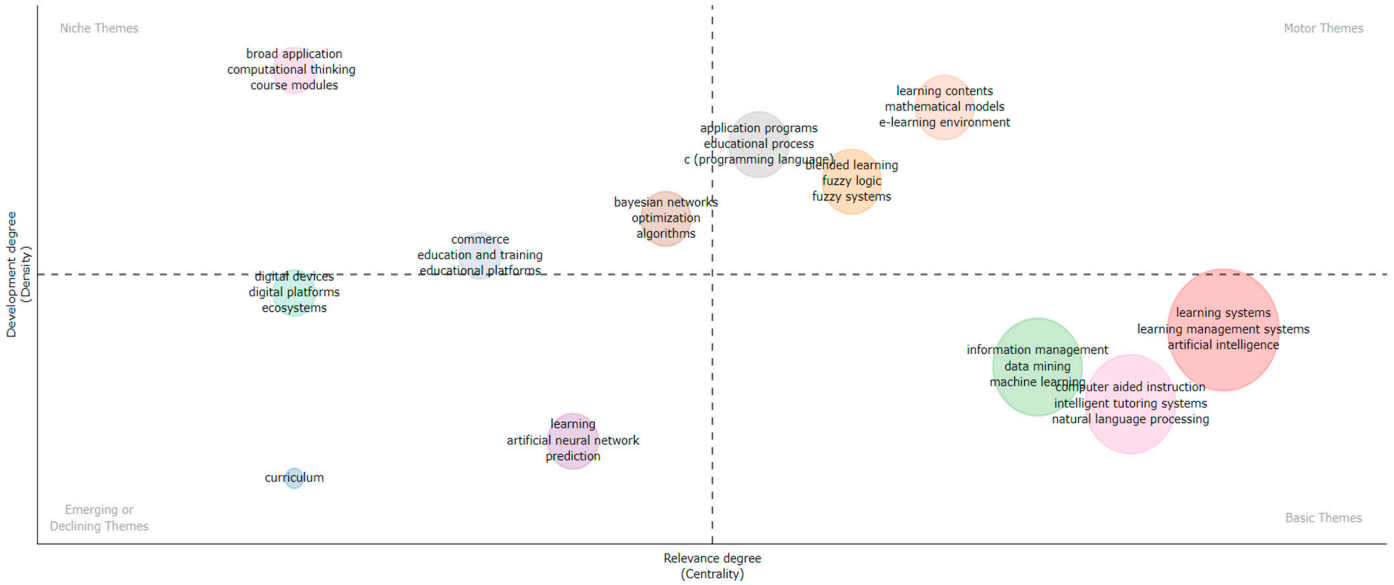

Figure 11. Thematic map of the topic.

To analyze the trend topics over the years, the keywords of the documents were used. Figure 12 presents the trend topics that arose from 2008 to 2023. The gradual transition toward more intelligent systems that aim to aid educational and instructional activities across modalities as well as to support both teachers and students was evident. The role of learning analytics and educational data mining also emerged as pivotal. In the context of personalized learning within learning management systems enriched with artificial intelligence, machine learning, deep learning, natural language processing, and intelligent tutoring systems also played a vital role.

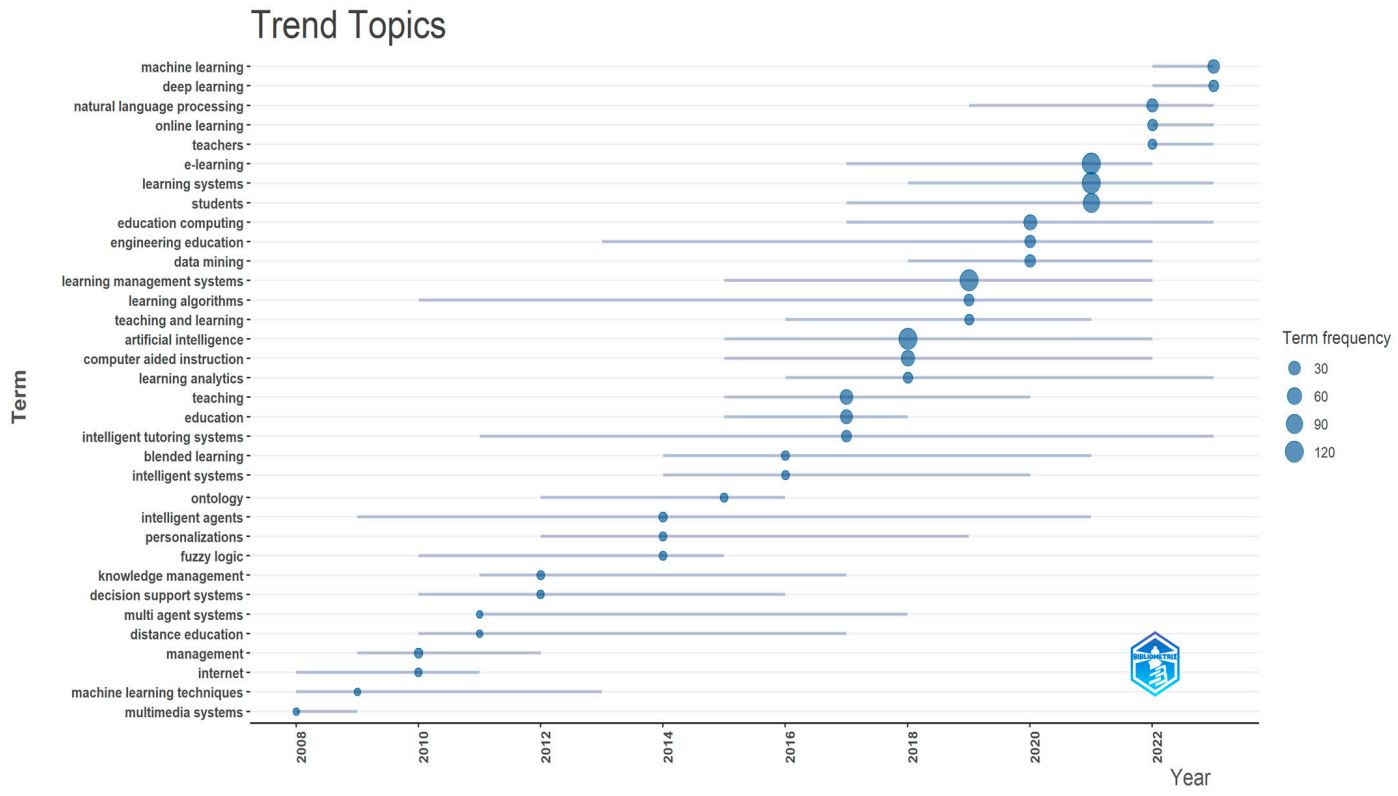

Figure 12. Trend topics based on keywords plus.

As the documents spanned across the period of 2004–2023, four equally divided time periods were set to examine the topic thematic evolution. The thematic evolution is presented in Figure 13. The gradual integration of artificial intelligence into educational and learning management systems can be observed. During 2009–2013, the integration of artificial intelligence into curricula, knowledge management systems, and decision-making systems by exploring students' learning styles and different learning algorithms was evident. In the initial period of 2004–2008, emphasis was put on students, the Internet, and the advancement of artificial intelligence through the study of learning algorithms and architectural designs. During 2014–2018, the use of artificial intelligence in intelligent tutoring systems, the capitalization of social networks, the use of virtual learning environments, the utilization of decision support systems, fuzzy logic, and deep neural networks, as well as advanced learning and course management systems (e.g., Moodle) became more prominent. In the period of 2019–2023, focus was placed on the role of artificial intelligence in learning systems, electronic assessment, decision making, and information management. Additionally, the use of virtual reality and classification algorithms was also highlighted. Finally, among the different educational subjects, engineering education seems to be more widely examined.

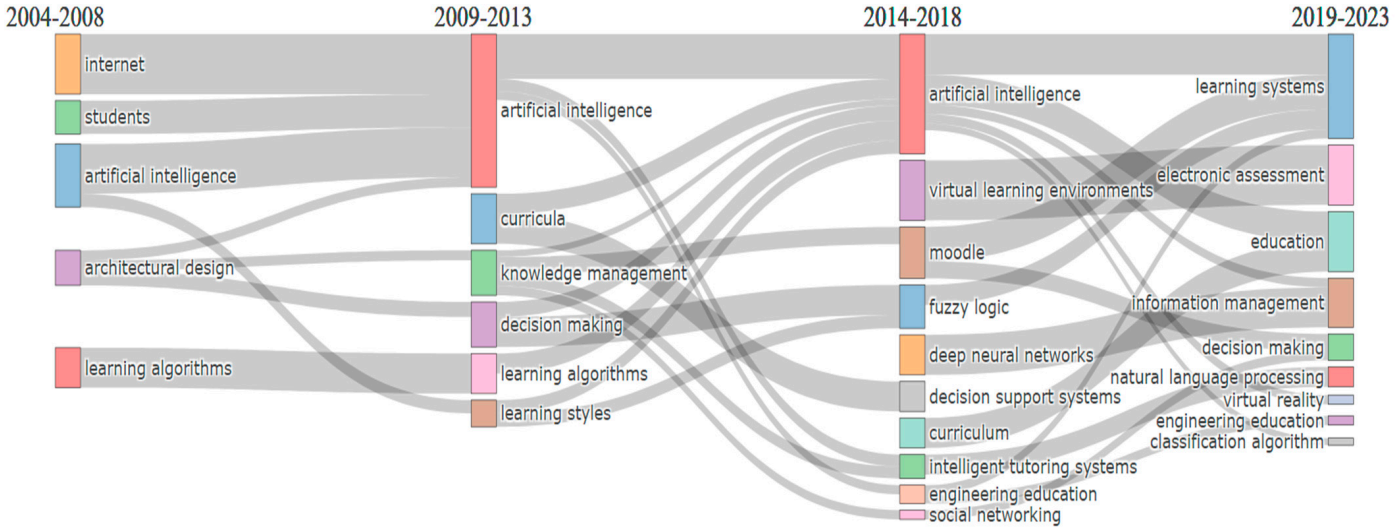

Figure 13. Thematic evolution of the topic.

4. Discussion

The synergy between learning management systems and artificial intelligence can help education undergo a significant transformation. The integration of artificial intelligence into learning management systems will transform education by offering more personalized and efficient learning experiences. Using artificial intelligence algorithms, learning management systems can analyze student behavior and progress, identify learning patterns, and automatically adapt content and activities to meet the individual needs of each learner. In addition, artificial intelligence can empower the interaction between students and teachers through intelligent systems (e.g., chatbots, virtual assistants, etc.) that provide instant responses to questions, assist in self-directed learning, and offer personalized assistance, feedback, and assessment in real time [27].

Integrating artificial intelligence into learning management systems also enables the automation of administrative tasks and the generation of advanced analytical reports. Artificial intelligence algorithms can help administrators and educators more efficiently manage courses, allocate resources, detect potential learning problems, and provide personalized recommendations to improve the learning experience. Artificial intelligence can also facilitate the detection of trends and behavioral patterns in system data, enabling

educational institutions to make informed and strategic decisions to optimize their teaching and learning programs.

However, in order for artificial intelligence to be effectively integrated into learning management systems and be introduced in classrooms, there are several ethical issues as well as privacy and security concerns that should be taken into account [49–51]. Additionally, technical aspects (e.g., algorithmic bias, etc.) should also be considered [52–54].

According to the outcomes of this study, it can be inferred that the integration of artificial intelligence in learning management systems is still at its early stages. However, due to its potential benefits, more studies are being conducted that examine its use. This fact can be justified by the majority of the studies (57.03%) having been published in the last three years (2021–2023) and the average document age within the document collection being 4.74 years. The high annual growth rate (25.42%) further highlights the importance of this topic and its potential to transform the educational sector. Impactful sources in the form of journals, conferences, and books have been used to publish relative to the topic documents. Sources of different types were identified in the list of the most impactful sources with 24 (12.37%) out of the 194 being regarded as highly relevant. It should be noted that among the top sources, some published related documents only in 2023. Authors from 55 countries from various continents have contributed to this topic which highlights its eminent importance and its potentials to enrich teaching and learning processes. However, a lack of international collaborations was noticed. Therefore, there is a clear need for more international and interdisciplinary collaborations to be established to further advance this field of study.

The findings of this study further confirm and expand upon those of other systematic review studies which have examined the role of artificial intelligence [55–57] and learning management systems in education [1,58,59]. When examining the keywords of the documents, the close relationship between artificial intelligence and learning management systems with teaching and learning processes became evident.

After the first search in the Scopus and WoS databases, additional search fields were added to identify the importance of the different advantages of the integration of artificial intelligence in learning management systems (Table 6): (i) improve information management; (ii) support teaching and learning activities; (iii) create intelligent educational systems; and (iv) provide educational data mining and learning activities.

Besides being used to improve information management, distribution, and creation, the integration of artificial intelligence within learning management systems can create intelligent educational systems which will amplify adaptive and personalized learning and will support both teaching and learning activities. Educational data mining and learning analytics are essential aspects for providing personalized learning [60]. Their important role in the realization of intelligent educational systems, intelligent tutoring systems, computer-aided instructions, and intelligent agents was revealed. Virtual reality environments and immersive virtual experiences also emerged as suitable learning environments to increase learning outcomes when combined with artificial intelligence.

Table 6. Advantages of artificial intelligence integration in learning management systems.

Advantages	Description	Added Search Field	References
Improve information management	The integration of artificial intelligence in learning management systems has significantly improved information management, enabling more accurate learning personalization, real-time data analysis, and optimization of educational resources, thus resulting in a more efficient learning experience tailored to individual student needs.	AND (“informa*”) AND (“manag*”)	[61,62]

Table 6. *Cont.*

Advantages	Description	Added Search Field	References
Support teaching and learning activities	It enables more precise personalization of learning, as well as continuous support and prediction of teaching and learning activities, thus improving students' understanding and academic performance in a personalized and effective way.	AND ("support") AND ("teach*" OR "learn*" OR "activiti*")	[63,64]
Create intelligent educational systems	Capable of dynamically adapting the contents and pedagogical methods to the needs and learning styles of students.	AND ("intel*") AND ("educ*" OR "system")	[65,66]
Provide educational data mining and learning activities	AI can process and analyze large volumes of student-generated data, such as interactions, performance, and participation patterns, quickly and accurately. This makes it possible to identify trends and behaviors that help personalize and improve the educational process.	AND ("data*" OR "mining")	[67,68]

5. Conclusions

This bibliometric review focused on examining the integration and use of artificial intelligence in learning management systems. Specifically, it examined 256 documents from 2004 to 2023. The analysis included the examination of the document collection specifications, citations, sources, affiliations, countries, and documents. Additionally, it explored the evolution of the topic and identified emerging themes and trends.

The outcomes of this study can support education stakeholders and policy makers as well as revealing meaningful future research directions. Based on the outcomes, the potentials of artificial intelligence to enrich the educational process were highlighted. Learning management systems are becoming more important in teaching and learning activities. The integration of artificial intelligence into learning management systems can further amplify and improve their capabilities. Such intelligent systems provide adaptive and personalized learning experiences which, in turn, can promote and support self-regulated learning as supported by the Self-Regulated Learning (SRL) theory, which emphasizes the importance of personalized feedback and adaptive learning environments in fostering self-regulation among learners [69]. Moreover, they can increase students' motivation and engagement which, in turn, can promote active learning as supported by Vygotsky's theory underscoring the role of interactive and collaborative communication in promoting active learning [70]. These systems can also improve equal access to education by supporting the creation, use, management, and distribution of open educational resources. Furthermore, as machine learning and deep learning models become more advanced and computing capabilities increase, studies have started to examine their role in enriching learning management systems. Studies have also focused on the use of learning management systems in online learning environments. More emphasis should be put on how intelligent driven learning management systems can be used in face-to-face classes to support teaching and learning activities. As the use of artificial intelligence matures and its integration into learning management systems advances, it is important to also examine its use in virtual learning environments and immersive learning environments as well as the role of learning analytics and educational data mining as a means to provide more effective and personalized learning. As the current focus remains on technological aspects and on the improvement of the intelligent learning systems, more emphasis should be placed on students' characteristics and performance and how they can influence the use of such systems as well as how intelligent systems can identify them and adapt accordingly to provide students with more personalized learning experiences. Recent advances in generative artificial intelligence have also highlighted the need to further rethink how artificial intelligence can be used to provide meaningful feedback and assessment at an individual level. Additionally, there is a need to further explore how the use of artificial intelligence

and learning management systems can promote and support the creation, distribution, adoption, and use of open educational resources to ensure equal access to high quality education for all. In this sense, it is essential to examine how such intelligent systems can be created to support the universal design for learning guidelines to improve accessibility in education.

As this study adopted a bibliometric analysis and review approach, there are some limitations that should be taken into account. Specifically, there is a lack of more in-depth examination of the practical implementations of artificial intelligence in learning management systems, ethical considerations, technical details, and geographical diversity considerations. Hence, future studies should focus on systematically analyzing relevant case studies and providing more practical insights. Additionally, future studies should look into ethical considerations and issues about the integration of artificial intelligence into education and how it can potentially influence teacher–student interactions so as to acquire a better understanding of the impact of artificial intelligence on education. Furthermore, there is a need to further examine the technical aspects associated with artificial intelligence, its use in learning management systems, and its adoption and integration in classrooms. Future studies could also explore how the use of artificial intelligence is advancing in different countries and analyze its geographical diversity in terms of its adoption and use in classrooms.

As the topic is further advancing, it is important for more experimental studies to be conducted to explore the implications and effects of integrating artificial intelligence and learning management systems into education at all educational levels. It is also significant to identify suitable design approaches and methods to effectively introduce and integrate them into classrooms. There is also a need to examine how they can influence face-to-face, online, and hybrid learning. In addition, future studies should focus on how students' personalities, characteristics, and learning preferences can affect and are affected by the integration of artificial intelligence into teaching and learning processes. It is important to explore how such tools can be effectively used and integrated by administrators and teachers and how they can support them. Finally, future studies should focus on examining the current state of education stakeholders' artificial intelligence literacy and how to further improve it, as well as how they adopt and integrate artificial intelligence in their classrooms. On the other hand, the inclusion of self-regulated learning theory (SRL) and Vygotsky's theory in the debate about the potential of AI in LMSs could open a new line of study.

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