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Learning Management System (LMS) Research During 1991–2021: How Technology Affects Education

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Abstract—Learning Management System (LMS) has been a widely-used learning media so a study is required to know the trend of its development. The present study aimed to analyze the types of documents, languages, contributing countries, top affiliates, sponsorship funding, top productive authors, research citations, subject areas, top source titles, trend mapping visualization, and top-cited 100 publications, and review some publications on LMS research during 1991–2021 using bibliometric analysis. The metadata were obtained by Scopus database and analyzed by VOSViewer within 2.689 documents. The bibliometric analysis results showed that LMS research had conference papers as the most widely published document type and English was the most commonly used language. The country with the most publications was the United States of America. National Natural Science Foundation of China became the top funding sponsor. The top affiliate was Bina Nusantara University. The most productive authors were Sabin Graf. Top cited author achieved by Fred D. Davis, and the top subject areas were Computer Science. Then, *Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence and Lecture Notes In Bioinformatics* became the title of the top source. Trends of LMS research in 1991–2021 were: 1) related to E-learning; 2) implementation of learning activities and student-teacher cases; 3) technology integration in learning; 4) distance learning; 5) technology education; 6) online learning environment; and 7) interactive learning environment.

Keywords—bibliometric, education, learning management system

1 Introduction

The learning implementation has undergone many transformations and developments, especially in the learning management system. In this widely altered situation, skills and propensities are essential for the 21st-century citizens to live, work, and function effectively, hence, they have been comprehensively identified [1]–[5]. Technology is an essential aspect of most school or university curriculum [6]–[9]. The learning management system (LMS) is an education platform providing an integrated objective for

3 publishing, collaborating, and sharing educational materials among teachers, learners, and institution managers [10]. Adapting LMS in higher education or another level of education has been a significant concern for the implementation of the digital learning process [11], [12]. Practitioners and experts emphasize that portraying the role of the new LMS needs to be consistent with teaching and learning theories [13]. LMS is a software or application that assists teachers in managing reporting, tracking, documentation, and delivering educational courses or training programs [14].

As LMS has become a promising technical tool in recent education, the precursors to adopting and using these educational techniques need to be considered in terms of consumer behavior. More specifically, a study in Malaysia required consideration of acceptance and preparation when using LMS for distance learning due to a lack of learner control and communication [15], [16]. LMS enables the integration of various objects and services into the ecosystem, especially in the education field and sequent students' training experiences. The main advantage of LMS is advanced tracking features and communication for discussion [17], [18].

Opportunities offered by using LMS include the ease of organizing and conducting online courses, ability to complete online assessments, accessibility and availability of learning materials, ways to save time and money for students and faculty, and communication and interactivity [19]. In addition, the LMS challenges that students face when adopting these technologies have the following shortcomings: Lack of student self-discipline and the discrepancy between LMS and specific academic programs [20]–[23]. However, as LMS technology increases in different countries, environments, consumer styles, traditional or creative, there are no boundaries in LMS research [24].

Research publications on LMS education tend to increase every year. A simple method that can be undertaken is through the bibliometric to input on Scopus with the keyword "Learning Management System Education or LMS Education.". The findings in 2018 resulted on 16 publications and 27 publications in 2021. This shows that research on LMS in education is increasing year by year. Therefore, in order to develop and adequately support a research topic, efforts must be made to find and understand the situation and trends of the research topic [25], [26], especially in LMS Education. Bibliometric studies can provide a solid foundation and objective for subject progress and relevant information on scientific publications [27]–[30]. Previous research [31] conducted an analysis review on choosing the proper LMS education. The study provided readers with data to help them make their judgments when selecting an LMS platform depending on their school's demands. This previous research used a literature study to discuss the potential of LMS. Hence, to distinguish from previous research, the present study is conducted using the bibliometric study to digest the information about LMS technology trends and their contribution to the education field.

This study conducted a bibliometric analysis on LMS in 1991–2021 using the meta-data in the Scopus database and assisted by the VOSViewer mapping application. This study was expected to find out trends, patterns, novelty, and future education in the LMS Education. Specifically, the objectives of this study are drawn as follows:

- a. To analyze the documents, languages, and countries that contributed to LMS research during 1991–2021
- b. To analyze the top affiliates and sponsorship funding of LMS research during 1991–2021

- c. To identify the top 10 most productive authors of the LMS research during 1991–2021
- d. To analyze the research citations, subject areas, and top source titles on LMS research during 1991–2021
- e. To identify the results of research trend mapping visualization on LMS research during 1991–2021
- f. To identify the results of research trend mapping visualization in the top 100 cited publications in LMS research during 1991–2021
- g. To analyze the distribution of top 100 cited publications in LMS research during 1991–2021
- h. To explore the top 5 cited publications in LMS research in the Education field during 1991–2021

2 Methods

This study was a bibliometric study using descriptive analysis. To analyze the publication data, this study needed to structure the database [32]–[36] on the Scopus (www.scopus.com). Scopus was the most extensive database and had more than 77.8 million core records from various fields with various metadata and document types, either non-academic or academic fields [36]–[41]. Hence, Scopus was chosen as the database source for this research. Figure 1 illustrates the research stages.

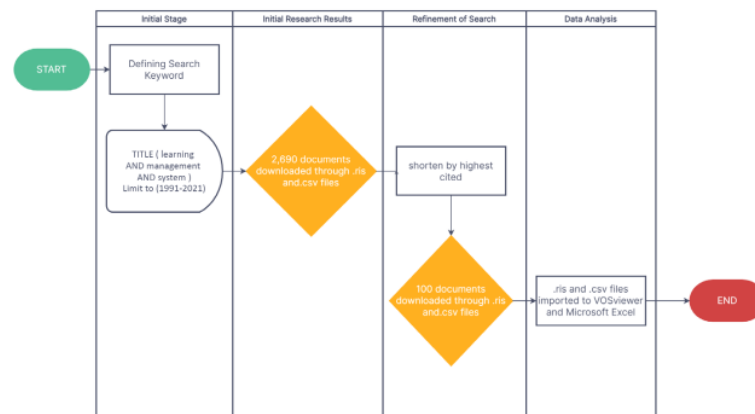


Fig. 1. Research stages

The data were collected on March 3, 2022. The obtained results were sorted by “citation count” from high citation to low citation. Afterwards, the data for the one hundred most cited articles were downloaded in .csv and .ris file format. These 100 documents were shortened with the ‘highest citation’ criteria. Then, it was suggested to

upload those files into VOSViewer software to detail the transcript of the data and visualize the bibliometric mapping [42]–[46]. For the final stage, the data were analyzed descriptively to answer the research objectives.

3 Results and discussion

3.1 Types of document, language, and countries that contributed to LMS research

As the final search and filtration process, there were 2,689 documents (LMS research for 1991–2021) consisting of conference papers with a total of 1371 documents, articles with 1106 documents, book chapters with 134 documents, and other types of document types including reviews, editorials, erratum, books, notes, conference reviews as many as 78 documents. Thus, the distribution of documents was broader and more widely used by many people as a reference source. Most researchers published conference papers because they had a high-quality reputation compared to other sources. Moreover, it had a more significant and more accessible influence, as it was displayed at a conference to be seen by many experts from various fields [47]. In coping with the language use, English became the most widely used language (2612 documents) and it was followed by Spanish (32 documents), German (20 documents), Chinese (11 documents), and Portuguese (7 documents). It was due to the fact that English was an international language that everyone could understand [48]–[51].

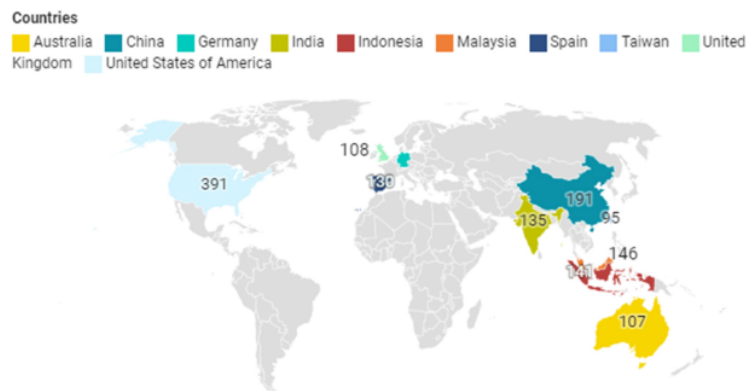


Fig. 2. Top 10 contributed countries to LMS research during 1991–2021
Source: Scopus – created with Datawrapper.

The metric search results showed that 116 countries had contributed to LMS research during 1991–2021. Figure 2 shows the top 10 countries that significantly contributed to LMS research. The United States of America led the productivity with 391 documents and it was followed by China with 191 documents and Malaysia with 146 documents in the top 3 countries.

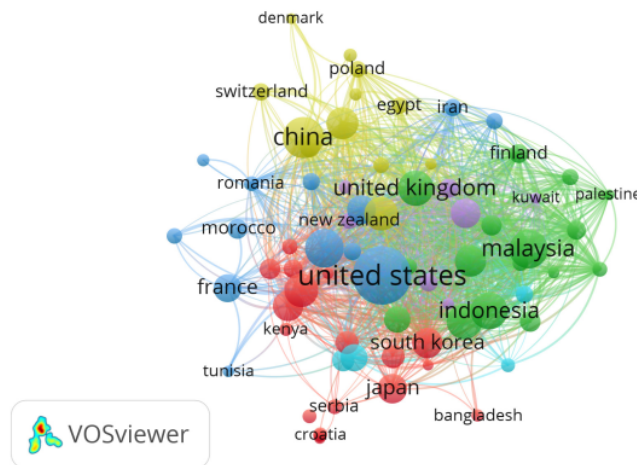


Fig. 3. Cluster countries mapping

Figure 3 shows mapping countries by cluster. There were six main clusters found the present study. Cluster 1 consisted of 18 countries namely Austria, Bangladesh, Bosnia and Herzegovina, Brazil, Canada, Chile, Croatia, Ireland, Japan, Kenya, North Macedonia, Norway, Russian Federation, Serbia, Slovenia, South Korea, Taiwan, and Vietnam that were connected by the red line. Cluster 2 consisted of 16 countries covering Finland, Ghana, Hong Kong, India, Indonesia, Iraq, Malaysia, Nigeria, Oman, Pakistan, Palestine, Philippines, South Africa, Thailand, Turkey, and the United Kingdom, which were connected by the green line.

Cluster 3 consisted of 13 countries namely Belgium, Colombia, Czech Republic, France, Iran, Italy, Mexico, Morocco, Romania, Slovakia, Spain, Tunisia, and the United States, which were connected by a blue thread. Cluster 4 consisted of 12 countries namely Australia, Bulgaria, China, Denmark, Egypt, Germany, Israel, Netherlands, Poland, Sweden, Switzerland, and Ukraine, which were connected by the yellow line. Cluster 5 consisted of 7 countries covering Singapore, Jordan, Lebanon, Qatar, Kuwait, New Zealand, and Saudi Arabia, which were connected by the purple line. And, cluster 6 consisted of 4 countries namely Cyprus, Greece, Portugal, and United Arab Emirates, which were connected by aqua line. The collaboration between countries on LMS research had been relatively good, as more than 70 countries involved.

3.2 Top funding sponsors and top affiliation

Table 1 shows the top 5 funding sponsors and top affiliations in LMS research within thirty years. In accordance with the top 5 funding sponsors, the most sponsorship funding was the National Natural Science Foundation of China with 28 documents, the National Science Foundation with 26 documents, the European Commission with 24 documents, the National Research Foundation of Korea with 21 documents, and the Japan Society for the Promotion of Science with 16 documents.

Table 1. The top 5 funding sponsors and affiliations with LMS research during 1991–2021

Top Funding Sponsors		Top Affiliations	
Funding Sponsor	Total	Affiliation	Total
National Natural Science Foundation of China	28	Bina Nusantara University	28
National Science Foundation	26	Universiti Kebangsaan Malaysia	26
European Commission	24	Athabasca University	23
National Research Foundation of Korea	21	Universiti Putra Malaysia	20
Japan Society For the Promotion of Science	16	Universidad Nacional de Educacion a Distancia	18

In addition, the top 5 affiliations were Bina Nusantara University with 28 documents, Universiti Kebangsaan Malaysia with 26 documents, Athabasca University with 23 documents, Universiti Putra Malaysia with 20 documents, and Universidad Nacional de Educacion a Distancia with 18 documents. This implied that publications on LMS research were not focused on one country but were evenly spread from Asia to Europe.

3.3 The top 10 most productive authors

The metadata results on Scopus showed the author of the publication of LMS research in 1991–2021. Table 2 depicts the top 10 most productive authors of LMS research in 1991–2021.

Table 2. The top 10 most productive authors on LMS research during 1991–2021

Top 10 Authorship			
Author	Total	Author	Total
Graf, S.	17	Chkouri, M.Y.	8
Kinshuk	11	Colazzo, L.	8
Molinari, A.	11	Outloud, M.	8
Lonn, S.	9	Sahari, N.	8
Castro, M.	8	Smith, S.	8

According to Table 2, Graf, S. was the most prolific author with 17 publications, followed by Kinshuk and Molinari, A. with 11 publication documents each. Then, other authors had fewer than 10 publications.

3.4 Top research citations, subject areas, and sources titles

Table 3 shows the top 10 research citations, subject areas, and source titles for LMS research during 1991–2021. Based on research citations, Wang Q., Woo H.L., Quek C.L., Yang Y., and Liu M. were the author with the most citations namely 369 citations.

Table 3. Top research citations, subject areas, and source titles on LMS research during 1991–2021

Top Cited Authors		Top Subject Areas		Top Source Titles	
Author	Cited By	Subject Areas	Total	Source Titles	Total
Davis, F.D.	373	Computer Science	1617	Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics	90
Venkatesh, V.	318	Social Sciences	1001	ACM International Conference Proceeding Series	55
Romero, C.	147	Engineering	760	Communications In Computer And Information Science	40
Ventura, S.	136	Mathematics	302	Journal of Physics Conference Series	35
Wang, Y.	133	Business, Management, and Accounting	241	Advances In Intelligent Systems And Computing	34
Ajzen, I.	118	Decision Sciences	193	ASEE Annual Conference And Exposition Conference Proceedings	26
Morris, M.G.	117	Energy	117	Coeur Workshop Proceedings	24
McLean, E.R.	114	Physics and Astronomy	97	Turkish Online Journal of Distance Education	21
Hair, J.F.	109	Medicine	85	Education And Information Technologies	20
Delone, W.H..	108	Arts and Humanities	67	International Journal of Emerging Technologies In Learning	18

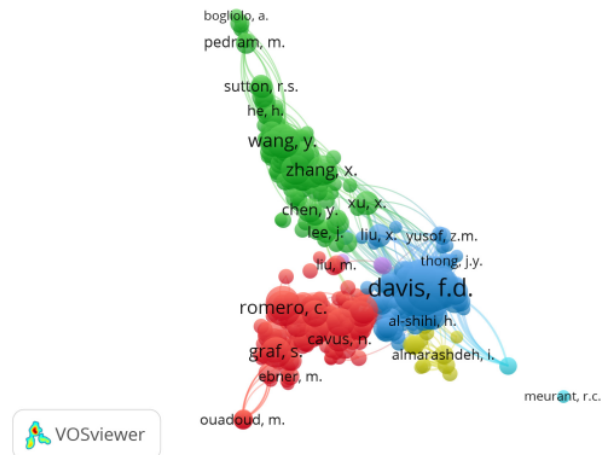


Fig. 4. Top-cited authors mapping visualization on LMS research during 1991–2021

Figure 4 shows that some top-cited authors were interconnected with each other. There were 7 clusters found in the top-cited authors. Davis, F.D. was considered the author with the most citations on LMS research from 1991–2021, namely 373 citations. He was followed by Venkatesh, V. with 318 citations and McGill T.J., Klobas J.E. with 147 citations. The seven main clusters were indicated by several colored nodes: the first cluster with red nodes ($n=173$), the second cluster with green nodes ($n=136$), the third cluster with blue nodes ($n=127$), the fourth cluster with chartreuse nodes ($n=12$), the fifth cluster with purple nodes ($n=3$), the sixth cluster with turquoise nodes ($n=2$) and the seventh cluster with orange nodes ($n=1$). Davis, F.D. was the most cited because of the highest number of citations and the link strength, but it belonged to the third cluster.

Based on subject areas, there were “Computer Science” with a total of 1617 publications, “Social Sciences” with 1001 publications, “Engineering” with 760 publications. Other subjects included Mathematics ($n=302$), Business, Management and Accounting ($n=241$), Decision Sciences ($n=193$), Energy ($n=117$), Physics and Astronomy ($n=97$), Medicine ($n=85$), and Arts and Humanities ($n=67$). In coping with the title of the top source, “Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics” was the main source in LMS research with a total of 90 citations, followed by “ACM International Conference Proceeding Series” with a total of 55 publications and “Communications in Computer and Information Science” with 40 publications.

3.5 Mapping-trend visualization to fundamental contribution

LMS was the main keyword in LMS research. The most occurrence keywords were analyzed before mapping out the visualization of LMS research trends during 1991–2021 (see Table 4). The highest total link strength and the most frequently occurring keywords were “Learning Management System,” 5171 and 721 respectively. The second keyword was “E-learning,” with total link strength of 4903 and an occurrence of 609, then was followed by Learning Systems, Students, Teaching, Education, Management, LMS, Learning, and Distance Education.

Based on this pattern, the trends of LMS research in 1991–2021 were related to E-learning, implementation of teaching and learning activities for students and teachers, technology integration in learning, distance learning, technology education, online learning environment, and interactive learning environment.

Table 4. Top 15 keywords of all and top 100 cited LMS research during 1991–2021

All LMS Research			Top 100 Cited Research		
Keyword	Total Link Strength	Occurrence	Keyword	Total Link Strength	Occurrence
Learning Management System	5171	721	E-Learning	82	30
E-learning	4903	609	Learning Systems	73	25
Learning Systems	4570	554	Learning Management System	70	25
Students	3127	359	Students	66	16
Teaching	2342	239	Education	64	15
Education	2238	239	Management	60	14
Management	1719	192	Learning Management Systems	49	15
LMS	851	131	Teaching	44	11
Learning	783	87	Interactive Learning Environments	33	6
Distance Education	651	83	Distance Education	27	6
Higher Education	530	89	Surveys	27	6
Learning Management Systems	361	64	Artificial Intelligence	24	11
Educational Technology	358	40	Learning	13	7
Technology Acceptance Model	253	36	Knowledge Management Learning	12	7
Online Learning Environment	150	15	LMS	9	6

To find the novelty of previous research, the mapping of metadata keywords was suggested to be undertaken [52]–[55]. Therefore, it was essential to look at the relationships between minor keywords or fewer keywords.

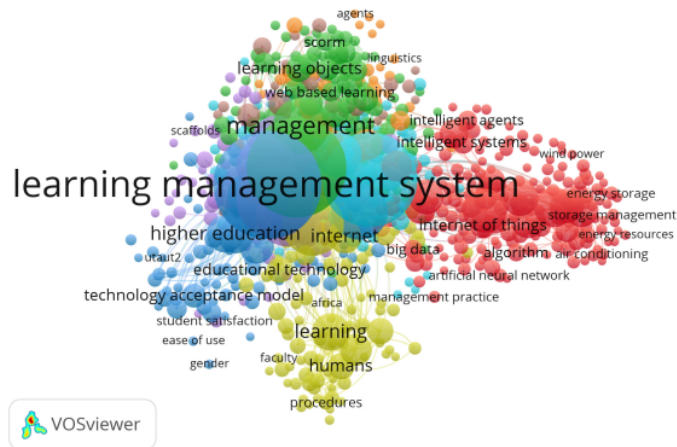


Fig. 5. Mapping visualization of keywords co-occurrence on all LMS research (1991–2021)

Figure 5 shows visualizations of keyword co-occurrences in all LMS research over the past thirty years to find the novelty and interrelationships between studies. The mapping visualization showed eight main clusters as the focus of LMS research. The first cluster was indicated by a red node ($n=185$) consisting of 5G mobile communication, artificial intelligence, deep learning, and reinforcement learning. The second cluster was indicated by green nodes ($n=93$) consisting of communication systems, e-learning, educational process, laboratories, and web-based learning. The third cluster was indicated by blue nodes ($n=87$) comprising learning management systems, blended learning environments, computer self-efficacy, conceptual frameworks, higher learning institutions, and secondary schools.

Figures 6a–6c were the top trends in LMS research during 1991–2021, whereas Figures 6d–6f were the opposite. If future researchers wanted to explore LMS on the top trends, there was still a chance to explore LMS research because the top trends still had a wide range and various fields of terms. This was because LMS could improve and assist education in many aspects. Some examples of specific keyword mapping visualization results on LMS encompassed e-learning, education, gamification, multimedia systems, and websites.

Whereas for fewer trends such as Figures 6d–6f, these could be used as an alternative future research field, especially to investigate LMS on gamification, multimedia systems, and website focus. For instance, future researchers wanted to explore LMS in a websites field (see Figure 6f). In that case, they might focus on web services, computer-aided instruction, e-learning, teaching, education, management, and learning systems.

Therefore, there was still a chance for future research to develop the LMS research based on the mapping visualization of the keywords. As mentioned, there were still possible opportunities to conduct research in LMS to less-used keywords or make an improvement to greater-used keywords.

3.6 Mapping-trend visualization on top 100 cited

In accordance with Table 4, the keyword that had the most total link strength and often appeared was E-learning. There were some other keywords such as learning systems (n=25), LMS (n=25), students (n=16), education (n=15), management (n=14), teaching (n=11), and distance education (n=6). Thus, it could be concluded that these keywords greatly influenced LMS research. Future researchers could conduct research in those fields because they had impactful research and a high citation rate.

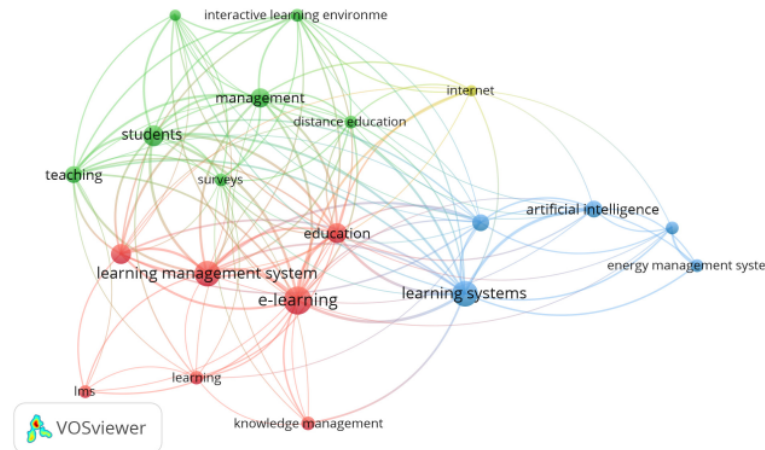


Fig. 7. Mapping visualization of keywords co-occurrence on all LMS research during 1991–2021 within the top 100 cited articles

Figure 7 shows visualizations of keyword co-occurrences on all LMS research over the past thirty years for the top 100 cited articles. Mapping visualization showed the existence of four clusters. First, the cluster of the red-coded line ($n=7$) focused on learning management systems, e-learning, education, LMS, knowledge management, and learning management systems. The second cluster of the green-coded line ($n=7$) was in the field of distance education, interactive learning environment, management, post-secondary education, students, surveys, and teaching. Third, the cluster of the blue-coded line ($n=5$) focused on artificial intelligence, energy management, energy management systems, information management, and learning systems. The last cluster of yellow-coded line ($n=1$) focused on the field of internet research.

3.7 Distribution top 100 cited publications

Table 5 shows the distribution of publications on LMS research over the past thirty years, with 100 cited publications. According to Table 5, 1992–1996, 1998–2000, 2004, and 2020 had no published documents. In 2010, it was the year with the most publications. Furthermore, the fewest citations were 1992–1996, 1998–2000, 2004, and 2020 because they did not have published documents, followed by 2019 with 49 citations. Meanwhile, the highest citation was in 2018 with 1052 citations.

Table 5. Top 100 cited distribution publications

Year	Paper	Cited	ACPP	ACPPY	Citable Years
1992	0	0	0.00	0.00	30
1993	0	0	0.00	0.00	29
1994	0	0	0.00	0.00	28
1995	0	0	0.00	0.00	27
1996	0	0	0.00	0.00	26
1997	2	220	110.00	4.40	25
1998	0	0	0.00	0.00	24
1999	0	0	0.00	0.00	23
2000	0	0	0.00	0.00	22
2001	2	111	55.50	2.64	21
2002	2	277	138.50	6.93	20
2003	3	364	121.33	6.39	19
2004	0	0	0.00	0.00	18
2005	2	325	162.50	9.56	17
2006	4	265	66.25	4.14	16
2007	5	489	97.80	6.52	15
2008	7	586	83.71	5.98	14
2009	7	913	130.43	10.03	13
2010	11*	706	64.18	5.35	12
2011	4	310	77.50	7.05	11
2012	6	722	120.33	12.03	10
2013	3	184	61.33	6.81	9
2014	8	571	71.38	8.92	8
2015	9	617	68.56	9.79	7
2016	9	764	84.89	14.15	6
2017	7	622	88.86	17.77	5
2018	6	1052*	175.33*	43.83	4
2019	2	94	47.00	15.67	3
2020	0	0	0.00	0.00	2
2021	1	49	49.00	49.00*	1
Total	100	9241	1874.38	246.96	—

Notes: * = the highest number; ACPPY = Average Citation Per Paper Per Year; ACPP = Average Citation Per Paper.

3.8 Review of top 5 cited publications in LMS research

Table 6 reviews the top 5 publications cited as impactful studies on LMS research during 1991–2021. Each article was analyzed based on the citation, Scimago Journal and Country Rank (SJR) accessed on www.scimagojr.com [56]–[59], CiteScore accessed on www.scopus.com (per March 6, 2022), and findings and recommendations in the publication.

Table 6. Review of top 5 cited publications in LMS research

Author(s)	Citation	SIR	CiteScore and Percentile to Education	Findings	Recommendations
Wang, Qiyun; Woo, Huay Lit; Quek, Choon Lang; Yang, Y.; Liu, M. [60]	368	1.79 (Q1)	7.6 (98th)	Basically, students were happy with Facebook's offer because the basic functionality of LMS could be easily integrated into Facebook groups. However, there were certain restrictions on using Facebook groups as an LMS. Direct uploads in other file formats were not supported, and The discussion was not threaded. In addition, students did not feel safe and comfortable due to potential privacy breaches.	Future research should consider comparing the learning benefits of students when using Facebook as an LMS and when using a commercial LMS in an online-only learning environment. This gives us a better understanding of Facebook's potential. Still, it can also be an improbable temporary obstacle that the limits currently being considered can be overcome in the spirit of ongoing research efforts.
Coates, H.; James, R.; Baldwin, G. [61]	278	0.62 (Q2)	2.3 (70th)	It was a broad and critical review of the potential impact of these online systems on university education and learning. In particular, it describes the potential implications of LMS on classroom practice and students. Commitment to the nature of scientific research and the management of scientific knowledge.	We need to conduct future LMS in higher education in lively and wide-ranging education-oriented discussions and debates.
McGill, T. J.; Klobas, J. E. [62]	271	3.03 (Q1)	14.4 (99th)	The results of the research strongly supported the importance of task and technology compatibility. This influenced the perception of the direct and indirect impact on learning through the level of use. The suitability of tasks and technology had a substantial impact on the perceptual effects of LMS on the process of learning but had a weak impact on student performance-related outcomes. Contrary to expectations, shared social norms and supportive conditions did not affect the LMS performance.	This research should explore further the impact of task technology on the success of LMS. This research also makes an essential contribution by recognizing the role that student awareness and teacher beliefs play in the importance of using LMS for the success of LMS. When teachers question the value of LMS in the classroom, it can potentially unknowingly and adversely affect student performance.

(Continued)

Table 6. Review of top 5 cited publications in LMS research (Continued)

Author(s)	Citation	SIR	CiteScore and Percentile to Education	Findings	Recommendations
Lonn, S.; Teasley, S. D. [63]	239	3.03 (Q1)	14.4 (99th)	The perceived advantages of using LMS to support traditional learning were reported by students also faculty at major Midwestern universities in the United States. This research surveyed two years of research data that focused on specific platforms of LMS that emphasized either efficient interactive or communication teaching and learning practices. This research matched the sum of user log data appropriate to the survey items to determine if system usage matches the pattern of survey results.	Find out how specific teachers successfully attracted students in and out of the classroom using more interactive tools. Furthermore, future research was needed to help students and teachers to identify the most effective ways to use these technologies to improve education and the learning process, especially in higher education.
Graf, S.; Kinschuk; Liu, T. C. [64]	138	1.45 (Q1)	7.2 (97th)	This research described an automated student modeling approach to identify their learning style based on the LMS-Felder Silverman-learning style model and the tools that implemented this approach and make it applicable to teachers. The proposed approach was to use the student's behavior during the learning process to collect clues about the learning style. By applying a simple rule-based mechanism, students' learning styles tend to be calculated based on the clues. The evaluation of the approach gave good results showing that the approach was suitable for identifying the students' learning style associated with FSLSM and demonstrating the functionality of the tool.	Development of the concept of dynamic automatic student modeling was needed. In addition, future research needed to plan to work on evaluating and improving the usability of DeLco in the future to better support teachers.

The ⁷view and analysis results in the top 5 cited publications presented in the Table 6 tended to examine the impact of LMS in education. The use of LMS could be integrated into the classroom from various levels of education. LMS was able to provide positive results in classroom learning. Implications of the review of the top 5 cited publications required more integration of better technology use and further research related to the attitudes of students and teachers in the use of LMS. These publications became fundamental for future research, so they had outstanding citations and impacted on LMS subjects' development. On March 6, 2022, most of the top 5 cited publications were listed in the rank journal Quartile 1 (Q1) with CiteScore of 7.2–14.4, of which they got a percentile of 97th–99th in the field of education. Journals with quartile rank 2 (Q2) had CiteScore 0.62 with a percentile of 70th in the field of education. This implied that publications with top 5 cited performance were publications with undoubted credibility since the publisher had a good reputation. Analysis of the SJR indicator assigned a different score to citations based on the importance of the citation source journal. Hence, citations from influential journals will be more valuable, and the journals receiving them will gain more fame [65].

4 Conclusions

This pioneering study is to review and analyze bibliometric top-cited publications on LMS research during 1991–2021 using the Scopus database and assisted by the VOSViewer application. This focus has become one of the research fields that has undergone significant development and improvement and technological development along with its contribution to education impact. This study has eight conclusions. First, conference paper becomes the most widely published type of document with English as the most widely spoken language. Moreover, the country with the most publications is the USA. Second, National Natural Science Foundation of China becomes top funding sponsors and the top affiliate that most often uses LMS keywords is Bina Nusantara University. The most prolific authors are Graf, S, then Kinshuk and Molinari, A.. Third, top cite⁴ author was Davis, F.D. and the subject areas that has been published the most is *Computer Science and Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics*. Fourth, the trends of LMS research in 1991–2021 were related to E-learning, implementation of learning activities and students' and teachers' cases, technology integration in learning, distance learning, technology education, online learning environment, and interactive learning environment. In the top 100 cited research, e-learning becomes the most widely used keyword, learning systems, and LMS. Hence, future researchers can research these subjects for they have an impactful study and high citation rate. Sixth, the years 1992–1996, 1998–2000, 2004, and 2020 had no published documents, while 2010 becomes the year with the most publications. The fewest citations are in 1992–1996, 1998–2000, 2004, and 2020 because there have been no published documents, and so does in 2019.

Meanwhile, the highest citation⁷ in 2018. Seventh, the review and analysis results in the top 5 cited publications tend to examine the impact of LMS in education. The use of LMS can be integrated into the classroom from various levels of education. LMS is able to provide positive results in classroom learning. These publications become

fundamental for future research, so they have outstanding citations and an impact on LMS subjects' development. Eight, most of the top 5 cited publications are listed in the rank journal with Quartile 1 (Q1) level and CiteScore ranging from 70th, 97th to 99th in the field of education.

The implication of this study is to digest the information about LMS technology trends and their contribution to the education field. Furthermore, future researchers can develop or improve the LMS ideas research to contribute to increasing the education field. Moreover, future researchers are welcome to define a profile of the types of documents that can be given to further focus on the research path. The researchers can find the topics most relevant to Scopus' LMS and the authors who have had the most significant impact and identify the main research lines in each defined period. Therefore, it also helps to narrow down the following trends that can be developed in this field of research.

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