



Learning Management System (LMS)

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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 VOS Viewer within 2.689 documents. The bib-biometric 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 Sabine 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 active-ties and student-teacher cases; 3) technology integration in learning; 4) distance learning; 5) technology education; 6) online learning environment; and 7) inter-active learning environment.

Keywords: Learning Management Systems, E-learning, Online Education, Educational Technology, Personalized Learning, Student Engagement, LMS Development, Artificial Intelligence, Mobile Learning, Intelligent Teaching System (ITS), Gamification.

I. 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 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 subsequent 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 VOS Viewer 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:

- To analyze the documents, languages, and countries that contributed to LMS research during 1991–2021
- To analyze the top affiliates and sponsorship funding of LMS research during 1991–2021
- To identify the top 10 most productive authors of the LMS research during 1991–2021
- To analyze the research citations, subject areas, and top source titles on LMS research during 1991–2021
- To identify the results of research trend mapping visualization on LMS research during 1991–2021
- To identify the results of research trend mapping visualization in the top 100 cited publications in LMS research during 1991–2021
- To analyze the distribution of top 100 cited publications in LMS research during 1991–2021
- To explore the top 5 cited publications in LMS research in the Education field during 1991–2021

II. 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.

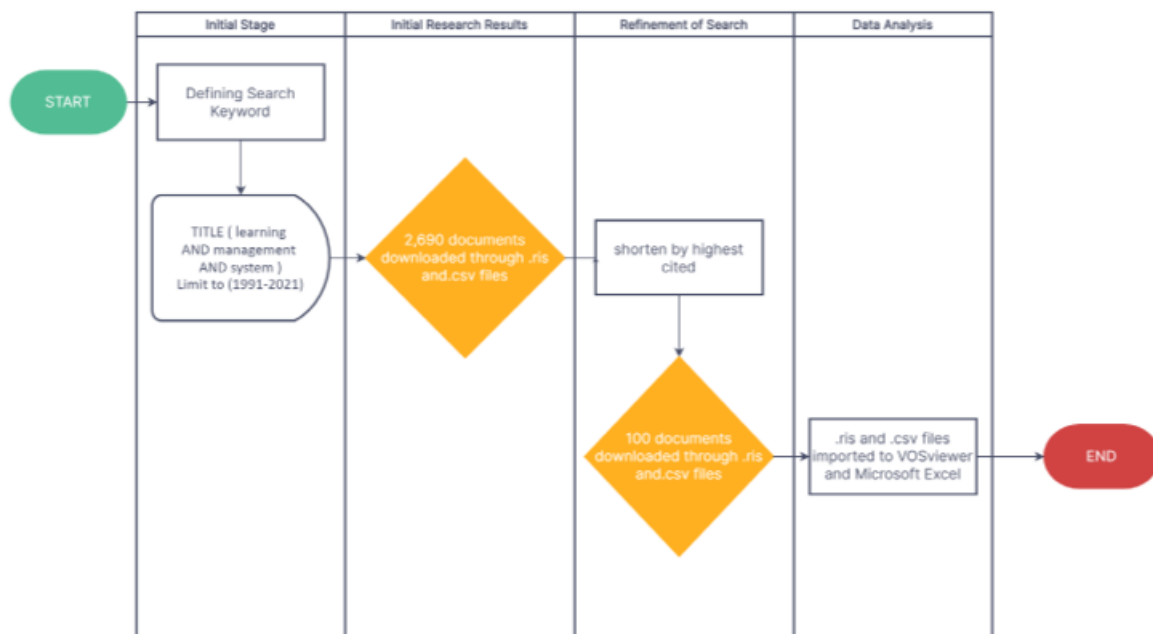


Fig. 1. Research stages

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 .rise file format. These 100 documents were shortened with the ‘highest citation’ criteria. Then, it was suggested to upload those files into VOS Viewer 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.



III. 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, arti-class 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]

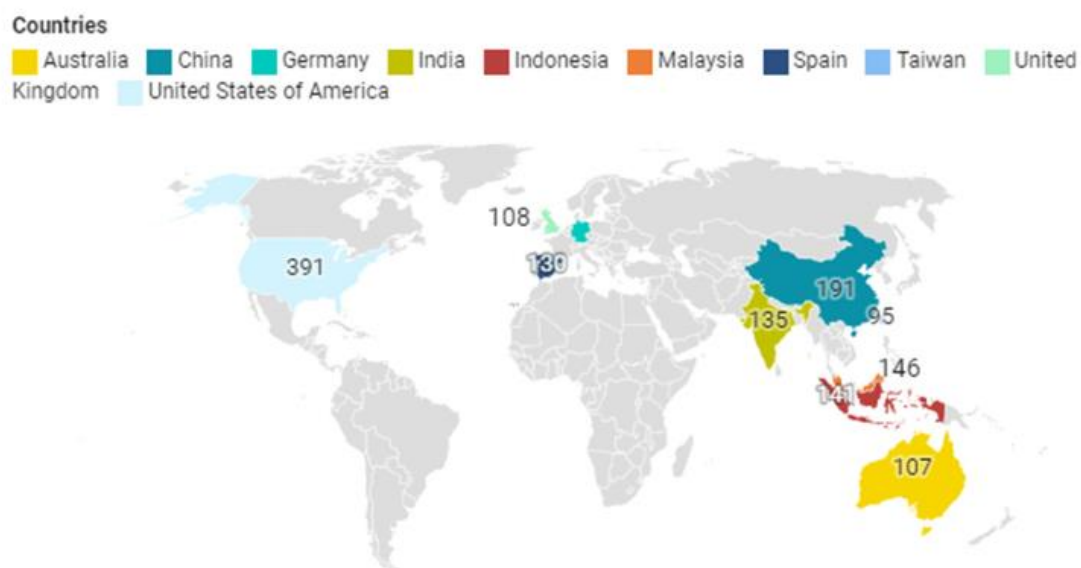


Fig. 2. Top 10 contributed countries to LMS research during 1991–2021 Source: Scopus – created with **Datawrapper**.

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

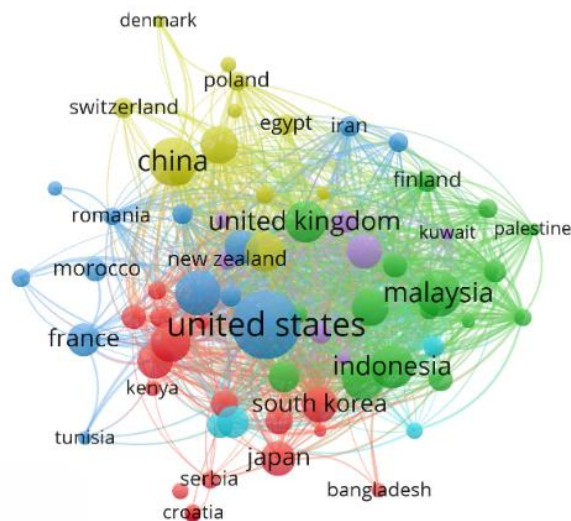


Fig. 3. Cluster countries mapping

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, University 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 author

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., Quек 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

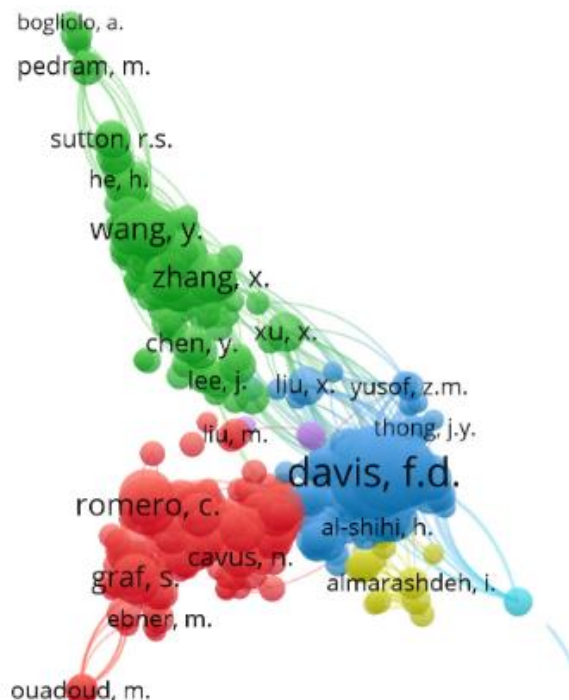


Fig. 4. Top-cited authors mapping visualization on LMS research during 1991–2021

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 occur-ring keywords were “Learning Management System,” 5171 and 721 respectively. The second keyword was “E-learning,” with total link strength of 4903 and an occur-Rence 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 teach-errs, technology integration in learning, distance learning, technology education, online learning environment, and interactive learning environment.

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 relation-ships between minor keywords or fewer keywords.

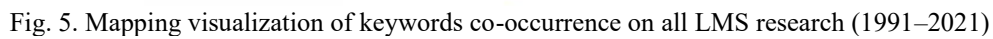


Fig. 6. Some specific keywords of mapping visualization results in the keywords of a) LMS, b) e-learning, c) education, d) gamification, e) multimedia systems, and f) websites



IV. CONCLUSION

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 VOS Viewer 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 cited 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 citation is 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 Cite Score 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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