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Learning Management System as a Digital Transformation in Elementary Schools: A Bibliometric Study (1989–2025)

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Abstract. This study aims to map the development of research on digital transformation in primary education through Learning Management Systems (LMS) published between 1989-2025 within the broader field of educational technology. The study focuses on four main aspects: (1) publication performance based on year, contributing countries, sources, and document types; (2) thematic structures, including dominant keywords, thematic evolution, and author collaboration networks; (3) intellectual structure analysis through co-citation, bibliographic coupling, and citation network mapping; and (4) the representation of adaptive learning within LMS-related research in primary or elementary education. The method used was bibliometrics utilising the Scopus database and analysed through RStudio (Bibliometrix/Biblioshiny), VOSviewer and Microsoft Excel. A total of 137 articles from 111 sources were included to generate comprehensive publication performance metrics and research network visualisations. The findings indicate that LMS research in primary education is gaining global attention, although publication growth remains relatively stable. Key themes include educational technology, digital literacy, gamification, adaptive learning and learning analytics. China and Indonesia emerge as major

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collaboration hubs, while *Computers & Education* dominates citation influence. The field is shifting from general e-learning towards adaptive and AI-supported LMS. This study contributes theoretically by clarifying the intellectual, conceptual, and collaborative structure of LMS research in primary education, providing a systematic foundation for understanding its evolution towards data-driven and personalised learning environments.

Keywords: Bibliometric analysis; digital transformation; LMS; primary educational technology; adaptive learning

1. Introduction

In the 21st century, digital technology has become an integral part of almost all aspects of life, including education (Sari, Ulusoy, & Pektaş, 2025). Rapid advances in information technology and global networks have accelerated the flow of information, creating an era of knowledge expansion that significantly influences teaching and learning practices (Zhu, 2024). In education, the convergence of information management, digitalisation, and artificial intelligence has intensified the adoption of digital learning systems, including mobile-based smart LMSs (SLMS), across educational levels (Luo & Wang, 2024). Digital transformation in primary education is urgent, with LMS evolving from administrative tools into integrated digital environments. AI-driven features such as adaptive learning, automated feedback, and analytics signal a fundamental shift in educational technology (Rahate et al., 2025).

However, most LMS-related research continues to focus on higher education and adult learners, leaving limited empirical and conceptual understanding of LMS implementation in primary or elementary education. Studies such as Arghir (2024) highlight that system quality, service quality and user satisfaction are key determinants of LMS effectiveness, yet these findings are largely derived from tertiary education contexts. This reveals a critical research gap concerning how LMS-supported digital transformation operates optimally for younger learners, who require simpler, more intuitive and child-friendly systems.

Existing studies confirm that LMS can enhance flexibility in teaching and learning, facilitate access to learning resources, and support teachers in monitoring student progress (Nastiti et.al., 2023). Research on educational technology also emphasises the importance of user experience (UX) design and usability in LMS development (Liamas et.al., 2025). Nevertheless, bibliometric studies on LMS trends have predominantly examined digital transformation at a general level, without specific attention to primary education contexts or adaptive learning features (Phuong et al., 2023).

The urgency of this research is further reinforced by persistent challenges in primary schools, including limited digital infrastructure, unequal access to devices and internet connectivity, and the need for sustained teacher guidance in online learning environments (Nafiah et al., 2022). While strategic evaluations such as SWOT analysis have been proposed to support LMS selection Bulaclac et

al. (2022) and recent studies highlight LMS potential in supporting character education Fajarianto et al. (2024), a comprehensive overview of how LMS research in primary education has evolved remains underexplored.

Although bibliometric evidence shows a significant increase in LMS-related publications since 2014, (Darmawan & Meisyani, 2025), systematic mapping of LMS-driven digital transformation in primary education remains limited, particularly on adaptive learning and AI. This study fills the gap through bibliometric analysis of trends, themes, collaboration, and intellectual structures, informing future research and policy. This study contributes theoretically and practically by mapping LMS research in primary education through bibliometric analysis. It fills literature gaps by revealing publication trends, collaboration patterns, thematic evolution and intellectual structures using co-word, co-citation and network analyses. The findings identify key research clusters, influential scholars, and emerging directions, providing a foundation for future studies and the development of more inclusive, adaptive LMS models for primary school learners.

In response to the limited systematic understanding of digital transformation through LMS in primary education, this study aims to provide a comprehensive bibliometric mapping of scientific research in this field for the period 1989–2025. Specifically, the objectives of this study are as follows:

a. To analyse the development and distribution of scientific publications on LMS implementation in primary education.
   Sub-objectives: a) to examine annual publication trends and growth patterns in LMS research, b) to identify the most productive countries, institutions and authors, c) to analyse leading publication sources and dominant document types.
b. To identify dominant research themes, key keywords and collaboration patterns in LMS-related studies within primary or elementary education contexts.
   Sub-objectives: a) to map dominant and emerging keywords using co-word analysis, b) to examine thematic evolution and research focus shifts over time, c) to analyse patterns of author collaboration through co-authorship networks.
c. To map the intellectual structure and developmental directions of LMS research in primary education.
   Sub-objectives: a) to identify influential authors, documents and journals using co-citation analysis, b) to examine research similarities and knowledge clusters through bibliographic coupling, c) to visualise citation networks that reveal knowledge flows and research frontiers.

The rapid growth of digital transformation has positioned LMS as a key component of education. However, LMS research largely focuses on higher education, leaving evidence in primary education fragmented. There is limited bibliometric mapping of publication trends, themes, collaboration patterns and intellectual structures specific to primary contexts, particularly regarding adaptive learning and child-centred design. Without addressing this gap, LMS development in primary education risks relying on unsuitable evidence, leading

to ineffective system design and policy decisions. Therefore, a systematic understanding is needed to support child-friendly, adaptive and pedagogically sound LMS implementation.

To address these gaps, this study employs a bibliometric analysis to systematically map the development, thematic structure, collaboration patterns and intellectual foundations of LMS research in primary education, thereby providing a data-driven basis for future research, innovation and evidence-based decision-making. Aligned with the problem statement and research objectives, this study addresses the following research questions:

a. RQ1: How has scientific publication on digital transformation through LMS in primary education developed in terms of annual trends, contributing countries, publication sources and document types over the past two decades?
b. RQ2: What are the dominant themes, keyword developments and author collaboration patterns in LMS research in primary education based on co-word, co-authorship and thematic evolution analyses?
c. RQ3: What is the intellectual structure and direction of scientific development regarding the implementation of LMS in primary education based on co-citation, bibliographic coupling and citation network analysis?

2. Literature Review

This section reviews the relevant literature on LMSs, digital transformation in primary education, and the theoretical frameworks underpinning this study, including technology acceptance and adaptive learning perspectives.

2.1. LMSs as a Core Component of Digital Transformation

Digital transformation in education is highly dependent on the creation of interactive learning environments through the use LMS, digital platforms, university forums, and academic groups (El Koshiry et al., 2024). These facilities enable more intense interaction between students and teachers, which is key to encouraging active participation, collaborative learning and a more meaningful learning experience. The interactivity created through these systems also strengthens access to teaching materials, academic discussions and real-time learning support, making digital transformation not only a technological change but also a change in the approach to the learning process.

Research on LMSs includes the integration of generative AI features directly into LMS, enriching the teaching and learning process and evaluating experiences (Arghir, 2024). The implementation of LMS presents its own challenges, especially for primary school students, so the teaching methods used must be appropriate for their characteristics (Al-Samarraie & Saeed, 2018). The implementation of the LMS system in primary education can help the teaching process by making it easier for teachers and learners to carry out learning activities more flexibly (Nasution, et al., 2024).

LMS are widely recognised as digital platforms that facilitate the administration, delivery, monitoring, and evaluation of teaching and learning processes in an integrated manner (Al-Fraihat et al., 2025; Bradley, 2020). Beyond their technical

functions, LMS serve as socio-technical systems that shape interactions between teachers, learners, content and assessment mechanisms. In the context of digital transformation, LMS represent not merely technological tools but enablers of pedagogical change, supporting learner-centred, flexible, and data-driven learning environments (El Koshiry et al., 2024). Recent advances have extended LMS functionalities through the integration of artificial intelligence, learning analytics and adaptive learning features, allowing systems to provide personalised feedback, recommend learning pathways, and monitor learner progress in real time (Arghir, 2024). However, these developments have largely been examined within higher education contexts, while their applicability and effectiveness in primary education, where learners have distinct cognitive, motivational and self-regulatory characteristics, remain insufficiently theorised.

2.2. Technology Acceptance and Use in Primary Education: TAM–UTAUT Perspective

To explain LMS adoption and utilisation, this study adopts an integrated TAM and UTAUT framework (Chan & Lee, 2021; Naseri & Abdullah, 2024). TAM emphasises perceived usefulness and perceived ease of use as key determinants of technology acceptance, while UTAUT extends this framework by incorporating performance expectancy, effort expectancy, social influence and facilitating conditions. In primary education settings, these constructs take on unique meanings (Al-kfairy, 2024; Jeon et al., 2020). Young learners require LMS interfaces that are intuitive, visually engaging and cognitively appropriate, making effort expectancy and ease of use particularly critical. Teachers' digital competence and attitudes strongly influence social influence, while infrastructure availability, device access, and institutional support determine facilitating conditions (Mahama et al., 2024; Nasution et al., 2024). This suggests that LMS adoption in primary education is shaped by a complex interaction between technological, pedagogical and contextual factors, rather than by system features alone.

2.3. Adaptive Learning, Learning Analytics and Pedagogical Implications

Adaptive learning has emerged as a key theme in LMS-driven digital transformation, enabling systems to tailor content, pace, and feedback based on learner data (Akavova et al., 2023; Das et al., 2024; Mustafa, 2024). LMS data reveal self-regulated learning behaviours, but time management and help-seeking remain weak among young learners. Adaptive LMS support differentiated instruction yet require child-centred design and teacher mediation to ensure effective learning gains.

A LMS is a specially selected software-based application that supports the learning process in higher education institutions (Aljaloud et al., 2022). A LMS is a software platform designed to facilitate administration, documentation, progress tracking, and delivery of educational courses (Al-Fraihat et al., 2025). An LMS is an application for organising e-learning (Restianto et al., 2022). LMS provides an online classroom that supports the learning process, so that both teachers and students are empowered in their teaching and learning activities (Bradley, 2020). Through the virtual classroom environment, the LMS facilitates interaction, material delivery and mentoring that strengthen the learning process.

LMS is an interactive digital software platform designed to facilitate the design, management, administration, tracking, assessment, and delivery of teaching and learning processes and training in an integrated and real-time manner (Al-Fraihat et al., 2025; Khan et al., 2025; Llamas et al., 2025; Simon et al., 2025; Vergara et al., 2024). An LMS is an interactive platform for managing, delivering and assessing learning. It supports online interaction and real-time progress monitoring, while Moodle data reveal students' self-regulation skills, though time management and help-seeking still need improvement.

Previous research highlights the use of LMS at the junior high school level in Indonesia by analysing 70 publications published between 2019 and 2024. The study revealed various trends in LMS implementation influenced by aspects such as the availability of technological infrastructure, teacher readiness, and digital literacy levels (Saputri et al., 2024). The use of LMS has not been optimal due to high data costs, negative perceptions of online learning, unsupportive student attitudes, low participation, and limited devices and internet connections (Mahama et al., 2024). The use of LMS platforms allows teachers to create, manage and share learning materials that can be accessed anytime and anywhere. Thus, LMS becomes an alternative solution when face-to-face learning cannot be implemented (R. M. Dewi et al., 2023).

The use of LMS in educational settings still faces serious challenges. High internet data costs are a major obstacle, especially in areas with limited digital infrastructure. The functions of LMS include the presentation of information specifically designed to record and track the progress of students in meeting learning objectives/expectations (Bradley, 2020).In addition, many students still have a negative perception of online learning because it is considered less interactive than face-to-face learning. Students' lack of enthusiasm and low active participation in online activities further exacerbate the effectiveness of the LMS. Other contributing factors are the lack of available devices, such as computers or adequate gadgets, and poor internet connection. This condition requires policy intervention and ongoing technical support.

Based on the theoretical foundation discussed above, the conceptual framework illustrating Digital Transformation in Primary Education through LMSs (1989–2025) is presented in Figure 1.

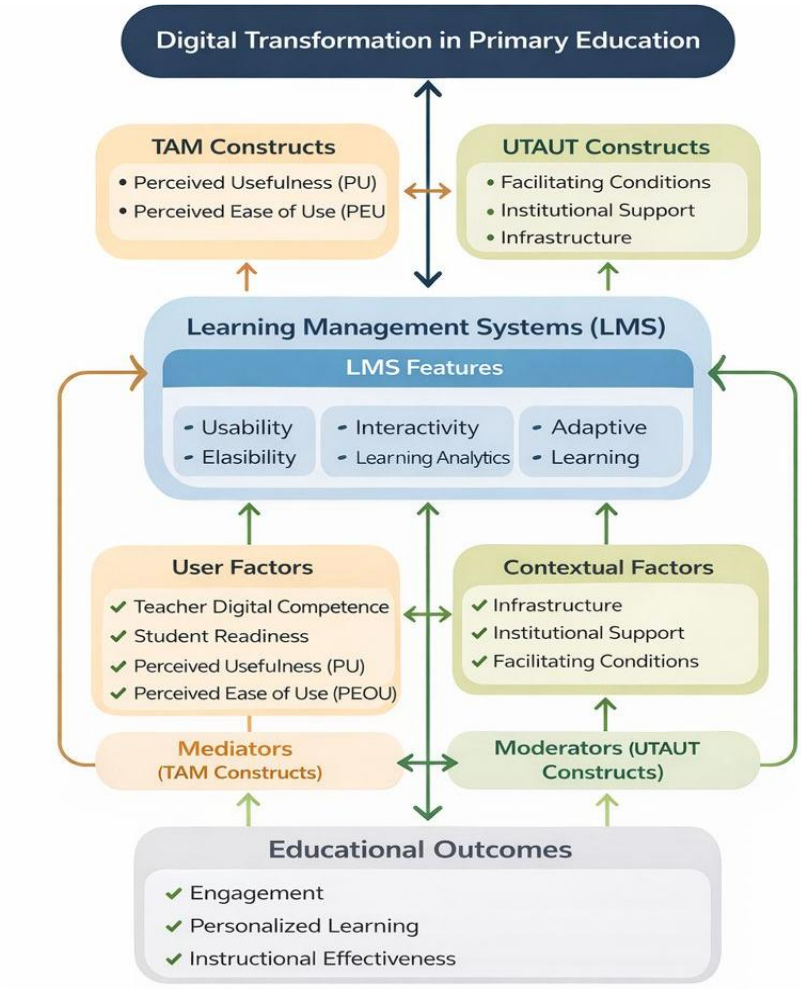

Figure 1: Conceptual Framework for Digital Transformation Through Adopting LMS in Primary Education

3. Methodology

This section outlines the bibliometric methodology employed in this study, including the research design, data sources and search strategy, data cleaning procedures, research instruments, data collection processes and analytical techniques used to address the research questions

3.1 Research Design

This study uses a bibliometric method to analyse the development of scientific publications related to LMS research. The bibliometric method was chosen because it provides a quantitative overview of publication trends, leading authors, scientific collaborations, research themes, and the direction of future research development (Alshater et al., 2021). This method provides a comprehensive review of academic literature and facilitates the identification of influential research, authors, journals, institutions and countries over time. With significant advances in scientific technology, various bibliometric methods and tools have emerged to assist researchers in their research (Ferdaus et al., 2024). This approach is widely used in scientific studies to identify knowledge structures, map themes and research dynamics in a field. Bibliometric analysis is

often used to evaluate citation patterns and measure the performance and impact of publications in a field. Citation parameters include the most cited studies, the most cited authors, the most cited journals, the most researched topics, the most collaborating countries, bibliometric combinations, authors cited together in a study, and the keywords and concepts they frequently use when discussing a particular subject (Abdi et al., 2024).

This study applied a three-stage design, adapted from the bibliometric meta-literature approach by Paltrinieri et al. (2019) and Alshater et al. (2021), consisting of data identification and collection, Bibliometric analysis and network mapping, content analysis for in-depth research themes. These stages ensure that the literature review process is conducted systematically, validly and comprehensively.

3.2 Data Sources and Search Strategy

This study employs a bibliometric design based on the methodological principles outlined in all the sources you have provided, including a bibliometric study on bilig (Kocasavaş et al., 2025), research on chatbots (Tanwar & Verma, 2024), greenwashing studies (Lin et al., 2025), Global Value Chains studies (Journal of Contemporary Management Issues, 2023), and bibliometric guidelines (Kumar et al., 2024) as outlined in your bibliometric research method document. Data were retrieved from the Scopus database, selected due to its comprehensive coverage of peer-reviewed publications and frequent use in bibliometric studies. Data collection was conducted in November 2025, covering publications from 1989–2025. Two keyword groups were combined using Boolean operators:

> *"learning management system" OR "LMS" OR "e-learning system" OR "digital learning platform*
> *" Primary education terms: "primary school" OR "elementary school" OR "primary education" OR "elementary education"*

The two groups of keywords were combined using the AND operator so that the search only displayed documents at the intersection between LMS and primary education. This approach was used to obtain scientific publications that were most relevant and appropriate to the research objectives.

3.3 Duplicate Handling and Data Cleaning

To ensure data accuracy, duplicate articles were removed during cleaning using OpenRefine. Clustering and text-matching detected duplicates by title, authors and year, followed by manual verification to retain only unique records. When duplicates had different metadata completeness, the most complete record was retained to avoid data loss. This OpenRefine-based cleaning ensured dataset consistency, accuracy and reliability, strengthening the validity of bibliometric and network analyses.

Raw data were integrated first, then duplicates identified by author, year and title. R-based removal deleted non-common columns, causing metadata loss. (Ullah et al., 2022). Figure 2 below shows the results of the bibliometric analysis, providing an overview of the characteristics of publications related to LMS:

Figure 2: Results of Bibliometric Analysis, Providing an Overview of the Characteristics of Publications Related to LMS

The bibliometric analysis of 137 documents published between 1989 and 2025 provides an overview of LMS research in primary education. Although LMS studies span more than three decades, substantial growth in primary education contexts has emerged mainly in recent years. The presence of 111 publication sources indicates a multidisciplinary field distributed across various journals and proceedings. The annual publication growth rate of 0% shows stable but limited output, suggesting that LMS research in primary education remains a developing niche within digital learning.

Collaboration is high, involving 513 authors, with an average of 4.05 authors per document and only eight single-authored papers, reflecting the interdisciplinary integration of pedagogy and technology. International collaboration accounts for 17.52%, showing global contributions, though cross-country partnerships remain moderate. A total of 462 keywords highlights thematic diversity, covering technology adoption, digital literacy, learning evaluation and user experience. The average document age of 7.67 years and 15.66 citations per paper indicate that studies in this field maintain strong academic relevance and impact.

3.4 Research Instruments

The research instruments combine scientific databases, bibliometric analysis software and data processing tools as used in all your methodological references. The main instrument is VOSviewer, which is used to construct keyword co-existence maps, author collaboration networks (co-authorship), citation maps, and bibliographic coupling analysis, in accordance with practices in bilig, chatbot, greenwashing and GVC research. In addition, this research also uses Bibliometrix (R Studio) and Biblioshiny, a tool highly recommended by Kumar et al. (2024) Biblioshiny was used to analyse publication trends and research structures without intensive coding. Excel supported data cleaning and normalization, while VOSviewer enabled thematic, structural and social mapping using complete bibliometric metadata.

3.5 Data Collection Procedures

To answer RQ1, the researcher extracted bibliographic metadata from the dataset using the standard export format as used in bilig and greenwashing research. The metadata collected included the year of publication, document type, author's country of affiliation, journal or conference name and number of citations, following the data extraction procedures used by Tanwar & Verma (2024) in their chatbot study and by Lin et al. (2025) in their greenwashing study. The annual data ware then sorted chronologically, while the country data was obtained through the aggregation of author affiliations as done in the bilig study, which mapped inter-country collaboration using the same metadata (Kocasavaş et al., 2025). All of this data was previously available in bibliometric statistics (e.g., annual growth rate 0%, 513 authors, international co-authorship 17.52%), so the collection process focused on metadata verification and normalisation.

Data collection for RQ2 included author keywords, keyword Plus, author names and institutional affiliations. The dataset contains 462 keywords, which form the basis for co-word analysis as used in chatbot and greenwashing research, emphasising that keyword analysis is essential for identifying thematic clusters and research dynamics (Lin et al., 2025; Tanwar & Verma, 2024). Additionally, author and institutional metadata were collected to enable co-authorship analysis, following the bilig study approach that assesses collaboration intensity based on the number of authors per document (4.05 average authors in your dataset) and the level of international collaboration (17.52%). Keyword data was also recoded to avoid term duplication, following the methodological recommendations in for Kumar et al. (2024) regarding the importance of normalisation before analysis.

Data collection RQ3 focused on metadata related to each document's reference list, number of citations, frequently cited documents and citation networks between articles. This technique mimics the co-citation and bibliographic coupling analyses used in GVC and greenwashing studies, which emphasise the importance of collecting complete reference data for each article (Lin et al., 2025). All reference lists were imported into software to identify document pairs that cite each other (citation networks) or share the same references (bibliographic coupling), following the procedures used in bibliographic research (Kocasavaş et al., 2025). The citation data was then checked for consistency and duplication, in accordance with the data cleaning principles emphasised in all your bibliometric references.

3.6 Data Analysis Techniques

The data analysis techniques in this study were developed by adapting the bibliometric approach used by Alshater et al. (2021), which emphasises the integration of performance analysis, science mapping and advanced citation analysis with the support of three main tools, namely RStudio, VOSviewer and Microsoft Excel. Bibliometric analysis has emerged as a crucial tool for measuring the scientific output of various scientific items (e.g., papers, authors, keywords, journals, institutions, and countries) in any field of research and examining how the intellectual, social, and conceptual structures of related fields have evolved based on the relationships and interactions between these items (Öztürk et al.,

2024). The following is the data analysis conducted in accordance with the research questions:

In the first stage, to answer RQ1 regarding the development of scientific publications related to digital transformation through LMS in primary education, the analysis used was a general performance analysis as conducted by Alshater et al. (2021) to map publication trends, contributing countries, affiliations, publication sources and document types through a series of metadata-based bibliometric calculations. This technique involves analysing annual growth, country productivity, institutions and publication sources, as well as document type classification, as shown in the data summary and annual graphs in their study. Data processing was performed in RStudio to generate publication statistics, while Excel was used to display trend graphs and document distribution, and VOSviewer was utilised to assist in visualising the distribution map of countries and institutions involved in LMS publications, following the visualisation approach also applied by Alshater et al. (2021) in their bibliometric analysis.

Furthermore, to answer RQ2 regarding dominant themes, keyword developments and author collaboration patterns, this study followed the science mapping techniques used by Alshater et al. (2021) namely co-word analysis, thematic clustering and co-authorship analysis. All keyword extraction processes and frequency calculations were performed using RStudio, while theme classification and keyword summary tables were managed through Excel, following the workflow used in the previous study. Data analysis techniques to answer RQ3 regarding the intellectual structure and direction of scientific development related to the application of LMS in primary education, this study adopted the advanced citation analysis techniques used by Alshater et al. (2021), namely co-citation analysis, bibliographic coupling and citation network analysis.

The VOSviewer software offers visualisation and exploration capabilities for these maps (Liang et al., 2024). Mapping techniques included co-citation, co-authorship, bibliographic coupling and keyword co-occurrence analyses. Fractional counting reduced author bias. Core high-citation documents in key clusters were examined through content analysis to identify research focus and future directions.

4. Results and Findings

This section presents the results of the bibliometric analysis, organised according to the research questions, including publication trends, thematic development and the intellectual structure of LMS research in primary education.

4.1 Publication trends based on year, contributing country, publication source and document type

The development of scientific publications on LMS in the context of basic education over the past two decades shows strong dynamics and reflects the increasingly profound digital transformation in the global education environment. The following are the results from R Studio showing annual trends,

contributing countries, publication sources and document types over the past two decades, explained as follows:

Table 1: Main Information from R Studio (Biblioshiny: the Shiny app for Bibliometrix)

Description	Results
Main Information About Data	
Timespan	1989:2025
Sources (Journals, Books, etc)	111
Documents	137
Annual Growth Rate %	0
Average Document Age	7.67
Average citations per document	15.66
References	0
Document Contents	
Keywords Plus (ID)	566
Author's Keywords (DE)	462
AUTHORS	
Authors	513
Authors of single-authored documents	8
Authors Collaboration	
Single-authored documents	9
Co-Authors per Document	4.05
International co-authorships %	17.5
Document Types	
Article	137

Table 1 presents the main characteristics of the LMS research dataset in primary education from 1989–2025. A total of 137 documents published in 111 sources indicate a multidisciplinary field spread across journals and proceedings. The annual growth rate of 0% reflects stable publication output within the filtered dataset. The average document age of 7.67 years and 15.66 citations per article show that studies remain recent and academically influential. High numbers of Author Keywords (462) and Keywords Plus (566) demonstrate thematic diversity in LMS and e-learning research. A

uthorship involves 513 researchers, with only nine single-authored papers and an average of 4.05 co-authors per document, confirming strong collaboration. International collaboration accounts for 17.52%, highlighting global participation. All documents are research articles, indicating dominance of primary empirical studies. Overall, the dataset reflects a collaborative, multidisciplinary and impactful research field supporting ongoing digital transformation in primary education. The research results also show a visualisation of local impact sources with the H-index for the topics of LMS, e-learning and digital education, as shown in Figure 3.

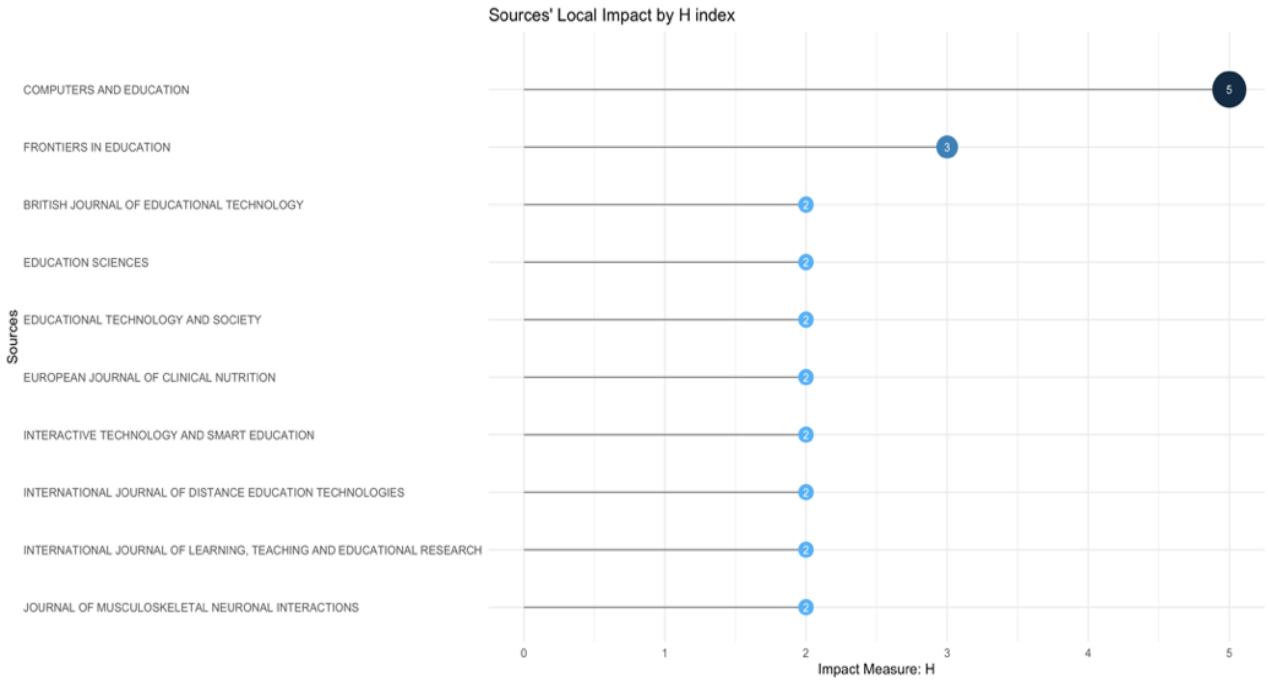

Figure 3: Visualisation of Sources' Local Impact by H-Index for the Topics of LMS, e-Learning and Digital Education

Based on Figure 3, the Sources' Local Impact by H-index visualisation shows journal influence in LMS and digital education research. Computers & Education ranks highest (H-index = 5), confirming its position as the leading reference in educational technology studies. Frontiers in Education follows (H-index = 3), contributing strongly to digital pedagogy research. Other journals, including the British Journal of Educational Technology, Education Sciences, and Educational Technology & Society (H-index = 2), play stable roles in disseminating e-learning and digital literacy studies. Several journals with H-index = 1 contribute to niche areas such as distance learning. Overall, the results indicate that LMS research is driven by reputable educational technology journals. Figure 4 below is a visualisation of the network map from VOSviewer showing the interrelationships between research topics:

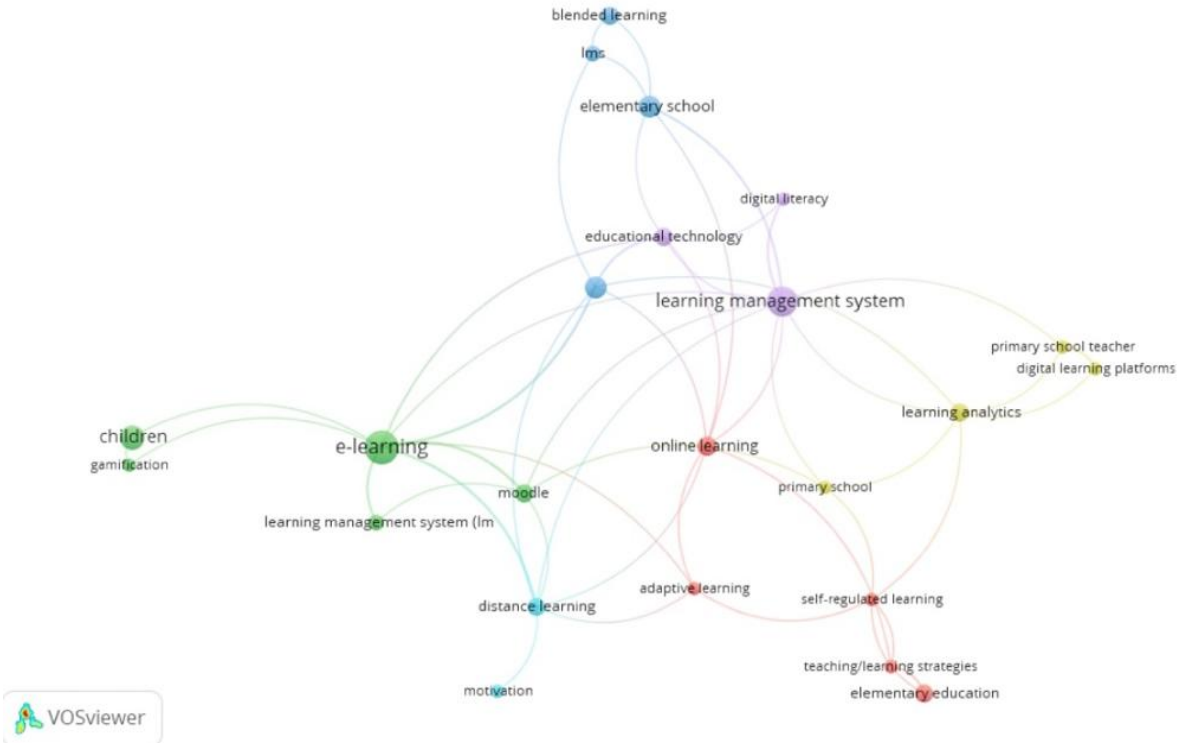

Figure 4: Network Map Visualisation from VOSviewer on LMS trends

Figure 4 shows strong interconnections among LMS research topics in primary education, with LMS positioned at the centre of the digital learning ecosystem. The blue cluster highlights educational technology, digital literacy and elementary education as core themes of digital transformation. The green cluster links e-learning, children, gamification and motivation, emphasising student engagement. The red cluster reflects online, adaptive, and self-regulated learning, indicating growing attention to learner independence. The yellow cluster focuses on teachers, digital platforms and learning analytics, showing the importance of teacher competence and data use. Overall, the map confirms rising academic attention to LMS in primary education and positions this study as addressing a key gap in LMS research traditionally centred on higher education.

4.2 Thematic maps covering dominant keywords, theme evolution, and author collaboration patterns

The collaboration framework related to LMS shows a sophisticated and complex global environment in interdisciplinary studies. The following are the results of author collaboration patterns in LMS research in primary education based on the country. This can be seen in Figure 5.

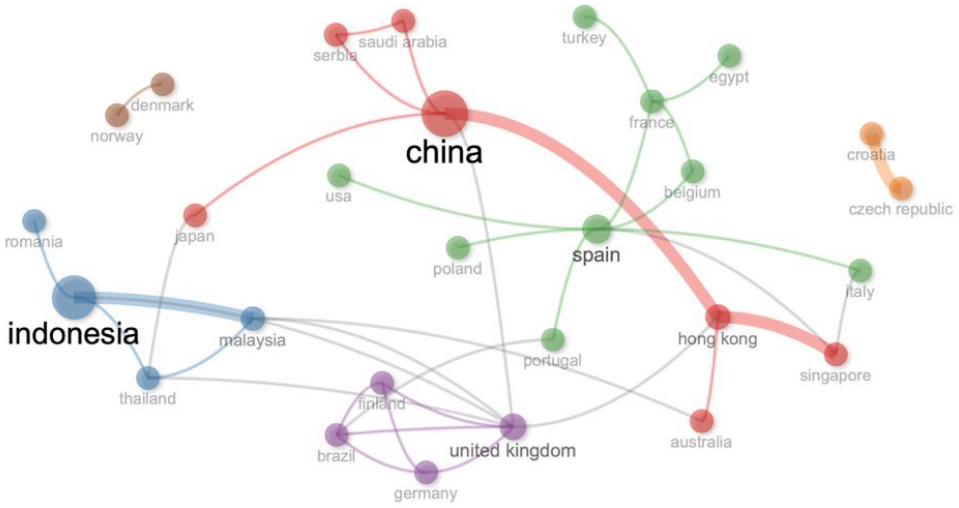

Figure 5: The Collaboration Network on LMS

Figure 5 illustrates global collaboration patterns in LMS research, showing several major international clusters. China emerges as the most dominant hub, with strong partnerships with Hong Kong, Singapore, Serbia and Saudi Arabia, reflecting high productivity and extensive collaboration in digital transformation and LMS studies. Indonesia also appears as a key Southeast Asian hub, linked with Malaysia, Thailand, and Romania, indicating a growing regional research network. European collaboration is more fragmented, with Spain as an active node connected to France, Belgium, Poland and Italy, while the United Kingdom forms a distinct cluster with Germany, Brazil and Finland. Overall, the map confirms the global nature of LMS research, highlighting China and Indonesia as strategic regional drivers of scientific collaboration.

The following is a visualisation of the Co-occurrence Network showing the most frequently occurring keywords in research related to LMS and basic education, as shown in Figure 6.

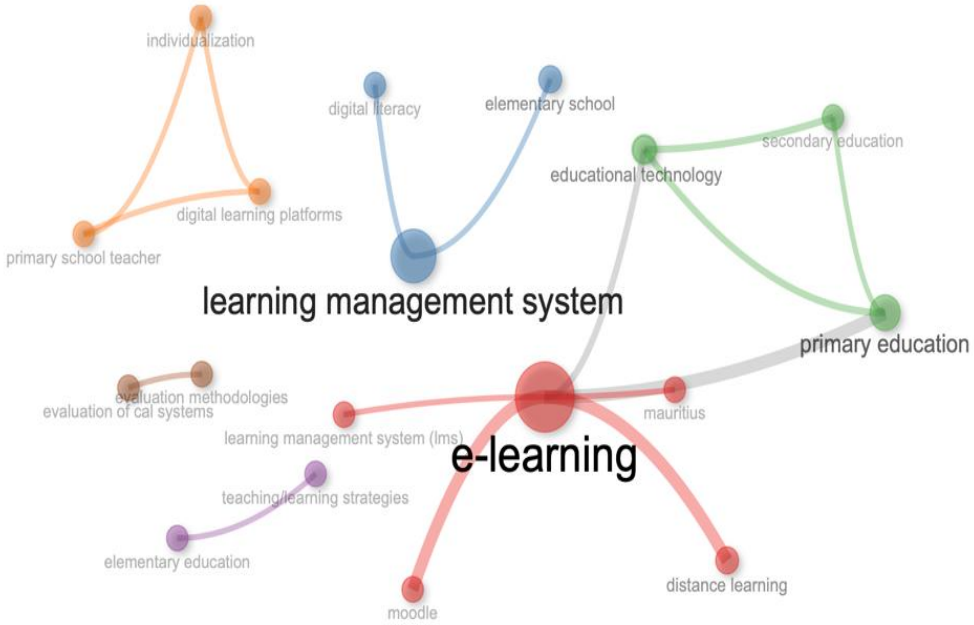

Figure 6: Visualisation of the Co-Occurrence Network for LMS and Basic Education

Figure 6 presents the keyword co-occurrence network of LMS research in basic education. "LMS" and "e-learning" dominate the network, indicating their central role and strong links with distance learning, Moodle and digital platforms. The blue cluster connects digital literacy and primary school, highlighting digital transformation in basic education. The green cluster links primary education, secondary education and pedagogy, showing LMS integration with teaching practices. Orange and brown clusters emphasise personalised learning, teacher roles, evaluation methods and learning platforms. Overall, the network confirms that LMS research in basic education focuses on digital pedagogy, literacy and expanding access through technology-driven learning environments.

The development of research themes based on two main indicators, namely centrality (the level of relevance of a theme in the research network) and density (the level of depth or development of a theme) can be seen in Figure 7.

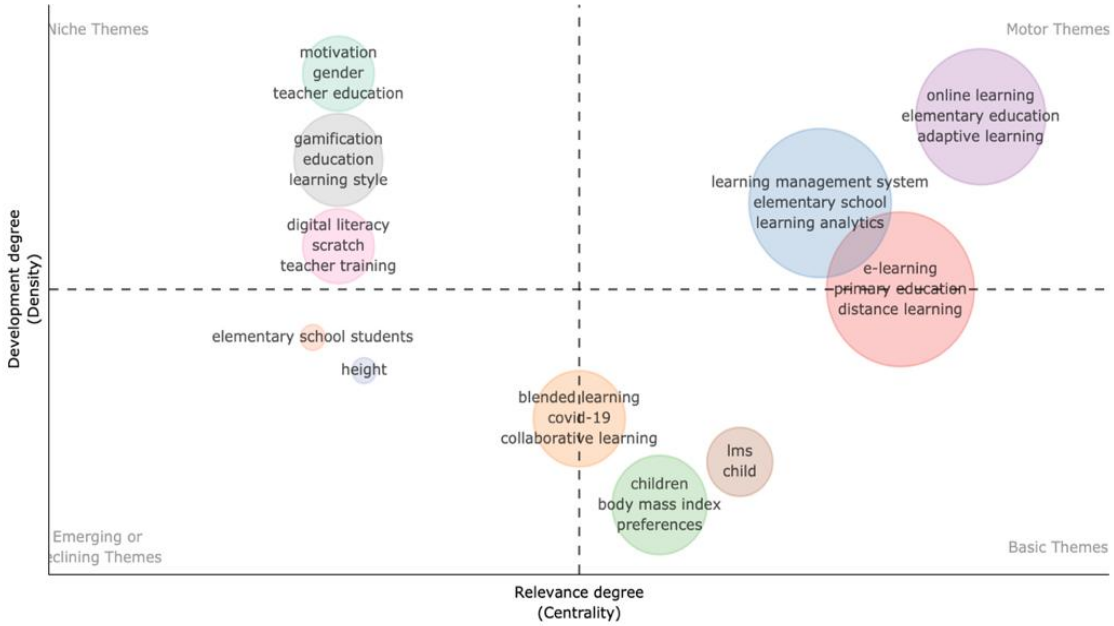

Figure 7: Visualisation of Thematic Map

Figure 7 presents the thematic map of LMS research in basic education based on centrality and density, dividing themes into four quadrants. Motor themes, such as online learning, elementary education and adaptive learning, show high relevance and development, driving digital education innovation, particularly after the pandemic. Basic themes, including e-learning, primary education and distance learning, serve as widely used research foundations but still require deeper theoretical and methodological exploration.

Niche themes, such as motivation, teacher education, gamification, and digital literacy, are well-developed but less connected to broader research streams. Emerging or declining themes, including blended learning, COVID-19, collaborative learning and children's preferences, reflect topics that are either gaining attention or decreasing in relevance. Overall, the map indicates that LMS research in primary education is moving toward adaptive online learning as a core driver, while e-learning and primary education remain foundational, and gamification and digital literacy continue to grow as specialised research areas.

The development and shift of research themes related to LMSs can be seen in Figure 8, the visualisation of thematic evolution below:

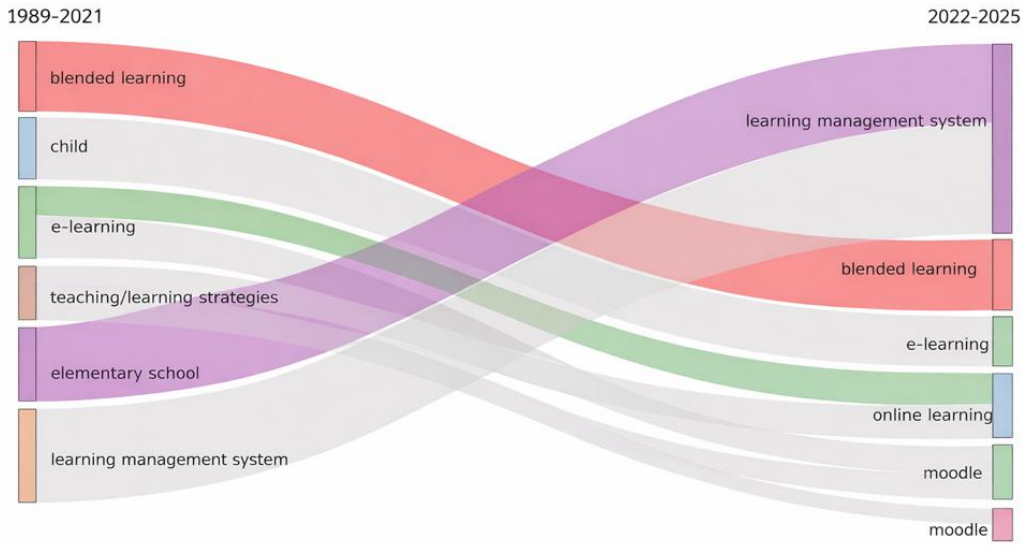

Figure 8: Visualisation of Thematic Evolution

Figure 8 illustrates thematic evolution in LMS research from 1989–2021 to 2022–2025. Early studies focused on broad themes such as e-learning, children, blended learning and learning strategies, reflecting general exploration of digital education and student characteristics. In the recent period, themes consolidated toward LMS as the dominant focus, indicating LMS as the core infrastructure of digital learning. Blended learning remains strong, while online learning and Moodle emerge as structured platform-based approaches. Overall, the evolution shows a shift from broad digital learning concepts to a more systematic, integrated and platform-oriented research direction in primary education.

4.3 The intellectual structure of research through co-citation, bibliographic coupling and citation network analysis

The direction of scientific development regarding the implementation of LMS in primary education is based on co-citation, bibliographic coupling and citation network analysis. Trends in research on LMS e-learning, and digital education can also be seen from the number of citations per year, as shown in Figure 9 below:

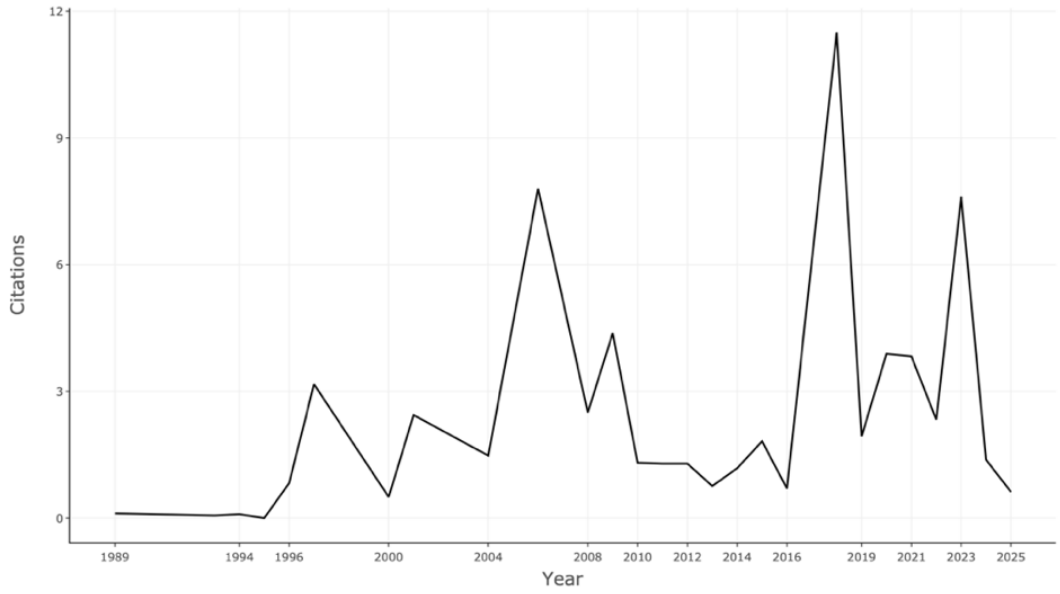

Figure 9: Average Citations per Year Graph on the Topics of LMS, E-Learning and Digital Education

Figure 9 presents the average annual citations of LMS and digital education research from 1989 to 2025. Early publications (1989–1995) received few citations, reflecting limited initial attention. Citations began rising in the late 1990s and early 2000s with growing interest in educational technology. A marked increase occurred between 2005 and 2010 alongside the expansion of e-learning and LMS adoption. The highest surge appeared in 2018–2019, driven by intensified research on digital transformation in education. Citations remained stable during 2020–2021, reflecting widespread LMS use during the pandemic, and rose again after 2022. Overall, the trend confirms sustained and increasing scholarly attention to LMS and digital learning, highlighting the field's growing relevance in contemporary education.

The development of publications can also be seen from the contributing journal sources Figure 10 below:

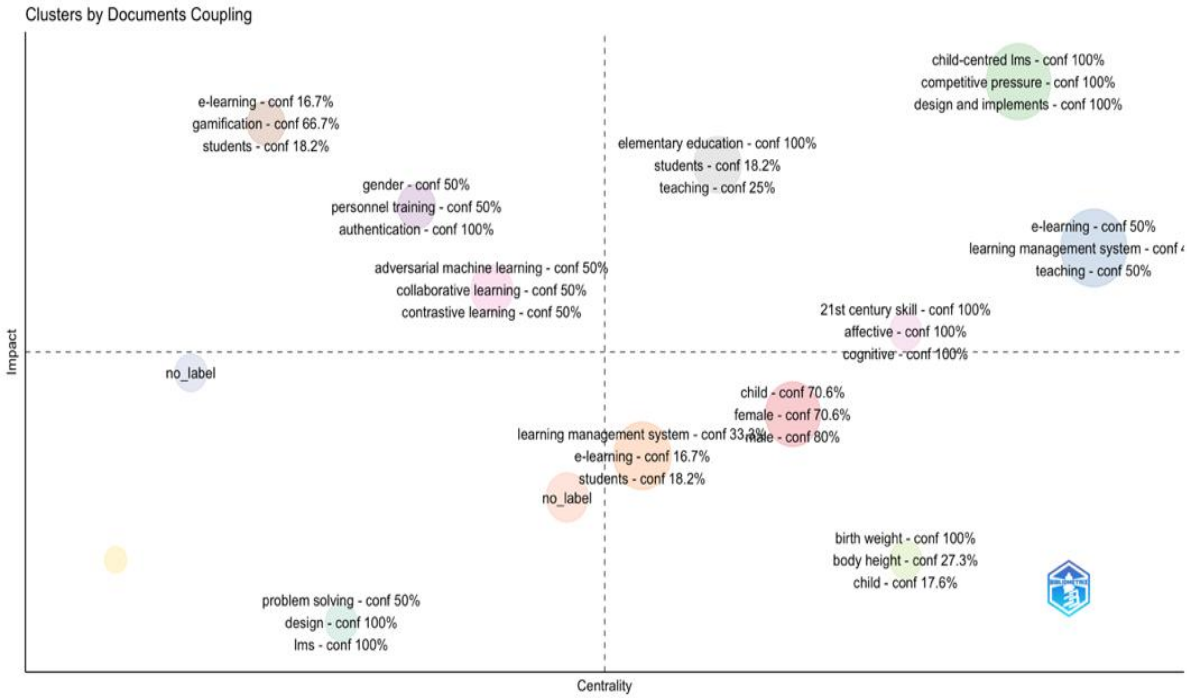

Figure 10: The Clusters by Documents Coupling Image Maps of the Relationships

Figure 10 presents document coupling clusters based on thematic proximity, revealing core structures in LMS research. The upper-right quadrant shows high-impact and high-centrality themes such as child-centred LMS, system design, implementation, e-learning, teaching and 21st-century skills, confirming that research primarily focuses on learner-oriented LMS development and digital transformation in education. The bottom-right quadrant highlights learner-related themes including children, students, and cognitive–affective aspects, indicating strong attention to learning behaviour and user experience supporting core research.

The upper-left quadrant contains high-impact but lower-centrality themes such as gender, machine learning, authentication and collaborative learning, reflecting specialised studies on security, personalisation and advanced technologies. The lower-left quadrant includes supportive topics like problem-solving and LMS design, showing lower influence but continued relevance in technical and instructional design discussions. Overall, the map demonstrates that LMS research evolves multidimensionally, integrating pedagogy, learner characteristics, system design and emerging technologies to optimise digital learning in primary education.

The three-field plot visualisation in the image illustrates the relationship between three main elements in scientific publications can also be seen from the Figure 11 below:

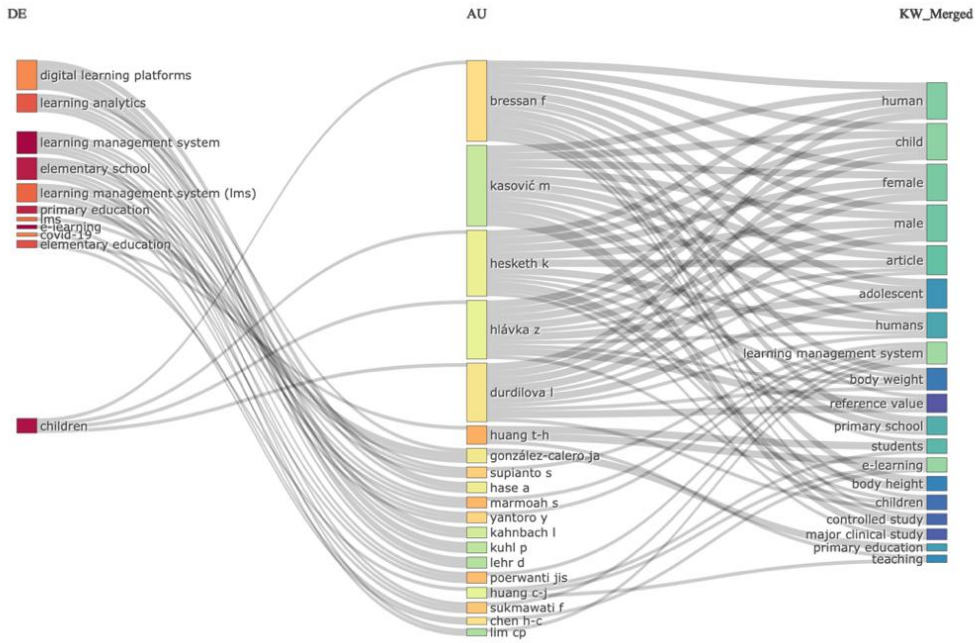

Figure 11: The Three-Field Plot Visualisation

Figure 11 illustrates the three-field plot linking descriptors (topics), authors and keywords in LMS research. Dominant topics include digital learning platforms, learning analytics, LMS and primary education, reflecting a strong focus on technology-driven learning improvement. Key authors such as Bressan, Kasović and Hesketh connect major topics to research keywords. Frequently used keywords—child, students, primary school, e-learning and LMS—indicate that research centres on digital platforms and learner characteristics in primary education. Overall, the plot shows an integrated research pattern connecting educational technology themes, influential scholars and consistent keyword trends in LMS studies.

5. Discussion

The predominance of journal articles (137 documents) indicates that LMS research in primary education is strongly grounded in empirical studies, reinforcing its position within evidence-based educational technology scholarship. The concentration of publications in leading journals such as *Computers & Education* and *Frontiers in Education* further highlights the academic maturity and credibility of this research field. Citation trends also reflect increasing global attention to flexible and mobile-based LMS that enhance accessibility and student motivation (Shin & Kang, 2015).

The distribution of dominant keywords, including learning management system, digital learning platforms, primary education and e-learning, demonstrates a

clear focus on the integration of LMS within elementary education contexts. This aligns with findings that LMS supports not only instructional delivery but also student character development, particularly in fostering discipline and responsibility (Fajarianto et al., 2024). At the same time, the emphasis on digital literacy reflects the growing importance of equipping students with 21st-century competencies, including creative and critical thinking skills (Widodo et al., 2021). The level of international collaboration (17.52%) further suggests that LMS research in primary education is increasingly shaped by cross-national academic engagement.

Co-word analysis reveals four dominant thematic clusters that define the structure of LMS research. The first cluster highlights the integration of educational technology and digital literacy as a central dimension of LMS implementation, emphasising its role in developing higher-order thinking skills (Widodo et al., 2021). The second cluster, focusing on e-learning, children, motivation and gamification, reflects the importance of designing engaging learning environments tailored to young learners. Gamification and mobile accessibility enhance participation and satisfaction, supporting more interactive learning experiences (Shin & Kang, 2015).

The third cluster centres on adaptive, online, and self-regulated learning, indicating a growing interest in personalised learning pathways. However, evidence suggests that self-regulation in primary students requires structured support mechanisms, including guidance features and progress monitoring tools (Widodo et al., 2021). The fourth cluster emphasises the role of teachers, learning analytics and digital platforms, highlighting that successful LMS implementation depends on teacher readiness, parental involvement, and effective use of data (Zainil et al., 2024).

The global collaboration network further illustrates the distribution of research influence, with China emerging as a leading hub characterised by strong international partnerships, particularly within Asia (Konch & Hazarika, 2025; Norliza et al., 2024; Yürümez, 2024). In contrast, European collaboration patterns appear more fragmented, although certain countries such as Spain and the United Kingdom act as important connectors across research networks (Fu et al., 2022; Ghani et al., 2022). These patterns indicate that LMS research development is shaped not only by technological advancement but also by regional research capacity and institutional collaboration dynamics.

The thematic evolution of LMS research shows a transition from general e-learning approaches toward more specialised topics such as blended learning, Moodle-based systems and adaptive learning technologies. This shift reflects the increasing integration of artificial intelligence and data-driven approaches in digital education (Luo & Wang, 2024). The growing focus on AI-supported LMS is also evident in recent studies highlighting adaptive systems that personalise learning based on student performance (Rahate et al., 2025). At the same time, the importance of teacher and parental involvement remains critical, particularly in

primary education settings where learners require continuous guidance (Nasser et al., 2011).

Network visualisation further confirms that LMS occupies a central position within the broader digital learning ecosystem, closely connected to key themes such as digital literacy, online learning, and student motivation (Darmawan & Meisyani, 2025). The clustering structure indicates an increasingly interconnected research landscape, where pedagogical, technological and behavioural dimensions converge. This convergence suggests that LMS is evolving into a comprehensive learning environment that integrates instructional design, learner engagement and data analytics.

Future research directions indicate a strong movement toward adaptive learning, learning analytics and personalised education. The integration of artificial intelligence is expected to enhance the ability of LMS to provide tailored learning experiences and support instructional decision-making (Kubsch et al., 2025). In addition, blended learning models are projected to remain a dominant approach, combining face-to-face and digital learning to improve educational effectiveness (Rosário & Dias, 2022). From an implementation perspective, the effectiveness of LMS depends on several critical factors, including system usability, interface design and alignment with student needs. LMS platforms must be designed to minimise cognitive load and support intuitive interaction, particularly for younger learners.

Continuous evaluation of LMS features is also essential to ensure relevance and effectiveness in changing educational contexts (Salah & Thabet, 2021). Cultural considerations, user diversity, and contextual factors further influence system adoption and effectiveness (Tinmaz & Lee, 2020). The use of learning analytics provides significant opportunities to enhance student-centred learning by enabling teachers to monitor progress, identify learning challenges and implement targeted interventions. Data-driven approaches, including clustering and data mining techniques, support more personalised instruction and improve learning outcomes (Levin, 2023; Sáiz-Manzanares et al., 2021). In addition, LMS platforms facilitate feedback mechanisms that allow educators to refine instructional strategies based on student responses (Tan et al., 2022).

LMS research in primary education highlights the importance of integrating digital literacy, pedagogy and teacher development within a unified framework. The ability of teachers to design effective learning experiences and utilise digital tools plays a central role in shaping student outcomes (Suparjan & Ismiyani, 2023; Torres, 2024). This transformation reflects a broader shift toward personalised and technology-enhanced learning environments, where LMS functions as a key component in supporting the future of education.

Overall, this study offers three key contributions. First, from a theoretical perspective, it advances the understanding of LMS as an integrated digital learning ecosystem by linking digital literacy, adaptive learning and data-driven pedagogy. Second, methodologically, this study contributes by applying a

comprehensive bibliometric approach that combines performance analysis, co-word analysis, co-citation and network mapping to reveal the intellectual and thematic structure of LMS research in primary education. Third, from a practical perspective, the findings provide guidance for the development of child-friendly, adaptive and data-informed LMS systems, emphasising the importance of teacher readiness, learning analytics and personalised learning strategies.

6. Conclusion

The research structure shows a collaborative character with an average of four authors per article and an international collaboration network of 17.52%. The thematic map reveals four main clusters: (1) the integration of educational technology and digital literacy as the foundation for the digitisation of primary schools; (2) children's learning motivation, gamification, and user experience as pedagogical focuses; (3) online learning, self-regulated learning, and adaptive learning as the direction for system development; and (4) the role of teachers, digital literacy and learning analytics as determinants of successful LMS implementation.

The recommendations for school leaders, strategic investment in digital infrastructure, device availability and technical support systems is necessary to ensure sustainable LMS implementation. Teachers require continuous professional development in digital pedagogy and data literacy to effectively utilise LMS features and interpret learning analytics for instructional decision-making. From a policy perspective, educational authorities should establish national guidelines for LMS implementation in primary education that address data privacy, child safety and ethical AI use, while embedding digital competency standards into teacher training and certification frameworks. Based on these implications, this study recommends short-term actions such as deploying age-appropriate LMS platforms, providing teacher training on LMS operation, and implementing basic learning analytics tools.

Long-term recommendations include developing AI-driven adaptive LMS engines, strengthening school–industry partnerships for child-centred system innovation, and formulating national quality assurance standards for LMS interoperability and ethical data management. Future research should move beyond bibliometric mapping to empirical investigations of AI-integrated LMS effectiveness, usability testing for young learners, and cross-country comparative studies on contextual factors influencing LMS adoption. Overall, these implications and recommendations support the transformation of LMS from administrative tools into evidence-based, pedagogically meaningful digital ecosystems capable of enhancing engagement, personalisation and instructional effectiveness in primary education.

7. Conflict of Interest

The authors declare that there is no potential conflict of interest in the research, writing or publication of this article. The entire research and analysis process was conducted independently without any influence from any party that could affect the objectivity of the research results.

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