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Enhancing Learning Analytics through Learning Management Systems Engagement in African Higher Education

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ABSTRACT

In the African higher education landscape, the pervasive integration of Learning Management Systems (LMS) is reshaping the educational journey, offering both opportunities and challenges. This study delved into the intricate interplay between students' engagement with LMS and its consequential impact on Learning Analytics (LA), specifically within the unique context of African higher education institutions. Employing the PRISMA systematic review approach, this research aimed to review significant work by researchers towards LMS and LA use in African universities in the form of contributing authors, keywords, citation statistics and growth patterns. The findings highlighted the transformative potential of LA and LMS use, which have the power to enhance both academic performance and the overall learning experience of African students. This research enhances the understanding of the complex relationship between LMS usage and LA in the African context, revealing how digital tools can address unique online learning challenges. As African institutions tackle 21st-century education challenges, this study provides a valuable roadmap for educators, administrators, and policymakers looking to leverage technology for meaningful educational outcomes. By contextualizing the findings within the African higher education landscape, this research contributes to the global discourse on the evolving role of digital platforms in shaping modern education.

Keywords: Educational Technology, Digital Learning, Student Engagement, Learning Experience, Technology Integration

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INTRODUCTION

The widespread adoption of Learning Management Systems (LMS) in higher education has yielded significant advantages within the educational sphere. In the past decade, research on LMS use and its benefits has increased.[1] The use of LMS for e-learning plays a vital role in shaping student academic success and helps develop the best strategy for e-learning at Higher Educational Institutions (HEIs).[2]

[1] Thanh-Thao Thi Phan et al., "Two Decades of Studies on Learning Management System in Higher Education: A Bibliometric Analysis with Scopus Database 2000-2020," *Journal of University Teaching and Learning Practice* 19, no. 3 (July 5, 2022),09. https://doi.org/10.53761/1.19.3.09.

[2] Stefan Hrastinski, Christina Keller, and Jörgen Lindh, "Is E-Learning Used for Enhancing Administration or Learning? On the Implications of Organisational Culture," in *Virtual Communities* (IGI Global, 2011), 1738–47, https://doi.org/10.4018/978-1-60960-100-3.ch510.

The emergence of the COVID-19 pandemic significantly accelerated the adoption of online educational technology in HEIs worldwide.[3] Nevertheless, the literature highlights that the integration of these technologies resulted in new challenges for HEIs, particularly in the realm of learning content management.[4] An evolving research interest in Learning Analytics (LA) has emerged among African Higher Education Institutions, as faculty higher degree committees and school boards strategically integrate educational technology to enhance the administration and management of teaching and learning.[5] Some scholars reflect on the emergence of LA as a rapidly growing, multi-disciplinary research area within higher education.[6] The utilization of LA aids institutions in acquiring insights about learners and their learning environments, enabling them to predict, model, and optimize e-learning.[7]

In pursuit of this objective, HEIs throughout Africa are increasingly embracing Learning Management Systems and incorporating Learning Analytics systems into their operations.[8] Schumacher and Ifenthaler argue that this adoption aims to enhance their comprehension of and assistance for student learning.[9] King and Boyatt argue that although research has been conducted on the impact of e-learning adoption in developed countries such as the United Kingdom, it is necessary to conduct research in different countries with different contexts.[10] There is a plethora of research within the African context on the adoption of LMS and its perceived benefits. However, not much research has been done within the African context on how learning analytics could enhance LMS engagement across higher educational institutions. As such, this study presents a systematic literature review with the objective of mapping the intricate interplay between students' engagement with LMS and its consequential impact on learning analytics, specifically within the unique context of African higher education institutions. This study aims to answer the following research questions:

Research Question 1: What is the status and growth pattern of research literature on LMS and LA use in African HEIs?

Research Question 2: Which authors are the most influential in terms of the volume of publications and citations in this field?

Research Question 3: Which countries have the most contributions in literature on the LMS and LA fields in African Higher Education?

Research Question 4: What recommendations can be made to improve the integration of LMS and LA for better educational outcomes in Africa?

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[3] Bongani T. Gamede, Oluwatoyin Ayodele Ajani, and Olufemi Sunday Afolabi, "Exploring the Adoption and Usage of Learning Management System as Alternative for Curriculum Delivery in South African Higher Education Institutions during Covid-19 Lockdown," *International Journal of Higher Education* 11, no. 1 (July 19, 2021): 71, https://doi.org/10.5430/ijhe.v11n1p71.
[4] Thi Phan et al., "Two Decades of Studies on Learning Management System in Higher Education: A Bibliometric Analysis with Scopus Database 2000-2020."
[5] Thi Phan et al., "Two Decades of Studies on Learning Management System in Higher Education: A Bibliometric Analysis with Scopus Database 2000-2020."
[6] Rebecca Ferguson, "Learning Analytics: Drivers, Developments and Challenges," *International Journal of Technology Enhanced Learning* 4, no. 5/6 (2012): 304, https://doi.org/10.1504/IJTEL.2012.051816.
[7] Dana-Kristin Mah, "Learning Analytics and Digital Badges: Potential Impact on Student Retention in Higher Education," *Technology, Knowledge and Learning* 21, no. 3 (October 9, 2016): 285–305, https://doi.org/10.1007/s10758-016-9286-8.
[8] Paul Prinsloo and Rogers Kaliisa, "Learning Analytics on the African Continent," *Journal of Learning Analytics* 9, no. 2 (June 4, 2022): 218–35, https://doi.org/10.18608/jla.2022.7539.
[9] Clara Schumacher and Dirk Ifenthaler, "Features Students Really Expect from Learning Analytics," *Computers in Human Behavior* 78 (January 2018): 397–407, https://doi.org/10.1016/j.chb.2017.06.030.
[10] Emma King and Russell Boyatt, "Exploring Factors That Influence Adoption of E-learning within Higher Education," *British Journal of Educational Technology* 46, no. 6 (November 25, 2015): 1272–80, https://doi.org/10.1111/bjet.12195.

LITERATURE REVIEW

The implementation of educational technology for e-learning purposes can have a dire impact on organisational strategy and functioning,[11] organisational culture,[12] and learning analytics.[13] Moreover, the implementation of e-learning demands substantial resources and infrastructure.[14] The adoption of e-learning further brings about other challenges, such as the need to train staff members,[15] data management, and data mining related to the use of these technologies. In a similar context, Aung and Khaing add that developing countries face additional challenges, such as poor network infrastructure, lack of ICT knowledge, and weakness of content development, etc, pertaining to the implementation of e-learning.[16]

Challenges Associated with LMS Integration

Yunus conducted a study within an Indonesian population to investigate the advantages and obstacles associated with the adoption of LMS.[17] Their research findings indicate that LMSs have the potential to enrich the educational experience by offering convenient and immediate communication channels, promoting collaborative learning, and facilitating student discussions. Conversely, LMS implementation can pose difficulties for instructors and educators, including issues like limited platform accessibility due to unreliable internet connections, inadequate training, and the challenges presented by students who may lack confidence in utilizing the associated technology.[18] Moreover, instructors may find themselves in the ongoing task of moderating students' discussions and comments, demanding a substantial time commitment.[19] According to Zheng et al., the successful integration of LMS within an institution largely depends on organisational support, technical support and lecturers' technology self-efficacy beliefs.[20] These observations underscore the inherent challenges that accompany the adoption of e-learning.

The adoption of digital technologies for teaching and learning comes with challenges. One of the main challenges highlighted in recent years is the lack of educational technology skills among instructors and teachers.[21] Due to the lack of these skills, universities have had to train their instructional staff on using these newly adopted educational technologies.[22] Dole et al. emphasized that educators must possess not only technical proficiency for integrating emerging technologies but also a profound understanding of innovative pedagogical approaches suitable for the realm of online learning.[23] In line with Marek, Chew, and Wu's findings, instructors confront many obstacles when

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[11] C. A. Shoniregun et al., "Impacts of E-Learning on Organisational Strategy," in *Proceedings of the First International Conference on Web Information Systems and Technologies* (SciTePress - Science and and Technology Publications, 2005), 474–81.
[12] Hrastinski, Keller, and Lindh, "Is E-Learning Used for Enhancing Administration or Learning? On the Implications of Organisational Culture."
[13] Prinsloo and Kaliisa, "Learning Analytics on the African Continent."
[14] King and Boyatt, "Exploring Factors That Influence Adoption of E-learning within Higher Education."
[15] Christian Rapp and Yasemin Gülbahar, "E-Tutor," in *Proceedings of the Third (2016) ACM Conference on Learning @ Scale* (New York, NY, USA: ACM, 2016), 327–28, https://doi.org/10.1145/2876034.2893401.
[16] Than Nwe Aung and Soe Soe Khaing, "Challenges of Implementing E-Learning in Developing Countries: A Review," in *In Genetic and Evolutionary Computing: Proceedings of the Ninth International Conference on Genetic and Evolutionary Computing* (Yangon, Myanmar, 2016), 405–11, https://doi.org/10.1007/978-3-319-23207-2_41.
[17] Hidayatullah Yunus, "Online Learning Management System (OLMS) in Indonesian Higher Education: Investigating Benefits and Obstacles," *PJEIS: Parahikma Journal of Education and Integrated Sciences* 1, no. 1 (2021): 1–8.
[18] Yunus, "Online Learning Management System (OLMS) in Indonesian Higher Education: Investigating Benefits and Obstacles."
[19] Ahmad Ridho Rojabi, "Blended Learning via Schoology as a Learning Management System in Reading Class: Benefits and Challenges," *Jurnal Linguistik Terapan*, 2019, 36–42.
[20] Yun Zheng et al., "The Impact of Organisational Support, Technical Support, and Self-Efficacy on Faculty Perceived Benefits of Using Learning Management System," *Behaviour & Information Technology* 37, no. 4 (April 3, 2018): 311–19, https://doi.org/10.1080/0144929X.2018.1436590.
[21] Mastura Azlim et al., "Designing Collaborative Learning Wizard to Assist Instructors in Utilizing Tools in LMS," in *2015 IEEE Conference on E-Learning, e-Management and e-Services (IC3e)* (IEEE, 2015), 81–85, https://doi.org/10.1109/IC3e.2015.7403491.
[22] Azlim et al., "Designing Collaborative Learning Wizard to Assist Instructors in Utilizing Tools in LMS."
[23] Sharon Dole, Lisa Bloom, and Kristy Kowalske, "Transforming Pedagogy: Changing Perspectives from Teacher-Centered to Learner-Centered," *Interdisciplinary Journal of Problem-Based Learning* 10, no. 1 (July 31, 2015).

shifting from conventional teaching methodologies to technology-enabled pedagogical approaches.[24] Researchers distinguished between the challenges that hinder the adoption of e-learning in developing and developed countries. In the context of African countries, e-learning was primarily embraced as a response to the COVID-19 pandemic. However, the lack of prior training for academic staff in using these educational technologies resulted in various difficulties when it came to accessing and utilizing LMS platforms.[25]

Consequently, higher education institutions bear the responsibility of supporting educators to facilitate a smooth transition. Bahar et al. additionally highlight that online learning introduces physical barriers that hinder direct interaction between students and teachers, thereby posing challenges for educators in assessing and verifying student progress.[26] Considering these challenges, Nadeem and Blumenstein argue that the implementation of LA has the potential to mitigate these issues and alleviate the cognitive burden on teachers, ultimately enhancing the learning experience.[27]

Benefits of LMS Integration in Higher Education

Along with these challenges, LMS have become integral tools in modern education, transforming the way educators deliver content and assess student performance. Moreover, the integration of learning analytics with LMS has added a layer of sophistication, enabling institutions to gather, analyze, and leverage data to enhance the learning experience.[28] The advent of COVID-19 has accelerated online learning adoption across many African universities. For instance, in South Africa, many universities have, over the past few years, adopted online learning platforms such as Sakai, Canvas, D2LBrightspace, Vula, Moodle LMS, Efundi, RUConnected and SunLearn.[29] These platforms allow students to readily access learning material, facilitate discussions, submit assessments, etc, all through the use of a computer or mobile phone.[30] The adoption of educational technology has many benefits for higher educational institutions. Implications are that universities can increase the use of LMS and achieve more effective outcomes from faculty for web-based distance learning and web-assisted course curricula by structuring their organisations better to support faculty in both technical and self-efficacy areas.[31]

Learning Analytics in Higher Education

The notion of LA is an emerging field devoid of a singular, universally accepted definition. Numerous academics have introduced divergent conceptualizations, contending that they pertain to LA, with a significant proportion of these conceptualizations being inherently contingent upon contextual variables.[32] According to Oreški, LA can be defined as "a data-centric field that applies machine

[24] Michael W. Marek, Chiou Sheng Chew, and Wen-chi Vivian Wu, "Teacher Experiences in Converting Classes to Distance Learning in the COVID-19 Pandemic," *International Journal of Distance Education Technologies* 19, no. 1 (January 2021): 89–109, https://doi.org/10.4018/IJDET.20210101.oa3.

[25] Gamede, Ajani, and Afolabi, "Exploring the Adoption and Usage of Learning Management System as Alternative for Curriculum Delivery in South African Higher Education Institutions during Covid-19 Lockdown."

[26] Müjde Çalıkuşu Aykar and Arzu Bahar, "Opinions of Nursing Students on Online Education in the Coronavirus Disease 2019 Pandemic: Qualitative Research," *Journal of Education and Research in Nursing*, 2023, 171–77, https://doi.org/10.14744/jern.2021.52077.

[27] Muhammad Nadeem and Marion Blumenstein, "Embedding Online Activities during Lecture Time: Roll Call or Enhancement of Student Participation?.," *Journal of University Teaching and Learning Practice* 18, no. 8 (2021): 11.

[28] Joel S. Mtebe, Katherine Fulgence, and Michael Gallagher, "COVID-19 and Technology Enhanced Teaching in Higher Education in Sub-Saharan Africa: A Case of the University of Dar Es Salaam, Tanzania," *Journal of Learning for Development* 8, no. 2 (July 19, 2021): 383–97, https://doi.org/10.56059/jl4d.v8i2.483.

[29] Kazeem Ajasa Badaru and Emmanuel O. Adu, "Platformisation of Education: An Analysis of South African Universities' Learning Management Systems," *Research in Social Sciences and Technology* 7, no. 2 (June 26, 2022): 66–86, https://doi.org/10.46303/ressat.2022.10.

[30] Napaporn Srichanyachon, "EFL Learners' Perceptions of Using LMS.," *Turkish Online Journal of Educational Technology-TOJET* 13, no. 4 (2014): 30–35.

[31] Zheng et al., "The Impact of Organisational Support, Technical Support, and Self-Efficacy on Faculty Perceived Benefits of Using Learning Management System."

[32] Olga Viberg et al., "The Current Landscape of Learning Analytics in Higher Education," *Computers in Human Behavior* 89 (December 2018): 98–110, https://doi.org/10.1016/j.chb.2018.07.027.

learning algorithms in the educational domain to analyze e-learning environment data."[33] The Society for Learning Analytics and Research (SoLAR) defined it as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs."[34] LA stands as an emerging science, which promotes the use of digital tools and methodologies to enhance the learning process within diverse educational technology platforms.[35] LA employs a combination of different disciplines, such as education, psychology, mathematics and computer science, to enhance the e-learning process.

Benefits and Challenges of Learning Analytics

LA enables data mining of educational data to discover learning patterns and predict student outcomes (i.e. whether or not students are likely to fail or pass).[36] LA is a powerful tool that can be used to gain insights into data collected through students' use of e-learning platforms. As such, LA can be used to predict student success in an e-learning environment. LA may additionally serve as a means to ascertain the potential impact of e-learning instructional methods on academic achievement outcomes.[37] Costa et al. conducted a study to evaluate the effectiveness of LA in determining the early prediction of students' academic failure in a programming course. Their findings unveiled LA as a viable strategy for anticipatory forecasting of student attrition rates, facilitating proactive interventions to mitigate such outcomes.[38] Cerezo et al. further assert that LA serves as a valuable instrument for assessing student behaviour within e-learning environments, particularly in relation to the allocation of time and effort dedicated to the learning process.[39]

The Intersection of LMS and LA in Higher Education

The application of LA in educational contexts underscores the significance of data acquisition as a foundation for informed decision-making within the field of education. Such utilization holds the potential to augment the operational efficacy of educational institutions, thereby fostering advancements in student academic attainment and enriching the overall educational experiences. Contemporary research underscores the paramount importance of integrating LMS data within the framework of LA.[40] Scholarly publications in peer-reviewed journals emphasize the imperative of harnessing LMS data proficiently via LA methodologies to elevate the quality of educational instruction and learning outcomes.

Numerous scholars assert that there exists a prevalent conflation between LA and LMS, suggesting an interrelationship between these concepts. Although LA and LMS are closely related components within the educational technology ecosystem, they serve distinct but complementary functions.[41] Whilst LMS focuses on enabling e-learning through the use of educational technology, LA involves the analysis of data from various e-learning sources using techniques such as big data

[33] Dijana Oreški, "Using Descriptive and Predictive Learning Analytics to Understand Student Behavior at LMS Moodle," in *The Thirteenth International Conference on E-Learning*, 2022, 18–24.
[34] Oreški, "Using Descriptive and Predictive Learning Analytics to Understand Student Behavior at LMS Moodle."
[35] Oreški, "Using Descriptive and Predictive Learning Analytics to Understand Student Behavior at LMS Moodle."
[36] Oreški, "Using Descriptive and Predictive Learning Analytics to Understand Student Behavior at LMS Moodle."
[37] Dragan Gašević et al., "Learning Analytics Should Not Promote One Size Fits All: The Effects of Instructional Conditions in Predicting Academic Success," *The Internet and Higher Education* 28 (January 2016): 68–84, https://doi.org/10.1016/j.iheduc.2015.10.002.
[38] Rahila Umer et al., "On Predicting Academic Performance with Process Mining in Learning Analytics," *Journal of Research in Innovative Teaching & Learning* 10, no. 2 (2017): 160–76.
[39] Filipe Dwan Pereira et al., "Deep Learning for Early Performance Prediction of Introductory Programming Students: A Comparative and Explanatory Study," *Revista Brasileira de Informática Na Educação* 28 (October 12, 2020): 723–48, https://doi.org/10.5753/rbie.2020.28.0.723.
[40] Aimad Qazdar et al., "Newly Proposed Student Performance Indicators Based on Learning Analytics for Continuous Monitoring in Learning Management Systems.," *International Journal of Online & Biomedical Engineering* 19, no. 11 (2023).
[41] Paulo Cristiano de Oliveira, Cristiano José C de A Cunha, and Marina Keiko Nakayama, "Learning Management Systems (LMS) and e-Learning Management: An Integrative Review and Research Agenda," *Journal of Information Systems and Technology Management* 13, no. 2 (August 30, 2016): 157–80, https://doi.org/10.4301/S1807-17752016000200001.

analytics, predictive analytics, data mining and the like to predict student learning outcomes.[42] LMS platforms generate an extensive repository of data pertaining to student interactions and performance, whilst LA offers the means to examine and derive insights from this dataset systematically. Viberg et al. underscored that, notwithstanding its inherent potential, LA lacks substantial empirical evidence supporting its capacity to significantly elevate student achievement.[43] Furthermore, its ethical deployment and widespread adoption remain relatively underdeveloped and incomplete. Another notable challenge of LA use is ethical and privacy issues pertaining to the secure management of data and the responsibilities attached to the use of these data.[44]

METHODOLOGY

This study employed a systematic review process using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology. The PRISMA methodology is a well-established framework designed to improve the transparency and rigor of systematic reviews, designed to enhance the quality and credibility of literature review research. The bibliometric method conducted in this study was initially proposed by Alan Pritchard.[45] To date, this approach has been used to explore the published scholarly literature relevant to a knowledge base.[46] In the field of higher education, many of its aspects were researched, for example; sustainable development,[47] speech disorders of pre-schoolers,[48] status of educational sciences,[49] and adoption of ICTs.[50] A look closer at higher education, Pham et al. applied the bibliometric method to review the scholars of international student mobilities in Asia. Moreover, Hallinger and Chatpinyakoop were interested in sustainable development in HEIs.[51]

Data Collection

Numerous scholars hold the perspective that Web of Science, Scopus, and Google Scholar stand out as the most widely recognized and utilized database sources within the academic community. This study opted for the Scopus database to answer the research questions and Google Scholar to retrieve documents for analytical purposes. The selection of the Scopus database had an advantage in evaluating the performance citation analysis. Meanwhile, the Google Scholar database was chosen for its well-established reputation as a fitting platform for retrieving scholarly literature information, particularly pertaining to academic articles. Moreover, the preference for the Scopus database arose from its superior capacity for retrieving journal citations, as its coverage was found to be more extensive in comparison to that of the Web of Science.[52] Consequently, Scopus was chosen as the primary data source for this research endeavour. The terms “learning management system” and “learning analytics” and their abbreviations “LMS” and “LA” were the two main keywords in the search string. Focusing on the topic study, the eligible documents had to be at the higher education

[42] Philipp Leitner, Mohammad Khalil, and Martin Ebner, “Learning Analytics in Higher Education—A Literature Review,” 2017, 1–23, https://doi.org/10.1007/978-3-319-52977-6_1.
[43] Viberg et al., “The Current Landscape of Learning Analytics in Higher Education.”
[44] Alessandro Mantelero, “AI and Big Data: A Blueprint for a Human Rights, Social and Ethical Impact Assessment,” *Computer Law & Security Review* 34, no. 4 (August 2018): 754–72, https://doi.org/10.1016/j.clsr.2018.05.017.
[45] Alan Pritchard, “Statistical Bibliography or Bibliometrics,” *Journal of Documentation* 25 (1969): 348.
[46] Ivan Zupic and Tomaž Čater, “Bibliometric Methods in Management and Organization,” *Organizational Research Methods* 18, no. 3 (2015): 429–72.
[47] Philip Hallinger and Vien-Thong Nguyen, “Mapping the Landscape and Structure of Research on Education for Sustainable Development: A Bibliometric Review,” *Sustainability* 12, no. 5 (March 4, 2020): 1947, https://doi.org/10.3390/su12051947.
[48] Ly Thi Bac La et al., “A Bibliometric Analysis Of Cohesive Speech Research Of Preschoolers From 1970 To 2020,” *Problems of Education in the 21st Century* 79, no. 4 (August 15, 2021): 611–25, https://doi.org/10.33225/pec/21.79.611.
[49] Quan-Hoang Vuong et al., “The Status of Educational Sciences in Vietnam: A Bibliometric Analysis from Clarivate Web of Science Database between 1991 and 2018,” *Problems of Education in the 21st Century* 78, no. 4 (August 10, 2020): 644–62, https://doi.org/10.33225/pec/20.78.644.
[50] Jerri Alejandro López-Sánchez et al., “Use and Adoption of ICTs Oriented to University Student Learning: Systematic Review Using PRISMA Methodology,” *Cogent Education* 10, no. 2 (December 11, 2023), https://doi.org/10.1080/2331186X.2023.2288490.
[51] Philip Hallinger and Chatchai Chatpinyakoop, “A Bibliometric Review of Research on Higher Education for Sustainable Development, 1998–2018,” *Sustainability* 11, no. 8 (2019): 2401.
[52] Hallinger and Chatpinyakoop, “A Bibliometric Review of Research on Higher Education for Sustainable Development, 1998–2018.”

level; the researchers therefore added "higher education" or "HE" to refine the search results. The initial query was conducted through the advanced search option on the Scopus database (www.scopus.com) at 17:31 on February 18, 2024, as presented in Table 1 below:

Table 1: Research Protocol

Search Term (Title, Abstract or Keywords)	(TITLE-ABS-KEY ("learning management system*" AND "Higher education*") OR TITLE-ABS-KEY ("learning analytics*")) AND PUBYEAR > 2013 AND PUBYEAR < 2023
Search Strategy	AND among groups, specifically, studies conducted with African higher education OR author is affiliated with an African higher educational institution
Database	Scopus (1 149 documents) and Google Scholar
Subject area	Social sciences-based research with higher education setting; Economics, engineering, health, accounting, and education
Publication Type	Peer-reviewed Academic papers, Conference papers, books, and book chapters.
Language	English
Search period	2013 – 2023 (10-year period)

***Source**: Author's own compilation*

The first search result yielded 1,149 documents. The PRISMA guidelines applied to the systematic review of research were conducted to narrow the first search results.[53] Figure 1 shows the steps of the PRISMA diagram. In the screening step, Scopus filters were used to exclude irrelevant records.

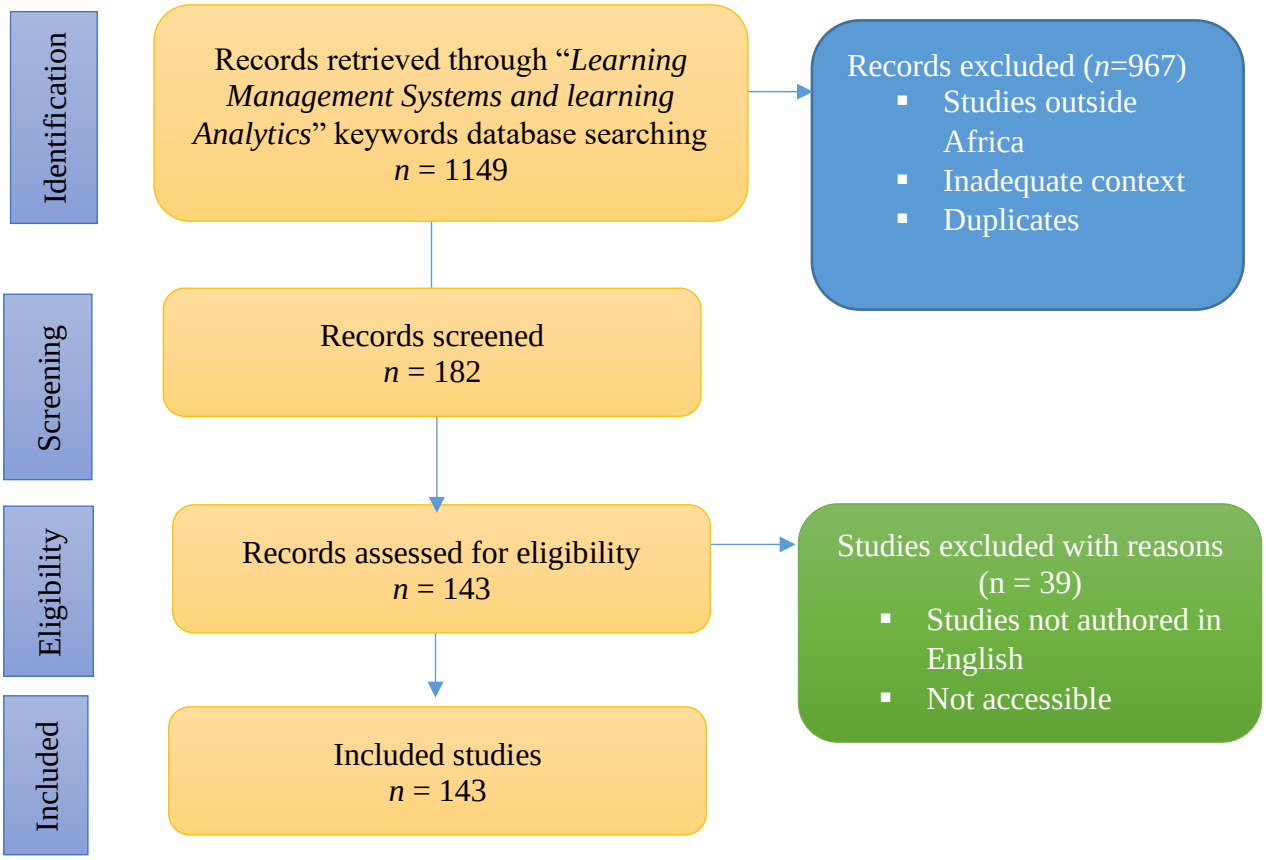

Figure 1: PRISMA Diagram representing the analysis of the LMS and LA in HEIs
Source: Author's own compilation

[53] David Moher et al., "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement," *PLoS Medicine* 6, no. 7 (July 21, 2009): e1000097, https://doi.org/10.1371/journal.pmed.1000097.

Data Analysis

In order to analyse the bibliometric data, first, the dataset as a Microsoft Excel file was downloaded. The Microsoft Excel dataset file had 143 records that were eligible for the analysis. Furthermore, the dataset contained records such as document title, document type, author name(s), author(s) affiliation, keywords, number of citations, document abstract, year of publication and document references. The dataset was used for bibliometric analysis in order to answer the four research questions of this study. The analysis of each research question was two-fold: scientific mappings and descriptive statistics. The descriptive statistics contained the author's names, authors' affiliations, and country of origin, as well as documents in LMS and LA in HE fields based on the citation count and number of publications. In this phase, three applications were utilised (i.e. VOSviewer, Tableau and Microsoft Excel). The VOSviewer and Tableau programs (https://www.tableau.com/) were utilised to visualise science mappings of the data. The researchers further used the science mappings to visualise the relationships between authors, affiliations, countries, and publications in LMS and LA subject areas. Their connections were established through the examination of co-authorship, co-citation sources, document coupling, and author keyword co-occurrences. Visualizations of scientific mappings in this study were generated using VOSviewer version 1.6.20 (available at https://www.vosviewer.com/).

RESULTS

Growth of LMS and LA literature over the years across African HEIs

Figure 2 depicts the results obtained from the longitudinal analysis of the dataset. The line graph shows the growth pattern of publications (i.e. publications comprised of articles, conference papers, books, and book chapters) in the literature from 2013 - 2023. The initial LMS and LA in African higher education-related publications were published in 2015.[54] The publication was about the building of an analytical tool for LMS to aid instructors and administrators in exploring students' online interaction patterns and knowledge development. The project recommended the use of Web log data generated by LMS to help instructors keep in touch with students' online interactions during distance learning.

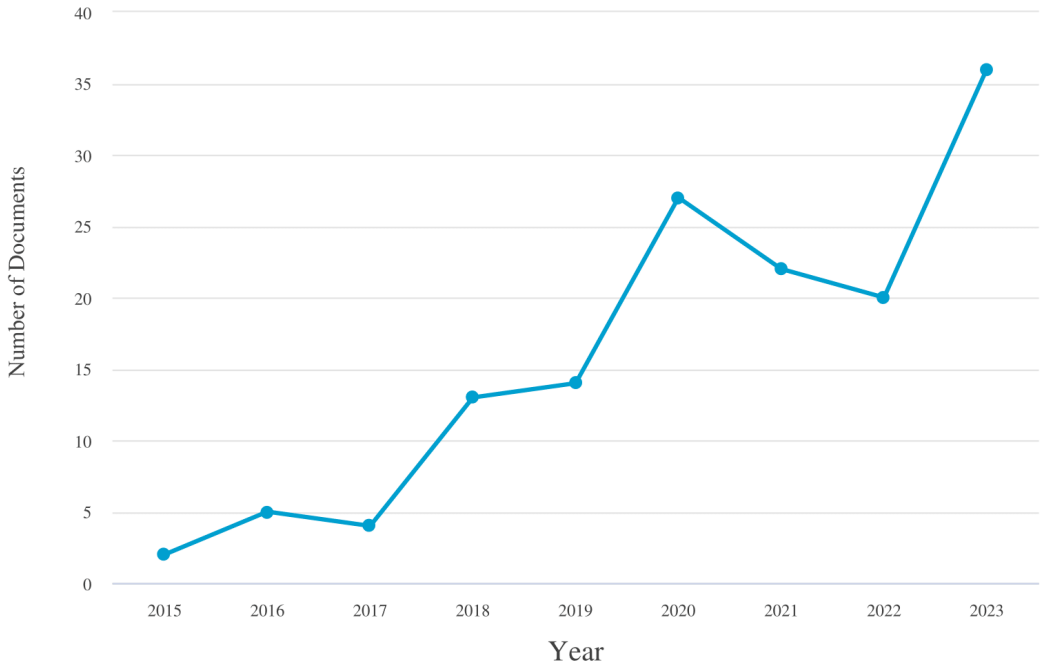

Figure 2: Publication count by year
Source: Scopus Database, 2024

[54] Yahya Al-Ashmoery, Rochdi Messoussi, and Raja Touahni, "Analytical Tools for Visualisation of Interactions in Online E-Learning Activities on Lms and Semantic Similarity Measures on Text.," *Journal of Theoretical & Applied Information Technology* 73, no. 1 (2015).

After the first publication in 2015, related studies on LMS and LA appeared to steadily increase between 2015 to 2016, followed by a slight decline in 2017. The next period, 2017 – 2020, witnessed a surge in publications. This was followed by a decline between 2020 – 2022, with publications dropping from 27 in 2020 to 20 publications in 2022. According to Makumane, the rise in publications from late 2019 to 2020 could be attributed to the COVID-19 pandemic occurrence wherein many African HEIs adopted LMS for teaching and learning during lockdown.[55] Interestingly, there was a significant rise in publications between 2022 to 2023 from 20 to 37 publications. This period could be best described as the fluctuation stage. Overall, 143 eligible publications on LMS and LA in HEIs were identified from Scopus-indexed sources, comprising conference papers (48.3%), empirical journal articles (35.7%), review articles (8.4%), books (2.1%), and book chapters (5.6%).

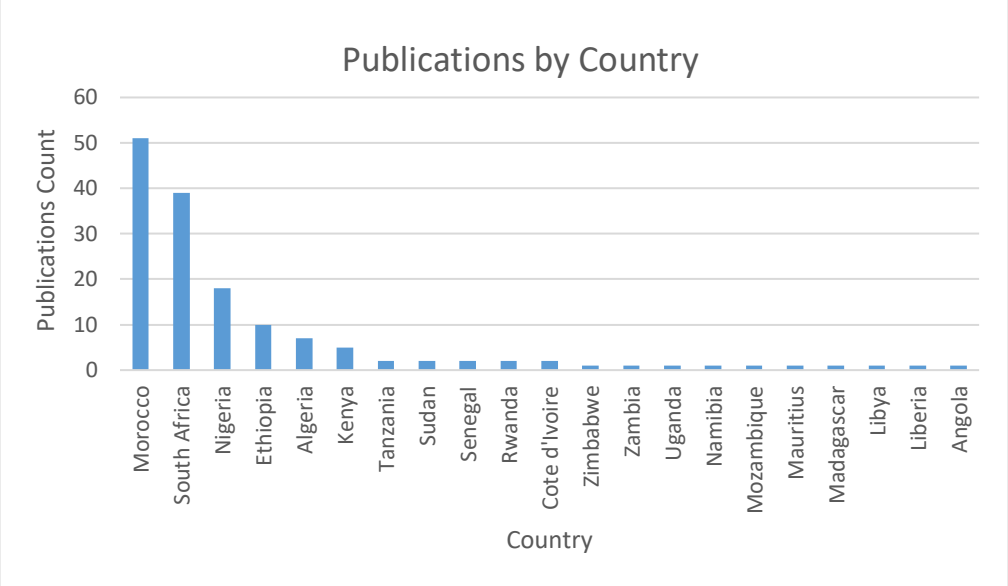

Figure 3: Graph showing the number of publications by country for the past 10 years
Source: Author's own compilation

Figure 3 shows the contributions to the LMS and LA in HE literature by countries; the map was configured according to the affiliation of the first author. Evidently, as indicated in Figure 3 above, scholars from 22 African countries have authored publications on this phenomenon. However, from these countries, certain African countries have reported a significant number of publications. Notably, Morocco, South Africa, Nigeria, and Ethiopia have the number of publications being 51 (34%), 39 (26%), 18 (12%), and 10 (6%), respectively. Furthermore, other countries were relatively active in this field, as Kenya (5), Tanzania, Sudan, Senegal, Rwanda and Cote D'Ivoire, all having 2 publications each. The rest of the countries each only had a single publication, this included countries such as Zimbabwe, Zambia, Uganda, Namibia, Mozambique, Mauritius, Madagascar, Libya, Liberia and Angola.

The Most Influential Authors

Table 2 illustrates the number of publications per author and related citation counts. As ranked by the total number of Scopus citations, the most cited authors are Oussous et al. (617), Mamoshina et al. (312), Jebli et al. (191) and Dhamija (150). The publication with the most citations (617) was published by published by Oussous et al. The study focused on the development of big data technologies pertaining to LMS adoption. The second most cited study in the period under investigation was a study conducted by Mamoshina et al. with 312 citations. This study investigated how emerging blockchain

[55] M. A. Makumane, "Students' Perceptions on the Use of LMS at a Lesotho University amidst the COVID-19 Pandemic," *African Identities* 21, no. 2 (April 3, 2023): 209–26, https://doi.org/10.1080/14725843.2021.1898930.

and artificial intelligence technologies could help decentralise and accelerate biomedical research. The earliest citation publication was authored by Ofli et al. in 2016 and had 117 citations at the time of the investigation. The most recent publication was authored by Kamble et al. and focused machine learning approach for the prediction of blockchain adoption in the supply chain. This publication had 144 citations at the time of the investigation.

Table 2: Summary of the most productive authors and citation count in LMS and LA

Rank	Publication title	Author	Citation in Scopus	Year of publication
1	Big Data Technologies: A survey	Oussous, Benjelloun, Lahcen, and Belfkih	617	2018
2	Converging blockchain and next-generation artificial intelligence technologies to decentralize and accelerate biomedical research and healthcare	Mamoshina, Ojomoko, Yanovich, Ostrovski, Botezatu, Prikhodko, Izumchenko, Aliper, Romantsov, Zhebrak. and Ogu	312	2018
3	Prediction of solar energy guided by Pearson correlation using machine learning	Jebli, Belouadha, Kabbaj and Tilioua	191	2021
4	Role of artificial intelligence in operations environment: a review and bibliometric analysis	Dhamija and Bag	150	2020
5	A machine learning-based approach for predicting blockchain adoption in Supply Chain	Kamble, Gunasekaran, Kumar, Belhadi and Foropon	144	2021
6	Combining human computing and machine learning to make sense of big (Aerial) data for disaster response	Ofli, Meier, Imran, Castillo, Tuia, Rey, Briant, Millet, Reinhard, Parkan and Joost	117	2016
7	Mapping mineral prospectivity through big data analytics and a deep learning algorithm	Xiong, Zuo and Carranza	114	2018
8	Using learning analytics to predict students' performance in 9moodle learning management system: A case of Mbeya University of science and technology	Mwalumbwe and Mtebe	89	2017
9	Research trends in measurement and intervention tools for self-regulated learning for e-learning environments—systematic review (2008–2018)	Araka, Maina, Gitonga and Oboko	78	2020
10	Machine learning in oral squamous cell carcinoma: Current status, clinical concerns and prospects for future—A systematic review	Alabi, Youssef, Pirinen, Elmusrati, Mäkitie, Leivo and Almangush	66	2021

Source: Author's own compilation

Table 3 depicts the most productive authors on the LMS and LA fields in Africa. According to the analysis of the Scopus database, the most productive authors were Atayero and Popoola from Covenant University, Nigeria and Manchester Metropolitan University, respectively. Both authors at the time of this investigation had a total of 3 publications each. Furthermore, other notable authors who were frequently cited were Zine-Dine and Addou from Morocco, with 2 publications each. The

latter was based at the Hassania School of Public Works, whilst the former was based at the Mohammed V University.

Table 3: Summary of the most productive authors

Author	Quantity	Country	Affiliation	Keywords
Atayero A.A	3	Nigeria	Covenant University	Biometrics; Attendance System; Education portal System, Learning analytics, Smart campus, Energy efficiency, Energy management, Learning analytics,
Popoola S.I	3	Nigeria	Manchester Metropolitan University, Manchester, United Kingdom	Learning analytics, Smart campus, Energy efficiency, Energy management, Learning analytics, Nigerian university, Education data mining, STEM Education
Zine-Dine K	2	Morocco	Mohammed V University, Faculty of Sciences	IoT and Big-Data platform; Machine-learning algorithms; Micro-grid systems; Model predictive control, Smart buildings
Addou M	2	Morocco	Hassania School of Public Works	Big data analytics, Machine Learning, Smart data, Multi-agent system, Automation; decision-making, Machine Learning

Source: Author's own compilation

VOSviewer Analysis

To explore the most noteworthy publications in the LMS and LA field within African higher education, this study analysed citation occurrence using the VOSviewer software to compare the impact of the publications. The analysis using VOSviewer was two-fold; first, a threshold of at least twenty citations was set to identify the most frequently cited publications. Secondly, VOSviewer was used to visualise the connections in relation to the co-occurrence of commonly used keywords in LMS and LA fields within the African context. The VOSviewer revealed two networks of keyword co-occurrences displayed in red and green clusters in Figure 4. The red cluster depicts studies that primarily focused on Learning Analytics, whilst the green cluster depicts keywords related to Learning Management Systems. The analysis showed that the most commonly used keywords in relation to Learning Analytics were; big data, big data analytics, deep learning, artificial intelligence and predictive analytics. The second cluster (green) of the keywords shows connections among keywords associated with LMS. The most commonly used keywords were; information management, students, learning management system, data mining and decision making.

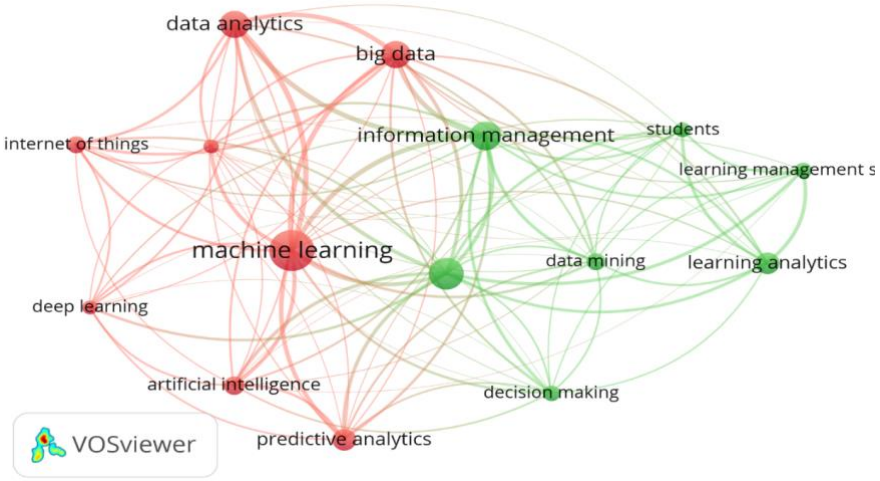

Figure 4: A visualisation map of the co-occurrence of keywords
Source: VOSviewer

In addition, a threshold of 15 citations was set using VOSviewer to visualize connections among frequently cited authors, as depicted in Figure 4. Figure 4 illustrates 14 authors divided into 12 clusters. Each cluster comprises authors who focus on similar subject areas and utilize similar research approaches.[56] Thus, each cluster represents authors whose research stems from a similar framework or school of thought. Furthermore, the presence of clusters with fewer authors highlights the lack of interrelatedness among authors in the LMS and LA fields. Furthermore, the network connections revealed that only three clusters had authors who were interrelated, namely, the red cluster comprising Iksal and May; the blue cluster comprising Bakhouy and Benhaddou, and the green cluster comprising a single author (i.e. Atayero). Notably, the authors who had the most cited publications, Atayero and Popoola (3 publications each), were not interrelated with other authors. Their research focused mainly on the use of learning analytics for educational support.

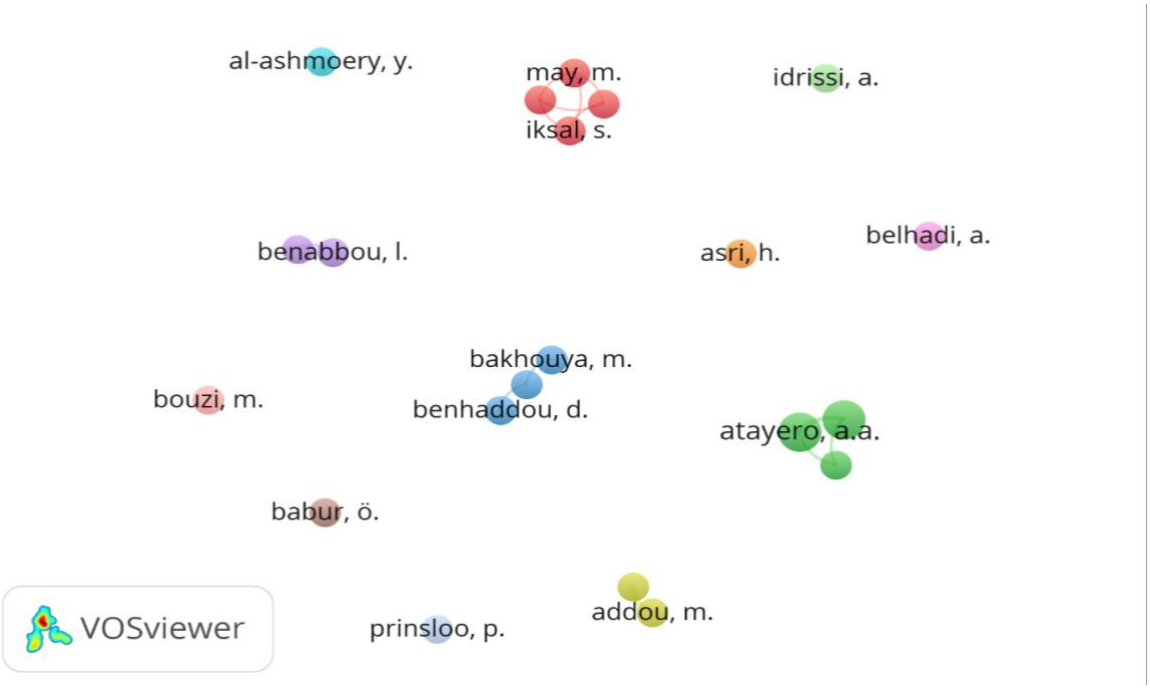

Figure 5: A visualisation map of co-authorship
Source: VOSviewer

Scholarly Recommendations for African Higher Education

A content analysis was conducted to identify the main themes that were pertinent in the recommendations on improving LMS and LA integration in African higher education. Owing to the large number of publications identified, the recommendations were divided into specific themes: student performance, big data analytics, learning behaviour and student learning support. A minimum of 10 Scopus citations was set as a requirement for the recommendations of a publication to be included in any of the four themes.

The **student performance** theme addressed issues pertaining to the use of LMS and LA to enhance student performance in various fields of study. The most notable scholars in this theme recommend the use of LA to guide student performance evaluation and to predict the likelihood of students dropping out based using predictive analytics techniques. Another significant recommendation is the need to build analytic models that can be used to extract data from LMS and real-time student learning data to improve student performance and provide real-time interventions for identified students with a high drop-out risk. On the other hand, Mwalumbwe and Mtebe recommended the development of a Learning Analytics tool to determine the causality linkage between students' performance and LMS usage.

[56] Hallinger. "A bibliometric review of research on higher education for sustainable development, 1998–2018."

The second theme that derived from the content analysis based on the recommendations of highly cited authors was the use of **big data analytics.** In the higher educational context, big data analytics refers to the use of advanced analytical techniques to analyze large volumes of data generated within the LMS. Kalema and Segooa highlight the need for higher education institutions to use various big data analytics tools to predict student performance and achievement outcomes. According to Matsebula and Mnkandla, using big data analytics functions such as predictive modelling can aid institutions in modeling student outcomes forecast, such as the probability of a student dropping out or their performance on future assessments.[57] Therefore, it is necessary for administrators and educators in higher education institutions to implement the use of big data analytics to facilitate online learning.[58]

The third theme derived from the content analysis focuses on student **learning behaviour** when using online learning systems. The core foundation of depicting student learning behaviour is based on students' login algorithms when using LMS. The main findings under these themes suggest that institutions should encourage educators and instructional designers to use various machine learning programmes and learning analytics to predict student behaviour. According to Kasiroori and Chigwada, students' use of online library resources can show the correlation between the usage of e-resources and their academic achievement outcomes.[59] Scholars, therefore, recommend the creation of targeted and engaging content to facilitate independent learning.

The fourth and final theme explores the need for **student learning support** when using LMS. In the context of LMS usage, student learning support refers to the various tools, resources, and services provided within the LMS to help students succeed in their learning endeavours. Student learning support can be provided in numerous ways, such as assessment feedback, access to course materials, communication and collaboration tools, personalised learning paths and tutoring support services. Imhof et al. further recommend the use of predictors and algorithms to determine the various support functions that LMS users might need and have these support functions set up in advance. Precautionary measures should be put in place when implementing the use of predictors and algorithms in LMS.[60]

Table 4: Summary of recommendations on LMS and LA usage

Theme	Keywords	Recommendations	Main Authors
Student Performance	Medical education; Machine Learning; Student performance; Predictive learning	Learning analytics can be used to guide students' performance evaluation; Need to use machine learning to predict diseases; LA can be used to predict students' dropout risk	Oluwadele et al. 2023; Ajuwon et al., 2023; Jongile & Ivala, 2023; Mwalumbwe & Mtebe, 2017
Big data analytics	University funding; machine learning; Data analytics; Big Data Analytics; Predictive Modelling	Higher Education institutions' role players can use big data analytics to predict student achievement outcomes; Infuse machine learning with data analytics; The need for Big data architecture to facilitate learning	Kalema & Segooa, 2023; More & Wolkersdorfer, 2023; Matsebula & Mnkandla, 2017 Oussous, et al., 2018.

[57] Fezile Matsebula and Ernest Mnkandla, "A Big Data Architecture for Learning Analytics in Higher Education," in *2017 IEEE AFRICON* (IEEE, 2017), 951–56.
[58] Ahmed Oussous et al., "Big Data Technologies: A Survey," *Journal of King Saud University - Computer and Information Sciences* 30, no. 4 (October 2018): 431–48, https://doi.org/10.1016/j.jksuci.2017.06.001.
[59] Justice Kasiroori and Josiline Phiri Chigwada, "8 The Impact of Library Resources on Block Release Students' Academic Achievement in Zimbabwe," *Information Services for a Sustainable Society: Current Developments in an Era of Information Disorder* 183 (2023): 116.
[60] Christof Imhof et al., "Prediction of Dilatory Behavior in Elearning: A Comparison of Multiple Machine Learning Models," *IEEE Transactions on Learning Technologies* 16, no. 5 (2022): 648–63.

Learning behaviour	Learning Analytics, learning behaviour, login algorithms, e-libraries; Machine learning technologies; YouTube Analytics	Use of objective machine learning models; caution regarding selecting subjective models to predict learning behaviour; learning analytics should include all data generated by learners; create targeted and engaging content	Imhof et al., 2023; Kasiroori & Chigwada, 2023; van Heerden, 2023.
Student learning support	Academic learning support; Learning management platform; Educational data mining	Importance of factors needed for student learning support: LMS can be used to measure Self-Regulated Learning among students; the need to build LMS analytic tools to support online learning	Khumalo et al., 2023; Araka etr al, 2020; Al-Ashmoery et al., 2015.

Source: Author's own compilation

DISCUSSION

Through the bibliometric analysis of Scopus-indexed publications on LMS and LA fields in African Higher education published between 2013 and 2023, this systematic literature depicted the importance of the use of LA in LMS adoption in African higher education. The publication pattern indicates an increase in authorship of LMS and LA-related articles between the period under review (2013 – 2023), with the first publication recorded in 2015. This growth pattern indicates the awareness of higher education institutions regarding the associated benefits of LMS adoption for the purposes of teaching and learning. The analysis showed that the majority of publications consisted of conference papers and empirical and review articles. The wide adoption of LMS across higher education institutions in Africa has resulted in an increase in research pertaining to the benefits and challenges associated with the digitisation of learning.[61]

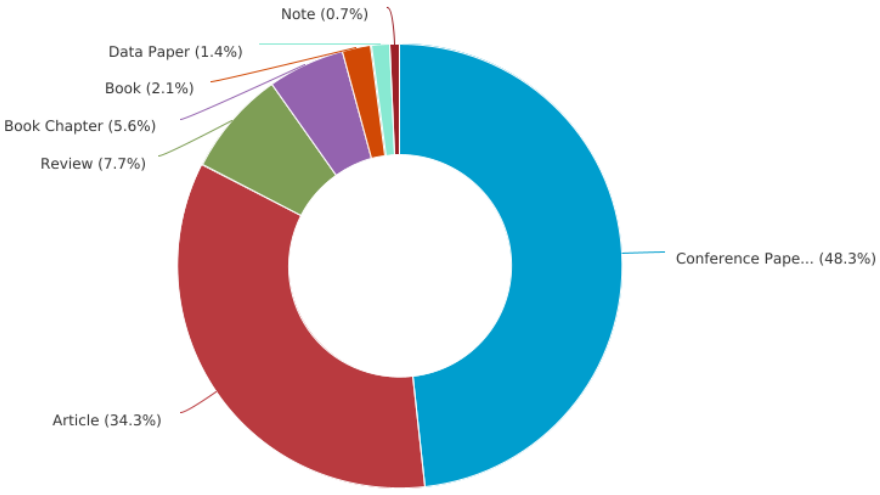

Figure 6: Publication types
Source: Scopus Database

[61] Brandford Bervell and Irfan Naufal Umar, "A Decade of LMS Acceptance and Adoption Research in Sub-Sahara African Higher Education: A Systematic Review of Models, Methodologies, Milestones and Main Challenges," *Eurasia Journal of Mathematics, Science and Technology Education* 13, no. 11 (2017): 7269–86.

Among the many studies published between 2013 and 2017 in the LMS field, findings suggest a steady growth of research across Africa, with most studies focusing on the use of Learning Analytics to understand student learning behaviours and the utilization of big data to uncover student learning patterns. Research by Islam and Mahmud indicates that the integration of learning analytics into LM has been shown to enhance the effectiveness of these systems.[62] This is particularly evident in the use of machine learning techniques to predict learner performance and engagement.[63] Universities are increasingly using LMS-based learning analytics to make informed decisions at various levels, from institutional to course section.[64] The occurrence of COVID-19 pandemic played a crucial role in the acceleration of LMS research across educational institutions. The adoption of LMS in African higher education during the COVID-19 pandemic has been a significant focus of research. For example; Mtebe, Fulgence and Gallagher highlight the successful use of LMS, particularly Moodle, in Tanzanian and South African universities, respectively. Badaru and Adu further explore the specific LMS platforms used in South African universities, with a shift towards online teaching and learning during the pandemic.[65]

Furthermore, the bibliometric analysis shows that the most cited authors in LMS and learning analytics were Ayatero and Popoola, with three publications each to their name and Zine-Dine and Addou, with two publications each to their name. Addou and Zine-Dine focused on learning analytics to uncover students' learning patterns as well as the use of big data analytics to predict student performance. It is noteworthy to mention that the most productive authors were based in Morocco and Nigeria, two African countries that are notable for spearheading the digitisation of the learning environment in African education.

Regarding the most productive countries, Morocco, South Africa and Nigeria were the leading productive countries with a significantly higher publication count when compared to other countries. According to Hannache-Heurteloup and Moustaghfir, a large number of universities in Morocco consider e-learning as an essential platform that would aid them in meeting the high demand for higher education and the provision of quality education.[66] However, many institutions across Morocco still face numerous barriers pertaining to e-learning therefore slowing down its adoption and use. Similarly, the adoption of LMS platforms among many university students in South Africa remains low. This could also explain the reason why South Africa has numerous publications that investigated factors associated with LMS adoption across higher education institutions.[67] The analysis further showed that a large number of African countries did not have a single publication in the LMS and learning analytics fields, further indicating the disparity in access to education across Africa.

In addition, the analysis found that scholars made numerous recommendations for the improvement of LMS adoption in African universities. The adoption of LMS and digital technologies presents several challenges and benefits. Through the content analysis of the recommendations, the recommendations were divided into four main themes; student performance, big data analytics, learning behaviour and student learning support. With regard to student performance, scholars presented numerous discussions on how LMS and learning analytics could be used to enhance student performance and aid drop-out-risk students. This can be achieved through the use of predictive learning and machine learning programs that could be embedded in LMS platforms. Furthermore, universities can use big data analytics to predict student performance and achievement outcomes. Another challenge noted by various scholars is that LMS platforms contain huge amounts of data regarding student behaviour, such as their login patterns, their engagement with content and their frequency of

[62] Islam and Mahmud. "Integration of learning analytics into learner management system using machine learning."
[63] Shareeful Islam and Hasan Mahmud, "Integration of Learning Analytics into Learner Management System Using Machine Learning," in *Proceedings of the 2020 2nd International Conference on Modern Educational Technology*, 2020, 1–4.
[64] T S Magudulela, Billy Mathias Kalema, and M A Segooa, "Conceptualizing a Model for Cloud-Based Hospital Management Systems for the South African Public Health Sector.," 2023.
[65] Badaru and Adu, "Platformisation of Education: An Analysis of South African Universities' Learning Management Systems."
[66] Narjisse Hannache-Heurteloup and Karim Moustaghfir, "Exploring the Barriers to E-Learning Adoption in Higher Education: A Roadmap for Successful Implementation," *International Journal of Management in Education* 14, no. 2 (2020): 159–82.
[67] Obert Matarirano, Onke Gqokonqana, and Abor Yeboah, "Students' Responses to Multi-Modal Emergency Remote Learning during COVID-19 in a South African Higher Institution," *Research in Social Sciences and Technology* 6, no. 2 (2021): 199–218.

accessing online learning platforms. Universities are encouraged to create targeted content to facilitate online collaborative learning. In addition, universities should ensure that adequate support functions are set up to assist administrators and educators in using learning analytics and other tools to support online learning.

Discussion Summary

This study contributes to the understanding of the complex relationship between LMS engagement and learning analytics in African higher education. This study employed bibliometric analysis to analyse 143 publications from the Scopus database pertaining to Learning Management Systems and Learning Analytics. The increase in publications involving LMS in the past decade across Africa implies that many educational institutions acknowledge the importance of online learning in this era of digital technologies. Most of the active authors in this field were from Morocco, Nigeria and South Africa. The number of publications on LMS adoption in a few developing African countries is superior to that of least-developed African countries. Moreover, their research focused on the adoption of LMS to enhance the online learning environment and student performance. The most productive authors in this field were Atayero, Popoola, Zine-Dine and Addou. Their findings highlight the importance of using learning analytics, deep learning, predictive learning and big data analytics to uncover student learning patterns. Most of the publications used the aforementioned keywords to uncover trends pertaining to the use of LMS for online learning purposes.

Implications for future research

The above findings imply that more research needs to be conducted on how higher education institutions in Africa can use LMS and other e-learning platforms to enhance the learning process. Over the past decade, there has been a growth pattern in LMS and learning analytics research conducted by academics in a few African countries. Therefore, it is expected that researchers from other African countries produce empirical research regarding this field. More empirical studies are needed in various study fields pertaining to the use of online learning or blended learning.

CONCLUSION

The incorporation of LMS and learning analytics across higher education institutions in Africa has transformed the learning environment. As universities adopt LMS to facilitate teaching and learning, the interaction and use of LMS by students remains paramount as it contributes to the success of higher educational institutions in Africa and to quality education. The main conclusion drawn from this study is that higher education institutions are leveraging the use of LMS and various learning analytics techniques to uncover student learning behaviour to enhance student performance related to online learning. The use of learning analytics techniques and big data could aid institutions combat challenges that educators and students face during e-learning. With the wide adoption of technology in the educational sector, institutions would need to equip their educators and support staff with online pedagogical methodologies and skills to help facilitate e-learning processes.

Limitations

One of the notable limitations of this study is that this bibliometric analysis only comprised research publications from the Scopus database to answer research questions. Future research could consider exploring other databases such as Web of Science, Emerald Insight, or Springer to explore this research field. Furthermore, the search results of this bibliometric analysis could have been narrowed to a more specific niche through the use of Boolean search functions. In this study, we used the keywords “Learning Management Systems” and “Learning Analytics”. Through the use of Boolean keywords search, perhaps other keywords could be added to the search, such as “e-learning”, “Predictive Learning”, “Big data analytics”, and more.

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