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Barriers to the effective adoption of learning management systems in higher education: A case study in South Africa

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Abstract: This study investigates the barriers to effective Learning Management System (LMS) adoption in South African higher education institutions, focusing on connectivity, digital content quality, and technical support challenges. A mixed-methods approach was employed, combining a systematic literature review (SLR) of articles published between 2015 and 2025 with a quantitative survey. A questionnaire was distributed to students enrolled in a distance learning module, yielding 337 responses from 455 students (74% response rate). The SLR revealed that poor internet infrastructure, high data costs, inadequate digital content localization, and insufficient technical support significantly impede LMS adoption. The quantitative survey confirmed these findings: 51% of respondents reported connectivity problems, 42.7% experienced content-related issues, and 46.3% encountered support challenges. These barriers disproportionately affect rural and peri-urban students, reinforcing the digital divide. Infrastructural inequalities, content development gaps, and weak institutional support structures limit effective LMS integration in South African universities. The study recommends addressing infrastructural disparities, enhancing localized digital content development, strengthening institutional support systems, and implementing government policies to standardize LMS adoption, particularly for resource-constrained rural institutions.

Keywords: *E-Learning implementation, Higher education, Learning management systems (LMS), South African universities, Technology adoption barriers.*

1. Introduction

Research Gap: While numerous studies have explored the adoption of LMS worldwide [1-3], it is noted that inadequate research has specifically focused on the unique barriers experienced by HEIs in South Africa. Most existing literature [4-6] tends to address either technological issues or pedagogical factors in isolation, with less emphasis on the intertwined challenges of connectivity, digital content quality, and institutional technical support within the South African context. In addition, there is a scarcity of studies blending systematic literature review with quantitative empirical evidence to provide an inclusive understanding of these barriers. This lack creates a gap in developing integrated, contextually relevant strategies to enhance LMS adoption that address infrastructural content and support disparities, especially affecting rural and financially under-resourced institutions.

Problem Statement: Despite growing investments in digital learning platforms, the effective adoption of LMS in South African HE remains inconsistent and uneven [7]. Persistent barriers such as unpredictable internet connectivity, inadequately localized and standardized digital content, and inadequate technical support continue to inhibit students' and lecturers' engagement with LMS platforms. These challenges disproportionately affect learners in rural and peri-urban areas and institutions with fewer financial resources, worsening existing educational inequalities. Without

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addressing these systemic barriers, LMS platforms risk becoming tools that reinforce rather than reduce the digital divide. LMS should not hinder efforts to achieve inclusive, quality education for all students across South Africa.

Purpose Statement: The purpose of this study is to investigate the central barriers to effective LMS adoption in South African HEIs, with particular emphasis on issues surrounding connectivity, digital content, and technical support. This research aims to identify key challenges and limitations that inhibit sustainable LMS usage by combining a systematic literature review and a quantitative survey within a distance-learning context. It seeks to provide evidence-based sanctions to inform institutional policies and government interventions aimed at improving digital infrastructure, content standardization, and technical capacity. Therefore, it strives to contribute to advancing equitable, inclusive, and effective digital learning environments in South African HE.

2. Literature Review

2.1. Introduction

The adoption of LMS in HE has become a global imperative as institutions seek to enhance teaching, learning, and administrative efficiency. In South Africa, the drive towards digital transformation has been accelerated by the need for flexible learning pathways, particularly within hybrid and blended learning models [8]. Despite the potential of LMS platforms to democratise access to education, several barriers have limited their effective adoption. This literature review synthesises existing scholarship on the challenges of LMS integration, focusing on issues of connectivity, digital content, and technical support within South African HEIs.

2.2. Learning Management Systems in HE

LMS platforms such as Moodle, Blackboard, and Canvas are designed to facilitate online learning by offering tools for content delivery, assessment, and interaction [9]. Globally, they have been linked to improved access, increased student engagement, and enhanced learning outcomes [10]. In South Africa, LMS adoption has been widespread across universities, yet evidence suggests that their effectiveness is uneven, particularly when socio-economic disparities intersect with digital access and support structures [11].

2.3. Connectivity Challenges

Connectivity is a foundational requirement for effective LMS adoption, yet it remains a critical barrier in South Africa. High internet costs, limited bandwidth, and inadequate infrastructure disproportionately affect students from rural and peri-urban regions [12]. Research shows that while urban students often have reliable access, their rural counterparts experience interruptions that undermine participation in online learning activities [13]. The "data poverty" phenomenon exacerbates inequality, with students forced to ration internet usage, thereby restricting engagement with LMS resources [14].

2.4. Digital Content Gaps

The quality and relevance of digital learning content significantly influence the success of LMS adoption. Studies indicate that poorly designed content, often static, text-heavy, or lacking localisation, fails to engage students effectively [15]. In South Africa, limited investment in contextually relevant digital resources has created gaps in aligning LMS materials with diverse student needs [16]. Moreover, lecturers often lack the pedagogical and technical expertise required to develop interactive, multimedia-rich content, resulting in a reliance on traditional teaching materials that do not leverage LMS capabilities [17].

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2.5. Technical Support Limitations

Effective use of LMS depends not only on access and content but also on technical support for both staff and students. In many South African institutions, training for lecturers is inadequate, leaving them ill-equipped to integrate LMS tools into their pedagogy [18]. Students similarly report difficulties navigating platforms, particularly when technical helpdesks are under-resourced or unavailable [19]. The lack of continuous professional development in digital pedagogy perpetuates a cycle where LMS adoption is superficial, limited to administrative functions rather than transformative learning practices [8].

2.6. Broader Implications: The Digital Divide

These barriers to connectivity, content, and support intersect to reinforce the broader digital divide in South African HE. While some students benefit from seamless integration of LMS tools, others are marginalised by structural inequities. Studies emphasise that without targeted interventions, LMS adoption risks reproducing existing inequalities rather than overcoming them [20]. The South African context is further complicated by socio-economic disparities, where access to devices, electricity, and digital literacy varies widely [21].

3. Research Methodology

3.1. Research Design

A quantitative approach was chosen because the study aimed to measure and analyze relationships between categorical variables (barriers) and an ordinal outcome (LMS usage frequency). This design allowed the use of statistical techniques such as descriptive analysis, Chi-Square tests, and ordinal logistic regression to test hypotheses and identify significant predictors of LMS adoption.

3.2. Population and Sampling

The target population consisted of students from a public university in South Africa. The study used a targeted sampling approach. A single module offering was selected as a case study, and a questionnaire was sent to all students enrolled in that module. A total of 337 students enrolled in a module at a South African HEI responded to the questionnaire. Respondents represented diverse age groups, levels of study, and experience with hybrid learning systems.

3.3. Data Collection

An online questionnaire was distributed via institutional mailing lists, focusing on connectivity, content quality, and technical support. The questionnaire captured: (1) Challenges faced when using LMS (coded into connectivity, content, and technical support categories); (2) Frequency of LMS usage (ordinal scale: Never, Once a month, Several times a month, Once a week, Daily).

3.4. Instruments

The questionnaire was developed from validated frameworks [9, 15] and tested for reliability using Cronbach's alpha (>0.70 threshold). The interview guide included closed-ended questions on connectivity, content, and support challenges.

3.5. Data Analysis

Quantitative data were analysed using SPSS, employing descriptive statistics and inferential tests. The analysis involved:

- Descriptive statistics to summarise frequencies and percentages of barriers and LMS usage.
- Chi-Square tests to explore associations between reported barriers and usage frequency. The equation for Chi-Square can be expressed as follows:

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$$\chi^2 = \frac{\sum(O_{ij}-E_{ij})^2}{E_{ij}} \quad (1)$$

Where:

$O_{ij} =$ the observed frequency in the cell for row i and column j.

$E_{ij} =$ the expected frequency for that cell, assuming no association.

$$calculated\ as: E_{ij} = \frac{(Row\ Total)(Column\ Total)}{Grand\ Total} \quad (2)$$

Ordinal logistic regression to model the likelihood of higher LMS usage as a function of the three barrier categories. The ordinal logistic regression for this study can be computed as follows:

$$log\left(\frac{P(LMS\ Usage \leq j)}{P(LMS\ Usage > J)}\right) = \alpha_j - \beta_1(Connectivity) - \beta_2(Content) - \beta_3(Support) \quad (3)$$

Where:

β_1: Effect of connectivity challenges.

β_2: Effect of content challenges.

β_3: Effect of technical support challenges.

α_j: Separate thresholds for each LMS usage level $(Never, Once\ a\ month, \ldots, Daily)$.

4. Results

4.1. Descriptive Analysis

4.1.1. LMS Barriers

Table 1 presents the frequency and percentage of barriers reported by students.

Table 1.
Frequencies and percentages of barriers.

Barrier	Frequency	Percentage
Connectivity	172	51.0%
Content	144	42.7%
Support	156	46.3%

Figure 1 shows the frequency distribution of reported barriers.

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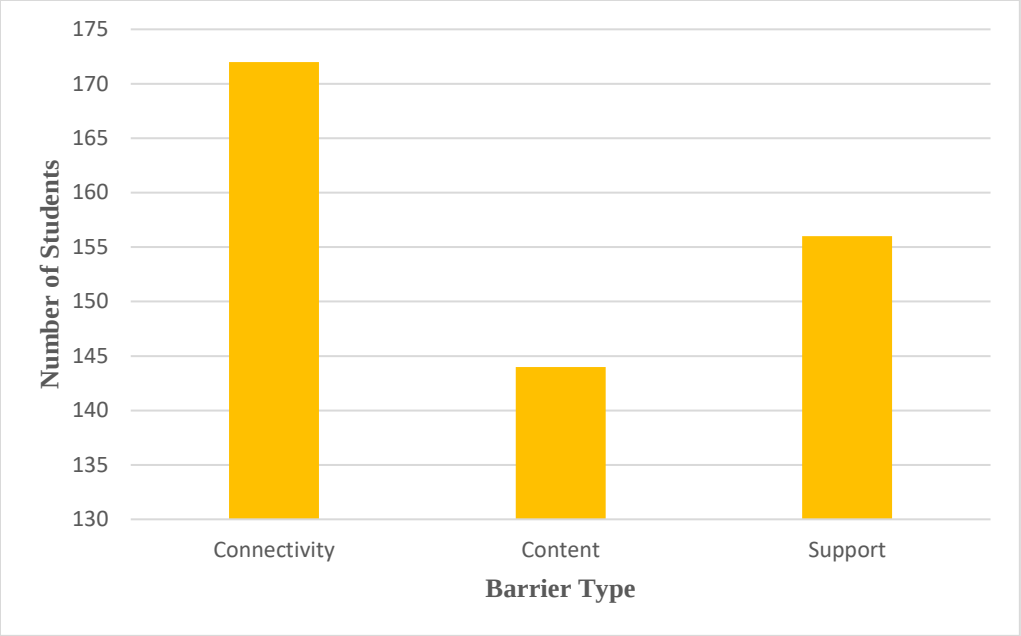

Figure 1.
Frequency of Reported LMS Barriers.

The descriptive analysis indicates that connectivity barriers were the most frequently reported at 51%, followed by technical support at 46% and content challenges at 43%. This suggests that more than half of the students struggled with internet-related issues, while a substantial proportion also encountered difficulties with support services. Fewer students had issues with the quality or availability of digital content.

4.2. LMS Usage

Table 2 represents the frequency and percentage of LMS usage by students.

Table 2.
Frequency table for LMS Usage.

LMS Usage	Frequency	Percentage
Several times a week	161	47.8%
Daily	160	47.5%
Once a week	12	3.6%
Rarely	4	1.2%

Figure 2 below illustrates LMS usage frequency among students.

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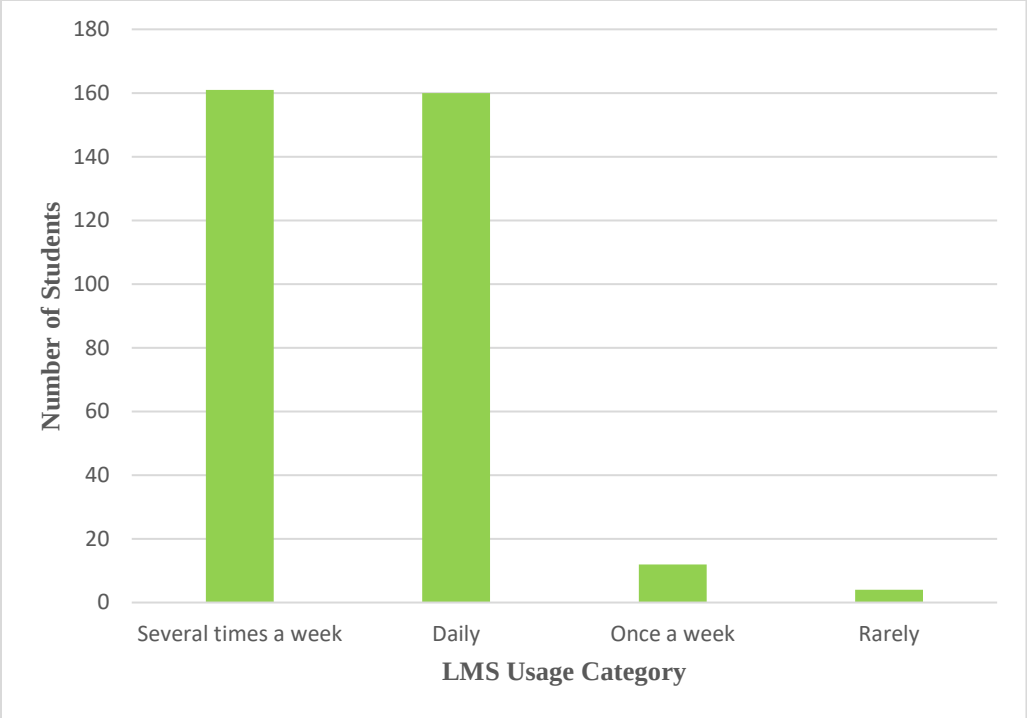

Figure 2.
Frequencies of LMS Usage.

Deducing from both Table 2 and Figure 2, the distribution of LMS usage shows that nearly all students engage with the platform frequently. Specifically, 47.5% (approximately 160 students) reported using the LMS daily, and 47.8% (around 161 students) used it several times a week. Only 3.5% indicated using it once a week, while 1.2% reported using it rarely or once a month. This pattern demonstrates a very high level of LMS adoption and reliance among students, suggesting that the system has become an integral part of their academic experience. However, high frequency of use does not necessarily indicate seamless adoption; students who face connectivity and content challenges may experience frustration, inefficiency, and unequal access to learning opportunities, even if they log in regularly.

4.3. Inferential Analysis

Chi-Square tests were conducted to examine associations between barriers and LMS usage.

Table 3.
Connectivity.

Connectivity	Daily (O)	Daily (E)	Once a week (O)	Once a week (E)	Rarely (O)	Rarely (E)	Several times a week (O)	Several times a week (E)
No (0)	92	78.34	4	5.88	4	1.96	65	78.83
Yes (1)	68	81.66	8	6.12	0	2.04	96	82.17

The observed frequencies from Table 3 differ noticeably from the expected values, indicating a statistically significant relationship between connectivity challenges and LMS usage frequency (χ^2 = 14.76, p = 0.002). Connectivity clearly affects LMS adoption and engagement levels, as students without connectivity problems are more likely to use the LMS daily and maintain consistent engagement, while those with connectivity barriers tend not to use it due to limited access or unstable internet connections.

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Although most students use the LMS frequently, poor connectivity reduces flexibility and creates unequal access, potentially impacting overall learning outcomes.

Table 4.
Content Barrier.

Content	Daily (O)	Daily (E)	Once a week (O)	Once a week (E)	Rarely (O)	Rarely (E)	Several times a week (O)	Several times a week (E)
No (0)	96	91.63	0	6.87	0	2.29	97	92.2
Yes (1)	64	68.37	12	5.13	4	1.71	64	68.8

The differences between observed and expected frequencies from Table 4 indicate a significant relationship between content barriers and LMS usage patterns ($\chi^2 = 22.52$, $p < 0.001$). Students without content challenges are more active, using the LMS daily or several times a week, while those experiencing content barriers tend to use it less frequently, with higher-than-expected occurrences in the "once a week" and "rarely" categories. This suggests that insufficient, outdated, or poorly designed learning materials reduce student motivation and hinder consistent participation in LMS-based learning activities.

Table 5.
Support Barrier.

Support	Daily (O)	Daily (E)	Once a week (O)	Once a week (E)	Rarely (O)	Rarely (E)	Several times a week (O)	Several times a week (E)
No (**0**)	80	85.93	8	6.45	4	2.15	89	86.47
Yes (**1**)	80	74.07	4	5.55	0	1.85	72	74.53

Deducing from Table 5, the observed and expected frequencies are closely aligned, indicating that there is no statistically significant relationship between support challenges and LMS usage frequency ($\chi^2 = 5.30$, $p = 0.151$). All students, regardless of whether they experienced support challenges, demonstrated similar levels of engagement with the LMS. Support-related issues, such as delayed assistance or system troubleshooting, did not substantially reduce usage frequency, suggesting that students effectively adapted by seeking peer assistance, engaging in self-directed learning, or relying on prior experience with the LMS to navigate and overcome technical difficulties.
Ordinal logistic regression was applied to predict LMS usage frequency on the three predictors (connectivity, content, and support) as shown in Table 6.

Table 6.
Ordinal logistic regression.

Predictor	β	Std. Error	p-value
Connectivity	-0.864	0.244	0.0
Content	-0.58	0.236	0.014
Support	0.028	0.232	0.905

4.4. Connectivity

$$\beta = -0.864, \text{Std. Error} = 0.244, \text{p-value} = 0.000$$

The negative coefficient and highly significant p-value ($p < 0.001$) indicate that connectivity challenges have a strong and statistically significant negative effect on LMS usage. In practical terms, as connectivity problems increase, the likelihood of students using the LMS frequently (daily or several times a week) decreases. This result reinforces earlier findings from the chi-square analysis, confirming that limited internet access, unstable connections, or high data costs significantly reduce LMS engagement.
Content

$$\beta = -0.580, \text{Std. Error} = 0.236, \text{p-value} = 0.014$$

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The negative β and significant p-value ($p < 0.05$) show that content barriers also negatively and significantly influence LMS usage. Students who perceive the learning content as insufficient, poorly organized, or difficult to access are less likely to use the LMS regularly. This suggests that the quality and accessibility of course materials are critical in sustaining student motivation and engagement in digital learning environments.

Support

$$\beta = 0.028, \text{Std. Error} = 0.232, \text{p-value} = 0.905$$

The near-zero coefficient and high p-value ($p > 0.05$) indicate that support barriers have no statistically significant effect on LMS usage. Whether students encounter challenges related to technical help, system assistance, or troubleshooting does not significantly influence how often they use the LMS. This aligns with the chi-square findings, confirming that students can maintain LMS engagement despite limited institutional support, likely relying on peer learning or prior experience.

4.5. Reliability and Validity

The reliability and validity of the research instruments were rigorously ensured to maintain the integrity and consistency of the findings. The questionnaire was developed based on validated constructs from previous studies on LMS evaluation and adoption, notably those by Al-Fraihat et al. [9] and Kaliisa and Picard [15]. To assess internal consistency reliability, Cronbach's alpha coefficients were computed for the three barrier constructs: connectivity, content, and technical support. All values exceeded the recommended threshold of 0.70, indicating strong internal reliability and consistency among the measurement items.

Content validity was established through expert review. Three experts in e-learning, educational technology, and statistics examined the questionnaire to ensure that each item accurately reflected the constructs being measured and was appropriate for the South African HE context. Construct validity was further supported through the statistical analysis results, where the observed relationships between variables (as shown in the chi-square tests and ordinal logistic regression) aligned with theoretical expectations and empirical evidence from existing literature. These results confirm that the instrument accurately measured the intended concepts, particularly the influence of connectivity and content barriers on LMS usage. Therefore, the study's data collection and measurement processes were both reliable and valid, providing a sound empirical basis for the interpretation of findings.

5. Discussion

The study findings highlight significant and interrelated barriers affecting the effective adoption of LMS in South African HE. Connectivity emerged as the most frequently cited barrier, reported by slightly over half of the students, validating the persistent challenge of internet access and infrastructure limitations. Sims [22] and Şulă [23] concur that in modern learning, where LMS is used, connectivity is an absolute necessity because when there is no connectivity, the learning environment converts instantly to an educational lack.

The results also show a significant negative association between connectivity issues and frequency of LMS usage. Al-Barakat et al. [24] regard this as highlighting the critical role that reliable internet plays in enabling consistent engagement with digital learning platforms. This also aligns with prior studies [25-27] documenting the digital divide's impact on educational equity. This refers particularly to rural and peri-urban contexts in which infrastructure development fails to match urban areas.

Content barriers also appeared to have a substantial and statistically significant influence on LMS use. Findings demonstrate that inadequate, outdated, or poorly localized digital learning materials diminish student motivation and reduce usage frequency. According to Abusamra et al. [28], this effect resonates with pedagogical theories highlighting the value of relevant and accessible content for effective online learning. The results indicate that while students might be ready users of LMS, their

continued engagement depends greatly on the apparent quality and relevance of learning resources provided through these systems.

Interestingly, technical support, while reported as a concern by nearly half of respondents, did not significantly affect the frequency of LMS usage. This suggests that students may have developed coping mechanisms, for example, peer assistance or independent problem-solving, which shield the impact of limited formal support services. The finding contradicts Alam et al. [29] that technical backing is imperative in LMS involvement. Nevertheless, support challenges might still affect other dimensions of user experience, such as satisfaction or learning efficiency, which calls for further qualitative inquiry.

Largely, the results highlight that high-frequency LMS use is not a smooth adoption. Students facing connectivity and content challenges could be using the systems under restricted and frustrating conditions, risking weakening learning outcomes and expanding inequities. Dealing with these complex, dynamic barriers requires integrated solutions that jointly address infrastructure, pedagogical quality, and institutional capacity.

5.1. Recommendations and Implications for Practice

5.1.1. Advance Digital Infrastructure and Connectivity

Governments and HEIs should prioritize expanding affordable, reliable internet access, especially in rural and peri-urban areas. Strategic investments in broadband infrastructure and partnerships with internet service providers could reduce connectivity barriers and enable equitable LMS access across diverse student populations.

5.1.2. Improve Quality and Localization of Digital Content

Institutions should develop policies to standardize and regularly update LMS content to ensure it aligns with curricula, is culturally relevant, and engages learners effectively. Incorporating feedback from students and educators can foster more contextually appropriate resources that sustain motivation and participation.

5.1.3. Fortifying Technical Support Structures

While support barriers did not significantly affect LMS usage frequency, improving timely and accessible support remains critical to enhancing the overall user experience. Training programs for lecturers and students on LMS functionalities, troubleshooting guides, and expanding peer-support initiatives could bolster users' confidence and reduce frustration.

5.1.4. Adopt Holistic Approaches to LMS Implementation

HEIs should implement integrated strategies combining infrastructural upgrades, content development, and technical support enhancements. Such coordination ensures that improvements in one domain are not negated by persistent weaknesses in others. Institutional commitment and multi-stakeholder collaboration, including government, educators, and technology providers, are essential.

5.1.5. Policy Development and Standardization

The government should consider policies that set standards for LMS adoption and digital learning quality, making access more uniform and sustainable across all HEIs. Special attention should be given to resource-poor institutions to avoid further marginalization within the digital learning ecosystem.

6. Conclusion

This study examined the key barriers affecting the effective adoption of LMS in South African HE, focusing on connectivity, digital content, and technical support. The findings revealed that connectivity and content barriers significantly influence LMS usage, while technical support challenges, though present, do not have a statistically significant impact on student engagement. Connectivity challenges,

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particularly unreliable or unstable internet access, were identified as the most critical impediments, especially for students in rural and peri-urban regions. Similarly, gaps in the quality, relevance, and accessibility of digital content were found to diminish motivation and hinder consistent LMS interaction. Future studies may also consider examining high data costs, as they can present an additional barrier to consistent internet access.

Conversely, despite limited technical support structures, many students adapted through self-learning, peer collaboration, or leveraging prior experience with the LMS. This adaptability highlights student resilience but also underscores institutional shortcomings in providing adequate digital learning support. The overall results suggest that while LMS platforms have been widely adopted, their potential for enhancing teaching and learning is constrained by infrastructural inequalities and content deficiencies.

To achieve equitable and sustainable digital learning, higher education institutions must prioritize investment in reliable connectivity infrastructure, affordable internet access, and the development of high-quality, localized digital content to cater to all ages as well as different languages. Strengthening institutional support mechanisms through regular training of lecturers and students can further enhance system usability and pedagogical integration. Addressing these challenges is vital to bridging the digital divide and ensuring that LMS adoption in South Africa contributes meaningfully to inclusive, effective, and transformative higher education.

Institutional Review Board Statement:

This study received ethical clearance from the Research Ethics Committee of Sefako Makgatho Health Sciences University. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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References

[1] U. Alturki and A. Aldraiweesh, "Application of learning management system (LMS) during the COVID-19 pandemic: A sustainable acceptance model of the expansion technology approach," *Sustainability*, vol. 13, no. 19, p. 10991, 2021. https://doi.org/10.3390/su131910991

[2] G. Lintao, I. G. Budasi, A. T. Atmadja, and N. W. S. Mahayanti, "Learning management system adoption in adults' continuing learning: A bibliometric analysis," *Journal of Cultural Analysis and Social Change*, vol. 10, no. 2, pp. 3146–3159, 2025. https://doi.org/10.64753/jcasc.v10i2.2067

[3] R. T. Molokomme, "Bridging the digital divide: enhancing emergency remote teaching through strategies informed by senior academics at a South African university of technology," *International Journal of Research in Business and Social Science*, vol. 14, no. 4, pp. 449-458, 2025. https://doi.org/10.20525/ijrbs.v14i4.3972

[4] E. C. Makazhe, "Exploring the transformative impact of digital technologies on higher education in South Africa," *Innovative Journal of African Education*, vol. 1, pp. 1–14, 2025.

[5] T. Musekiwa, S. Lubinga, and T. Masiya, "Barriers to digital inclusion in service delivery in South Africa: A systematic review," *International Journal of Electronic Governance*, vol. 17, no. 2, pp. 138-160, 2025. https://doi.org/10.1504/ijeg.2025.148154

[6] T. Shumba, T. Munkuli, and F. Saruchera, "Remote learning access, readiness, and support in South African higher education institutions Post-COVID-19," *Progressio*, vol. 46, no. 1, pp. 1-25, 2025. https://doi.org/10.25159/2663-5895/17437

[7] S. Simelane-Mnisi and J. M. Mthimunye, "Gender differences in lecturers' competency and use of learning management systems at a university of technology in South Africa," *Education Sciences*, vol. 15, no. 12, p. 1595, 2025. https://doi.org/10.3390/educsci15121595

[8] L. Czerniewicz and C. Brown, "The habitus and technological practices of rural students: A case study," *South African Journal of Education*, vol. 34, no. 1, pp. 1–14, 2014.

[9] D. Al-Fraihat, M. Joy, R. e. Masa'deh, and J. Sinclair, "Evaluating E-learning systems success: An empirical study," *Computers in Human Behavior*, vol. 102, pp. 67-86, 2020. https://doi.org/10.1016/j.chb.2019.08.004

[10] S. Dhawan, "Online learning: A panacea in the time of COVID-19 crisis," *Journal of Educational Technology Systems*, vol. 49, no. 1, pp. 5-22, 2020. https://doi.org/10.1177/0047239520934018

[11] S. A. Ngubane-Mokiwa and S. B. Khoza, "Lecturers' experiences using Blackboard for teaching and learning," *South African Journal of Education*, vol. 36, no. 4, pp. 1–9, 2016.

[12] N. Mlitwa and J. Van Belle, "A proposed interpretive framework to research ICT impact on education in South Africa," *International Journal of Education and Development Using ICT*, vol. 7, no. 2, pp. 36–49, 2011.

[13] C. Brown and L. Czerniewicz, "Debunking the 'digital native': Beyond digital apartheid, towards digital democracy," *Journal of Computer Assisted Learning*, vol. 26, no. 5, pp. 357-369, 2010. https://doi.org/10.1111/j.1365-2729.2010.00369.x

[14] M. Jantjies, "Bridging the digital divide in South African education: Challenges and opportunities," *South African Journal of Education*, vol. 39, no. S2, pp. S1–S9, 2019.

[15] R. Kaliisa and M. Picard, "A systematic review on mobile learning in higher education: The African perspective," *Turkish Online Journal of Educational Technology*, vol. 16, no. 1, pp. 1–18, 2017.

[16] B. Nkosi, "The quality and localisation of online learning content in South African universities," *Journal of Educational Studies*, vol. 20, no. 2, pp. 45–58, 2021.

[17] D. Laurillard, *Teaching as a design science: Building pedagogical patterns for learning and technology*. London: Routledge, 2012.

[18] M. J. Koehler, P. Mishra, and W. Cain, "What is technological pedagogical content knowledge (TPACK)?," *Contemporary Issues in Technology and Teacher Education*, vol. 9, no. 1, pp. 60–70, 2019.

[19] A. Afolabi, "The role of ICT support services in higher education: Enhancing e-learning adoption and sustainability," *International Journal of Education and Development Using ICT*, vol. 13, no. 2, pp. 123–135, 2017.

[20] J. Van Dijk, *The digital divide*. Hoboken, NJ, USA: John Wiley & Sons, 2020.

[21] M. Kgaphola and M. Langa, "Socio-economic inequalities and digital inclusion in South Africa: A higher education perspective," *African Journal of Science, Technology, Innovation and Development*, vol. 14, no. 4, pp. 981–992, 2022.

[22] D. A. Sims, "Online education and learning management system usage in a South African Economic and management faculty during COVID-19," *E-Learning and Digital Media*, vol. 22, no. 5, pp. 465-483, 2025. https://doi.org/10.1177/20427530241239429

[23] D. M. Şulă, "Accessibility, connectivity and community in Romanian pre-university education digitisation," *Management & Marketing Journal*, vol. 23, no. 1, pp. 197–208, 2025.

[24] A. A. Al-Barakat, S. B. Alotaibi, J. S. Alrashood, R. M. AlAli, K. M. Al-Saud, and N. A. H. Ibrahim, "Empowering science teachers: Leveraging communication skills to enhance primary science learning through digital platforms," *African Journal of Library, Archives and Information Science*, vol. 35, no. 1, 2025. https://doi.org/10.4314/ajlais.e35105

[25] S. S. H. Syed Hamid and R. Sueb, "Bridging the digital divide: a conceptual framework on teachers' digital competency and students' self-concept in a rural region," *GADING (Online) Journal for the Social Sciences*, vol. 28, no. 2, pp. 179-189, 2025. https://doi.org/10.24191/gading.v28i2.661

[26] A. S. Ojong, "Unmasking socioeconomic barriers to equitable access to digital tools," *International Journal of Science and Research Archive*, vol. 15, no. 1, pp. 1285–1300, 2025. https://doi.org/10.30574/ijsra.2025.15.1.1143

[27] X. Wang, L. Liu, and H. Zhang, "Subjective socioeconomic status, perceived support and self-efficacy: A model of e-learning engagement," *Journal of Educational Psychology*, vol. 115, no. 1, pp. 34–49, 2023.

[28] A. Abusamra, K. Muhtaseb, and R. Awawdeh, "How should E-learning be conceptualized in the context of higher education in MENA region?," *Social Sciences & Humanities Open*, vol. 12, p. 101808, 2025. https://doi.org/10.1016/j.ssaho.2025.101808

[29] S. Alam *et al.*, "Overview of the vital role of vitamin D: Functions, deficiency syndromes, and impact throughout life," *Current Pharmaceutical Research*, vol. 1, no. 2, pp. 163-174, 2025. https://doi.org/10.63785/cpr.2025.1.1.125136