



Evaluating Online Learning Management Systems Effectiveness for Student Learning Outcomes in K-12 Education

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Abstract: This study aims to examine the effectiveness of Learning Management Systems (LMSs) in relation to student learning outcomes by investigating the relationships among LMS usage, academic achievement, learning engagement, educational disparities, and teacher professional support in K–12 education. A quantitative cross-sectional correlational design was employed, involving 240 participants, comprising 200 students and 40 teachers from public and private schools in Java, Indonesia, who were selected through stratified random sampling. Data were collected using validated five-point Likert-scale questionnaires measuring LMS usage, learning engagement, educational disparities, and teacher professional support, while students' academic achievement data were obtained from official school assessment records. The data were analyzed using descriptive statistics, Pearson correlation analysis, and multiple linear regression. The findings revealed that LMS usage was positively associated with academic achievement ($r = .42, p < .01$), learning engagement ($r = .47, p < .01$), and teacher professional support ($r = .39, p < .01$), and negatively associated with educational disparities ($r = -.38, p < .01$). Multiple regression analysis identified LMS usage as the strongest predictor across the regression models, with the largest standardized coefficients for academic achievement ($\beta = .28, p < .001$), learning engagement ($\beta = .31, p < .001$), and educational disparities ($\beta = -.24, p < .001$). Teacher professional support also made significant contributions to academic achievement and learning engagement and was associated with reduced educational disparities. The findings suggest that effective LMS implementation, supported by sustained teacher professional development and equitable access to digital learning resources, may enhance student learning outcomes and contribute to sustainable digital transformation in K–12 education.

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Introduction

The rapid advancement of digital technologies has transformed educational systems worldwide, making Online Learning Management Systems (LMS) an essential component of teaching and learning in K–12 education. The increasing adoption of digital learning environments, accelerated by technological innovation and the growing demand for flexible education, has encouraged schools to integrate LMS platforms to support instructional delivery, learning resource management, communication, assessment, and student progress monitoring. These platforms provide opportunities for teachers to implement more interactive, learner centered, and data-informed instructional practices while enabling students to access educational resources anytime and anywhere (Algerafi et al., 2023; Jacob & Centofanti, 2024; Mahafdah et al., 2024). Furthermore, LMS facilitate collaborative learning, personalized instruction, and continuous feedback, which are considered fundamental



elements for improving student learning outcomes in contemporary education. However, the educational benefits of LMS depend not only on technological availability but also on effective pedagogical implementation, teacher readiness, institutional support, and students' active participation. Therefore, evaluating the effectiveness of Online Learning Management Systems has become increasingly important for enhancing student learning outcomes and supporting sustainable digital transformation in K–12 education(Syifa, 2026).

Recent studies have consistently demonstrated that Online Learning Management Systems (LMS) play a significant role in improving student learning outcomes by enhancing the quality, accessibility, and effectiveness of teaching and learning processes in K–12 education. Through centralized digital platforms, LMS enable teachers to organize instructional materials, deliver multimedia content, administer assessments, and provide timely feedback that supports students' cognitive development and academic achievement(Ahmed, 2024; Li & Ni, 2024; Xu et al., 2023). Furthermore, LMS facilitate personalized learning by allowing students to access learning resources at their own pace, revisit instructional materials, and engage in self-directed learning activities that accommodate diverse learning styles and abilities. Interactive features such as discussion forums, collaborative assignments, virtual classrooms, quizzes, and learning analytics further encourage active participation, knowledge construction, and meaningful teacher student interactions, thereby increasing learning engagement and motivation. Modern LMS also provide real-time data that enable educators to monitor students' progress, identify learning difficulties, and implement targeted instructional interventions to improve academic performance(Gkintoni et al., 2025; Sun & Song, 2026). These capabilities closely align with the principles of smart education, emphasizing evidence-based decision-making, continuous assessment, personalized instruction, and digital competence development. Consequently, governments, educational institutions, and policymakers have increasingly invested in LMS implementation as a strategic initiative to improve educational quality, promote equitable learning opportunities, strengthen digital resilience, and enhance student learning outcomes in response to the rapidly evolving educational landscape(Hassan, 2023).

Despite the increasing integration of Online Learning Management Systems (LMS) into K–12 education, evidence regarding their effectiveness in improving student learning outcomes remains inconclusive across different educational settings. Previous studies have generally examined specific dimensions of technology-enhanced learning separately, leaving limited evidence on how technological, pedagogical, and institutional factors jointly predict learning outcomes. For example, Liang (2024) primarily examined the effectiveness of virtual laboratories in engineering education through a meta-analytic approach, which provides valuable evidence on technology-supported learning but does not directly address LMS implementation in K–12 settings or simultaneously examine academic achievement, learning engagement, educational disparities, and teacher professional support. Similarly, Yang (2025) highlighted issues related to disparities in educational technology access and implementation; however, the study did not integrate these disparities with LMS usage and teacher professional support within a single predictive model of student learning outcomes. These limitations indicate a need for empirical research that simultaneously examines technological, pedagogical, and institutional dimensions of LMS effectiveness, particularly in K–12 contexts where differences in digital infrastructure, internet connectivity, device availability, teachers' digital competencies, and institutional support may influence students' opportunities to benefit from digital learning environments (Nabiem et al., 2024; Yang, 2025). To address this gap, the present study proposes a unified analytical model that examines direct predictive



relationships rather than mediating or moderating effects. Specifically, multiple regression analysis is used to determine the direct predictive contributions of LMS usage, learning engagement, educational gap, and teacher professional support to student learning outcomes, while also identifying the most dominant predictor within the regression models. This integrated approach constitutes the unique contribution of the study by simultaneously evaluating key technological, pedagogical, and institutional predictors of LMS effectiveness within K–12 education, thereby providing empirical evidence to support more effective, equitable, and sustainable digital learning implementation.

Addressing these research gaps, the present study proposes a comprehensive evaluation of Online Learning Management Systems (LMS) effectiveness by examining the relationships between LMS implementation and student learning outcomes within K–12 education. Unlike previous studies that have primarily investigated academic achievement, learning engagement, or technology adoption as separate constructs, this research integrates multiple educational dimensions into a unified analytical framework to provide a more holistic understanding of LMS effectiveness. The study was conducted in public and private K–12 schools across the Java region of Indonesia, representing urban, suburban, and rural educational settings and covering elementary, junior high, and senior high school levels. This geographical and social context is particularly relevant because the participating schools represent diverse educational environments in terms of school type, geographical setting, and access to digital learning opportunities, allowing the study to examine LMS effectiveness across heterogeneous K–12 contexts. Specifically, the study examines the direct predictive relationships among LMS usage, student academic performance, learning engagement, educational equity, and teacher professional support. By incorporating pedagogical, technological, and institutional perspectives, this research offers a broader explanation of the factors associated with successful LMS implementation and sustainable educational improvement. Furthermore, the study contributes to the existing literature by determining the relative predictive contributions of LMS usage, learning engagement, educational disparities, and teacher professional support to student learning outcomes. The findings are expected to provide empirical evidence that informs educational policies, supports school leaders and teachers in optimizing LMS implementation, and guides strategic decision-making for digital education. Therefore, this study aims to evaluate the effectiveness of Online Learning Management Systems in improving student learning outcomes while promoting educational quality, digital inclusion, and sustainable technology-enhanced learning practices across K–12 education.

Research Method

This study employed a quantitative cross-sectional correlational research design to evaluate the effectiveness of Online Learning Management Systems (LMS) in improving student learning outcomes within K–12 education. The research was guided by a conceptual framework integrating LMS usage, student academic performance, learning engagement, educational disparities, and teacher professional support (Alshammery & Alhalafawy, 2023; Damašević, 2024). The cross-sectional design enabled data collection at a single point in time without manipulating the learning environment. Quantitative data were collected from K–12 students and teachers who had actively used LMS for instructional purposes. The questionnaire used in this study was developed by the researchers based on relevant theoretical constructs and indicators identified in the literature rather than directly adopting a single established instrument. The questionnaire consisted of five-point Likert-scale items



measuring LMS usage, learning engagement, perceived educational disparities, and teacher professional support. The initial items were subjected to content validity and construct validity assessments, followed by reliability testing, to ensure that the instrument adequately represented the intended constructs and demonstrated acceptable measurement consistency. Students' academic performance was obtained separately from official school assessment records to provide an objective measure of learning outcomes and minimize self-report bias. The correlational approach was subsequently used to examine the strength and direction of the relationships among the research variables, while multiple linear regression was employed to determine their direct predictive contributions to student learning outcomes.

The participants in this study consisted of K–12 students and teachers from public and private schools in the Java region of Indonesia who had actively used an Online Learning Management System (LMS) for at least one academic semester. To ensure adequate representation across diverse educational contexts, stratified random sampling was employed based on geographical location (urban, suburban, and rural areas), school type (public and private), and educational level (elementary, junior high, and senior high school). A total of 240 valid participants were included in the study, comprising 200 students and 40 teachers. The adequacy of the sample size was determined through an a priori power analysis using G*Power for multiple linear regression (Faul et al., 2009), indicating that the final sample exceeded the minimum sample size required for the planned statistical analysis. The study examined five principal variables: LMS usage, student academic performance, learning engagement, educational disparities, and teacher professional support. Data for four questionnaire-based variables were collected using a five-point Likert scale. The LMS usage construct consisted of [XX] items covering [XX] indicators; learning engagement consisted of [XX] items covering [XX] indicators; educational disparities consisted of [XX] items covering [XX] indicators; and teacher professional support consisted of [XX] items covering [XX] indicators. Student academic performance was not measured through questionnaire items but was obtained from official school examination records to provide an objective measure of learning outcomes. Prior to data collection, the questionnaire underwent content validity, construct validity, and reliability testing to ensure measurement validity and internal consistency. The collected data were subsequently analyzed using descriptive statistics, Pearson correlation analysis, and multiple linear regression to examine the relationships among the variables and determine their direct predictive contributions to student learning outcomes.

Data were analyzed using a series of quantitative statistical procedures to evaluate the effectiveness of Online Learning Management Systems (LMS) in relation to student learning outcomes within K–12 education. Prior to hypothesis testing, the data were screened for incomplete responses, coding errors, outliers, and missing values to ensure data quality and consistency. Descriptive statistics were first used to summarize participants' demographic characteristics and the distributions of LMS usage, student academic performance, learning engagement, educational disparities, and teacher professional support using means, standard deviations, frequencies, and percentages. Pearson correlation analysis was subsequently conducted to examine the strength and direction of the bivariate relationships among the research variables. Multiple linear regression analysis was then performed to determine the direct predictive contributions of LMS usage, learning engagement, educational disparities, and teacher professional support to the specified student learning outcomes and to identify the most dominant predictor based on the magnitude of the standardized regression coefficients (β). Statistical significance was evaluated at an alpha level of .05, consistent with



conventional statistical criteria for hypothesis testing (Field, 2018; Hair et al., 2019). All statistical analyses were conducted using IBM SPSS Statistics version 28.0. This analytical approach enabled the study to assess the relationships among the variables and their relative predictive contributions to student learning outcomes within the K–12 LMS context.

Results and Discussion

Result

The results of this study demonstrate a consistent pattern regarding the effectiveness of Online Learning Management Systems (LMS) in improving student learning outcomes within K–12 education. Descriptive analysis indicates that LMS usage ($M = 3.42$, $SD = 0.78$), learning engagement ($M = 3.37$, $SD = 0.81$), and teacher professional support ($M = 3.29$, $SD = 0.83$) were reported at moderate to relatively high levels, while educational disparity showed a comparatively lower mean score ($M = 2.64$, $SD = 0.75$), suggesting moderate inequality in access to digital learning resources. Correlation analysis further reveals that LMS usage was positively associated with academic achievement ($r = .42$, $p < .01$), learning engagement ($r = .47$, $p < .01$), and teacher professional support ($r = .39$, $p < .01$), whereas it demonstrated a significant negative relationship with educational disparity ($r = -.38$, $p < .01$). Multiple regression analysis confirmed these findings by showing that LMS usage significantly predicted higher academic achievement ($\beta = .28$, $p < .001$) and stronger learning engagement ($\beta = .31$, $p < .001$), while simultaneously contributing to a reduction in educational disparities ($\beta = -.24$, $p < .001$). Teacher professional support also emerged as a significant positive predictor of both academic achievement and learning engagement, indicating that effective professional development and technical assistance strengthen the educational impact of LMS implementation. Collectively, these findings provide robust empirical evidence that effective LMS integration enhances student learning outcomes while promoting more equitable and sustainable digital learning environments in K–12 education.

Table 1. Pearson Correlation Matrix of LMS Usage, Academic Achievement, Learning

variable	LMS make use of	academic achievement	Learning Engagement	educational gap	Teacher Support
LMS Usage	1	.42**	.47**	-.38**	.39**
academic achievement	.42**	1	.35**	-.29**	.31**
Learning Engagement	.47**	.35**	1	-.32**	.44**
educational gap	-.38**	-.29**	-.32**	1	-.35**
Teacher Support	.39**	.31**	.44**	-.35**	1

Table 1 demonstrates a consistent pattern of relationships among the study variables. Greater LMS usage is associated with better academic achievement, stronger learning engagement, and greater teacher professional support, while being associated with lower educational disparities. Among these relationships, the association between LMS usage and learning engagement is particularly prominent, suggesting that greater utilization of digital learning platforms is closely related to students' active participation in learning activities. Teacher professional support is also closely associated with learning engagement, indicating that teachers' guidance and assistance may play an important role in facilitating students' participation in LMS-supported learning. Conversely, educational disparities show negative relationships with the other educational outcomes, suggesting that unequal access to digital learning resources may constrain the potential benefits of LMS implementation. Overall, the correlation pattern supports the proposed framework and provides a basis for examining the relative predictive contributions of these variables through multiple regression analysis.



Table 2. Multiple Linear Regression Analysis Predicting Student Academic Achievement

predictive variable	β	t	p
LMS make use of	0.28	4.93	<0.001
Learning Engagement	0.22	3.81	<0.001
educational gap	-0.16	-2.84	0.005
Teacher Support	0.19	3.27	0.001

Table 2 indicates that academic achievement is associated with multiple dimensions of the digital learning environment. LMS usage emerges as the most dominant predictor of academic achievement, indicating that students' utilization of LMS makes the largest unique contribution to explaining differences in academic performance among the predictors included in the model. Learning engagement and teacher professional support also contribute positively, suggesting that effective LMS implementation is strengthened when students actively participate in learning and receive adequate instructional and technical support from teachers. In contrast, educational disparities are associated with poorer academic outcomes, indicating that unequal access to digital resources and learning opportunities may constrain students' ability to benefit from LMS-supported instruction. Taken together, the findings suggest that academic achievement within LMS-supported learning environments is associated with the combined contributions of technology use, student engagement, teacher support, and equitable access to learning resources.

Table 3. Multiple Linear Regression Analysis Predicting Student Learning

predictive variable	β	t	p
LMS make use of	0.31	5.58	<0.001
Teacher Support	0.27	4.81	<0.001
The gap among teachers	-0.18	-3.16	0.002

Table 3 shows that student learning engagement is primarily associated with LMS usage and teacher professional support. LMS usage emerges as the most dominant predictor, suggesting that more extensive use of LMS is particularly important for explaining differences in students' participation and involvement in digital learning activities. Teacher professional support also makes a substantial positive contribution, indicating that the educational value of LMS is closely connected to the guidance, technical assistance, and instructional support provided by teachers. Educational disparities, however, are negatively associated with engagement, suggesting that unequal access to digital resources and learning opportunities may restrict students' ability to participate fully in LMS-supported learning. These findings indicate that student engagement is associated with both the availability and use of digital learning technologies and the pedagogical support surrounding their implementation.

Table 4. Multiple Linear Regression Analysis Predicting Educational Gap

predictive variable	β	t	p
LMS make use of	-0.24	-3.72	<0.001
Teacher Support	-0.2	-3.11	0.002

Table 4 indicates that both LMS usage and teacher professional support are associated with lower educational disparities. LMS usage emerges as the stronger predictor in the model, suggesting that greater utilization of LMS is particularly relevant to differences in students' access to digital learning opportunities. Teacher professional support also contributes meaningfully, indicating that professional guidance, technical assistance, and instructional



support may help facilitate more equitable participation in technology-supported learning. The overall pattern suggests that reducing educational disparities requires attention to both students' opportunities to use digital learning platforms and the institutional and pedagogical support provided by teachers. Thus, equitable LMS implementation appears to depend on the integration of technological access with adequate professional support.

The findings of this study provide strong empirical support for the proposed conceptual framework by confirming that Online Learning Management System (LMS) usage, learning engagement, educational gap, and teacher professional support collectively influence student learning outcomes in K–12 education. Correlation analysis revealed that LMS usage was positively associated with academic achievement ($r = .42$), learning engagement ($r = .47$), and teacher professional support ($r = .39$), while demonstrating a significant negative relationship with educational gap ($r = -.38$), indicating that increased LMS utilization contributes to reducing educational inequalities. Multiple regression analysis further confirmed that LMS usage was the strongest predictor of academic achievement ($\beta = .28$, $p < .001$) and learning engagement ($\beta = .31$, $p < .001$), whereas educational gap negatively predicted both academic achievement ($\beta = -.16$, $p = .005$) and learning engagement ($\beta = -.18$, $p = .002$). In addition, teacher professional support significantly enhanced academic achievement ($\beta = .19$, $p = .001$), learning engagement ($\beta = .27$, $p < .001$), and reduced educational disparities ($\beta = -.20$, $p = .002$), highlighting its critical role in maximizing LMS effectiveness. These findings are consistent with the principles of Constructivist Learning Theory, which emphasizes active participation and collaborative knowledge construction through digital learning environments, and the Technology Acceptance Model, which suggests that effective technology adoption depends on perceived usefulness and institutional support. Collectively, the results indicate that LMS effectiveness extends beyond technology implementation alone and is strengthened by active student engagement, equitable access to digital resources, and sustained professional support for teachers, thereby contributing to improved student learning outcomes and supporting sustainable digital transformation in K–12 education.

Discussion

The findings provide empirical support for the Technology Acceptance Model (TAM), Self-Determination Theory (SDT), and Constructivist Theory by demonstrating that LMS effectiveness in K–12 education is associated with the combined roles of technology use, student engagement, teacher professional support, and equitable learning opportunities. From the TAM perspective, LMS usage emerged as the strongest predictor of academic achievement ($\beta = .28$) and learning engagement ($\beta = .31$), suggesting that meaningful and sustained use of digital learning platforms is closely associated with students' educational outcomes. This extends TAM beyond technology acceptance by demonstrating the predictive relevance of actual LMS usage for learning outcomes. From the SDT perspective, the positive contribution of teacher professional support to academic achievement ($\beta = .19$) and learning engagement ($\beta = .27$) indicates that instructional guidance, feedback, and technical assistance may strengthen students' competence, autonomy, and connectedness within digital learning environments. These findings also support Constructivist Theory, as LMS environments can facilitate active participation, interaction, feedback, collaboration, and access to learning resources that enable students to construct knowledge through meaningful learning activities.

The findings are broadly consistent with recent international studies published between 2023 and 2026 that have reported positive relationships among digital technology utilization, teacher support, student engagement, and learning outcomes (Golden et al., 2023;



Jacob & Centofanti, 2024; Vargas-Madriz et al., 2024; Fan, 2024; Yang, 2024; Gkintoni et al., 2025; L  tourney et al., 2025; Sun & Song, 2026). In particular, recent studies indicate that meaningful technology use can enhance access to instructional resources, interaction, feedback, and active participation, while teacher support can facilitate motivation and engagement in technology-supported learning environments. However, the present findings differ from Alrashidi and Alshammari (2025) and Li (2025), who reported that teacher support did not exert a significant direct effect on online learning engagement and instead operated through psychological mechanisms such as self-efficacy, academic emotions, enjoyment, or motivation. This difference may reflect variations in educational level, learner autonomy, technological context, measurement, and model specification, particularly because K–12 students may require more direct instructional and technological guidance than university students. Furthermore, the negative predictive relationships of educational disparities with academic achievement ($\beta = -.16$) and learning engagement ($\beta = -.18$), together with the contribution of teacher professional support to reducing educational disparities ($\beta = -.20$), reinforce recent evidence that unequal access to devices, internet connectivity, digital resources, and technological competencies can restrict students' opportunities to benefit from digital education.

From a practical and policy perspective, the relative magnitude of these standardized coefficients indicates several priorities without implying causal effects. Given the comparatively strong predictive contribution of LMS usage, K–12 policymakers and school principals should promote meaningful LMS utilization through interactive learning activities, formative assessment, timely digital feedback, collaborative learning, and systematic monitoring of student participation rather than focusing primarily on platform provision. The contribution of teacher professional support indicates the need for continuous professional development that integrates digital competence with pedagogical skills, supported by peer mentoring, technical assistance, and the use of learning analytics. Meanwhile, the negative contribution of educational disparities highlights the importance of device-loan programs, affordable or subsidized internet access, school-based connectivity, digital literacy initiatives, and targeted assistance for students experiencing technological barriers. Collectively, these findings indicate that effective LMS implementation requires coordinated technological, pedagogical, and institutional support in which meaningful LMS use, sustained teacher professional development, and equitable digital access operate together to strengthen learning outcomes and support sustainable digital transformation in K–12 education.

Conclusion

This study provides empirical evidence that LMS usage, learning engagement, educational disparities, and teacher professional support are significant predictors of learning outcomes in K–12 education. LMS usage emerged as the most prominent predictor across the regression models, showing the strongest positive predictive contribution to academic achievement ($\beta = .28$, $p < .001$) and learning engagement ($\beta = .31$, $p < .001$), while also being associated with lower educational disparities ($\beta = -.24$, $p < .001$). Academic achievement was additionally positively predicted by learning engagement ($\beta = .22$, $p < .001$) and teacher professional support ($\beta = .19$, $p = .001$), whereas educational disparities showed a negative predictive relationship with achievement ($\beta = -.16$, $p = .005$). Teacher professional support also made a substantial contribution to learning engagement ($\beta = .27$, $p < .001$) and was associated with lower educational disparities ($\beta = -.20$, $p = .002$). These findings demonstrate that the effectiveness of LMS-supported education is associated with the combined



contributions of meaningful technology use, active student engagement, teacher professional support, and equitable digital learning opportunities. The relative magnitude of the standardized regression coefficients highlights LMS usage as the strongest predictor within the examined models, while the significant contributions of teacher support and educational disparities indicate that technology implementation should be accompanied by sustained pedagogical support and equitable access to digital learning resources. Accordingly, K–12 schools and policymakers should prioritize meaningful LMS utilization, continuous teacher professional development, and targeted strategies to reduce digital inequalities. Because the study employed a cross-sectional correlational design, these findings should be interpreted as predictive associations rather than causal effects; future longitudinal and experimental studies are recommended to examine the causal mechanisms underlying these relationships.

Recommendation

Based on the findings of this study, K–12 schools should strengthen the effective and equitable implementation of Learning Management Systems (LMS) by focusing on meaningful technology use, student engagement, teacher professional support, and equal access to digital learning opportunities. School teachers are encouraged to integrate LMS platforms into daily instructional practices through interactive learning activities, formative assessments, timely feedback, collaborative tasks, and accessible digital learning resources that promote active student participation. School principals should provide continuous professional development and technical assistance to improve teachers' digital pedagogical competencies, while also monitoring LMS utilization and student participation to identify learners who require additional academic or technological support. At the policy level, education authorities and policymakers should prioritize equitable digital infrastructure by improving internet connectivity, access to appropriate digital devices, technical support, and digital literacy programs, particularly for schools and students experiencing technological barriers. Policies should also establish clear standards for LMS implementation and provide sustained professional development programs that enable teachers to use digital platforms effectively for pedagogical purposes. Given that LMS usage emerged as the most prominent predictor of academic achievement and learning engagement, while teacher professional support and educational disparities also made significant contributions to the examined outcomes, future K–12 digital education initiatives should integrate technological access, pedagogical quality, teacher capacity development, and educational equity. Future research is recommended to employ longitudinal or experimental designs and include broader geographical settings beyond the Java region to examine whether these predictive relationships remain consistent across different K–12 educational contexts in Indonesia.

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