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User Satisfaction-Driven Requirement Mapping for Learning Management Systems in Higher Education: A PLS-SEM Approach

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Abstract

Background: The widespread adoption of Learning Management Systems (LMSs) in higher education has intensified the need for systematic, user-centered system evaluation. Despite the growing utilization of LMSs, few studies have simultaneously integrated psychological, cognitive, and technical factors into a unified requirement-mapping framework.
Objective: This study investigates the determinants of LMS user satisfaction in higher education using six constructs: Expectation of Quality, Software Adequacy, Feature Interactivity, Cognitive Presence, Computer Self-Efficacy, and Time Management.
Methods: A quantitative survey was employed to collect data from 132 students and 83 lecturers. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS, with 5,000-subsample bootstrapping.
Results: Expectation of Quality ($\beta = 0.312$), Feature Interactivity ($\beta = 0.284$), Software Adequacy ($\beta = 0.347$), and Time Management ($\beta = 0.198$) showed significant positive effects on user satisfaction. Cognitive Presence ($\beta = -0.164$) and Computer Self-Efficacy ($\beta = -0.128$) exhibited significant negative relationships with user satisfaction. A requirement-mapping model was developed using the *MoSCoW* prioritization approach.
Conclusion: LMS user satisfaction is primarily driven by system quality, feature interactivity, and time management. The integrated technical–psychological model offers a practical framework for user-centered LMS design and development prioritization.

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INTRODUCTION

Learning Management Systems (LMSs) have become an essential infrastructure in higher education, enabling asynchronous instruction, content delivery, and learner–instructor interaction. However, the challenges associated with implementing LMSs in higher education environments are substantial, with many lecturers still not fully utilizing available features and students reporting uneven engagement levels across platforms. This only reinforces the need to thoroughly assess the LMSs being used. So far, there is no measurement instrument that can systematically identify the factors influencing LMS user satisfaction through contextualized measurements (Turnbull et al., 2021). Instead of regarding an LMS merely as an administrative tool, it should be considered a learning ecosystem that contributes to users' learning objectives (Drach et al., 2024). Hence, a needs-mapping approach based on aspects of user satisfaction evaluation results is fundamental for outlining inconsistencies between the expected functionality of LMSs and their actual functionality, while also leading to more specific needs mapping regarding the developments that should occur within a system.

Research reveals that inappropriate LMSs that are not designed based on actual needs assessments lead to resistance to adoption, reduced participation, and lower academic achievement (Dhiman et al., 2022). Despite the widespread adoption of LMSs in higher education, existing studies primarily focus on technical system quality, while limited research simultaneously integrates psychological, cognitive, and user-experience factors into a requirements-mapping framework. Furthermore, previous research has not directly integrated user satisfaction with system requirements mapping to produce actionable development roadmaps. This study addresses this gap by developing an evidence-based model that links multidimensional satisfaction predictors to LMS feature prioritization using the MoSCoW approach.

Dhiman (2022) confirmed that platform service quality, interactivity, and the added value of learning materials enhance expectation confirmation and perceptions of usefulness and, therefore, promote student satisfaction and continuance intention. Additionally, high cognitive load reduces perceptions of usefulness and expectation confirmation, which subsequently leads to lower satisfaction. Other research draws attention to the role of confirmed instructor presence, as well as cognitive and social interactions, in shaping students' intentions to continue engaging with online learning.

Thus, to maximize the success of online learning, institutions should ensure that LMS characteristics and learning materials fulfill or even exceed students' expectations by offering interactive and distraction-free learning experiences (Nawanda & Tambotoh, 2024). In practice, however, many higher education institutions install LMSs after a typical, noncomprehensive mapping process that selects functionalities that fail to solve users' actual problems. In addition, this needs-mapping process often focuses on technical requirements without directly incorporating the psychological and pedagogical aspects that shape system usage and user satisfaction.

To mitigate these problems, an analysis of user satisfaction based on theoretical constructs (specifically Expectation of Quality, Software Adequacy, Feature Interactivity, Cognitive Presence, Computer Self-Efficacy, and Time Management) is necessary to guide LMS improvement strategies. The novelty of this research lies in three aspects: (1) the simultaneous integration of six theoretical constructs (spanning technical, cognitive, and psychological dimensions) into a single LMS user satisfaction model; (2) the direct linkage between empirical PLS-SEM findings and actionable system requirements mapping using the MoSCoW prioritization method; and (3) the application of this integrated framework specifically within the Indonesian higher education context, where LMS adoption is growing but systematic evaluation tools remain underdeveloped.

Literature Review

A theoretical review is a form of systematic literature review that focuses on gathering, reviewing, and integrating literature related to a specific scientific discipline (Hulland, 2020). This type of literature review serves to develop or extend the theoretical concepts within a research area (Adom et al., 2018). For example, a theoretical review aimed at gaining insight into theories relevant to research on student satisfaction with LMS use could include technology acceptance theories, information systems success models, and learning motivation theories (M. Cheng & Yuen, 2018). This enables researchers to identify the main concepts and the relationships among those concepts that will serve as the basis of the research.

This study applies a literature review method by searching for relevant scientific journal articles through the Scopus, ScienceDirect, and Google Scholar databases using a structured approach. The search keywords included "LMS satisfaction," "literacy-mediated discourses," and "e-learning evaluation." All articles obtained were published within the last ten years and were directly related to measuring user satisfaction with LMSs, from both technical and non-technical perspectives. The conceptual model for user satisfaction measurement and the theories underlying variable selection are discussed in the literature review section.

Based on the theoretical review, this study contributes to the development of a solid theoretical framework. This framework represents a strong theoretical foundation for hypothesis generation, variable selection, and methodological design. Therefore, a theoretical review not only consolidates existing knowledge but also opens opportunities to develop or modify existing theories for more contextual scenarios concerning student satisfaction with LMS platforms in the diversified digital education era (Adom et al., 2018). This study represents one of the first attempts of its kind within the specified geographic locality in Malaysia.

Review Results

Unlike the findings of the present literature review, most previous studies have focused on the impact of system quality and usability on LMS user satisfaction (Al-Fraihat et al., 2020). Another group of studies adapted models such as the Technology Acceptance Model (TAM), Expectation Confirmation Theory (ECT), and ISO/IEC 25010 to measure LMS quality. Alternatively, Lubis (2022) introduced an activity-based Literacy-Mediated Discourses (LM-D) practice-oriented perspective on digital literacy. This approach emerged in response to the growing recognition that LMS users perceive sociocultural dimensions and cognitive experiences that have been underrepresented in technical models.

Moreover, frameworks such as the Community of Inquiry (CoI) model relate to the interaction and cognitive presence dimensions of the online learning process, while Self-Regulated Learning Theory and Social Cognitive Theory describe psychological aspects and individual learning strategies. The current study combines these approaches to offer a more holistic and contextualized LMS satisfaction measurement model.

Needs Mapping Theory and Model

System requirements mapping is a systematic approach to discovering, analyzing, documenting, and validating the requirements of clients and stakeholders in the context of designing or assessing systems that depend on information technology, such as LMSs used for online learning. In the software engineering domain, this process is referred to as requirements engineering, which includes four main stages: elicitation, analysis, specification, and validation.

In the context of an LMS, system requirements relate not only to technical functions but also to user-centered aspects such as ease of use, interactive support, and learning experience. Therefore, student satisfaction factors—such as interactive features, digital literacy, and lecturer support—can be translated into concrete and measurable system requirements.

System requirements are generally classified into two categories: (1) Functional Requirements, which describe the main services and functions that the system must perform; and (2) Non-Functional Requirements, which relate to quality attributes such as performance, security, usability, and reliability (Li & Nong, 2022). Advances in machine learning have further enabled the automated classification of non-functional requirements, thereby improving the efficiency of requirements engineering processes in complex software projects (Li & Nong, 2022).

MoSCoW Model in Prioritization of Needs

The MoSCoW method is a commonly used technique for grouping and prioritizing requirements in system development projects (Miranda, 2022). MoSCoW is easy to use and serves as a useful starting point for feature negotiation and prioritization, including within LMSs (Sagrado & Águila, 2020). The acronym MoSCoW stands for: (1) Must Have: requirements that must be present for the system to function properly; (2) Should Have: important but noncritical needs that can be postponed without affecting the main function; (3) Could Have: desirable but optional needs, depending on resources or time constraints; and (4) Won't Have (for now): needs that will not be addressed in the near future.

In the context of user satisfaction-based LMS needs mapping, the MoSCoW method is highly useful for prioritizing needs based on their importance from the student perspective. For example, an assignment notification feature or an active discussion forum could be categorized as a "Must Have" feature, whereas the ability to customize the LMS display theme might be categorized as a "Could Have" feature. MoSCoW was selected in this study because it is flexible, easy to understand, and supports decision-making based on user perception data. Grouping needs according to these priorities is highly beneficial in the process of redesigning or improving LMS features in higher education.

LMS System and Quality Evaluation Standards

To ensure the quality of software systems such as LMSs, the international standard ISO/IEC 25010:2011 is widely used (Acharya & Sinha, 2013). This standard defines a product quality model covering eight main characteristics that guide systematic software evaluation and benchmarking.

ISO/IEC 25010 has become a widely recognized reference for assessing LMSs based on eight key software characteristics: functional suitability, performance efficiency, usability, reliability, security, maintainability, compatibility, and portability (Coulianos et al., 2023). Recent studies have shown that implementing ISO/IEC 25010 in LMS evaluation helps educational institutions identify system strengths and weaknesses. For example, strengths are often found in functionality and security, whereas weaknesses are commonly identified in performance efficiency and usability (Fiqri et al., 2023).

Evaluations are typically conducted through surveys, interviews, and technical testing involving end users such as students, lecturers, and IT experts (Burgos, 2021). The results of these evaluations provide concrete recommendations for improvement, such as enhancing user experience and system efficiency (Huda et al., 2023). In addition, the ISO/IEC 25010-based evaluation model can be combined with other approaches, such as ITIL 4 or design thinking, to enrich analysis and solution development (Yonia et al., 2024).

Research also highlights the importance of usability attributes, including effectiveness, efficiency, error protection, accessibility, operability, learnability, and user satisfaction (Al-Maani & Bani-Salameh, 2017). Overall, the use of ISO/IEC 25010 in LMS evaluation has been shown to improve system quality, provide objective guidance for the development and selection of digital learning platforms, and support the achievement of a better learning experience.

Research Issues and Trends

Research on user satisfaction with LMSs continues to grow alongside the increasing demand for reliable and adaptive online learning systems. A significant issue identified in the literature is the need to address both technical and user experience aspects in data collection and in measures used to predict LMS success. Some studies place greater emphasis on system performance than on the affective, cognitive, and social dimensions of the learning experience. This creates a gap in understanding how users engage with LMSs and how such engagement influences their satisfaction.

Conversely, recent trends indicate a shift from purely quantitative evaluation toward approaches emphasizing discourses and practices of digital literacy. Strategies such as Literacy-Mediated Discourses (LM-D), which address the cultural and narrative dimensions of LMS use, are more closely aligned with the contextual realities of teaching and learning in the digital age. There is also growing emphasis on interactivity, system personalization, and learner self-management of study time in both hybrid and fully online learning environments.

This paper responds to these challenges through a multidimensional approach that incorporates theory-driven constructs bridging the technical and educational dimensions of LMSs. The rapid evolution of artificial intelligence, particularly the demonstrated capacity of large language models to dissociate linguistic processing from genuine conceptual reasoning Mahowald (2024), further underscores the importance of designing LMS features that support authentic cognitive engagement rather than superficial information retrieval. Against this backdrop, user satisfaction evaluation must incorporate both technical quality and cognitive support dimensions.

Research Motivation

LMSs play a pivotal role as integral platforms supporting online learning, which has become a cornerstone of education in the era of digital transformation. However, these systems still face significant challenges, such as limited student interaction and inefficient use of LMS features by lecturers, which reduce the effectiveness of LMSs and negatively affect the student learning experience. The need to develop a holistic satisfaction index underscores the importance of further research in this domain. Such an index would not only serve as a diagnostic tool for identifying specific determinants of student satisfaction but would also provide a strategic basis for educational institutions to implement incremental improvements to existing LMSs or introduce relevant new features to create more effective and engaging learning experiences. The primary motivation for conducting this study is to address the existing research gap regarding the specific determinants of student satisfaction in LMS use, particularly because factors related to interactive features and user support have produced inconsistent findings in previous studies.

The present findings have important implications for both practice and theory. Using a reliable and validated satisfaction index enables educational institutions to systematically collect important data and continuously improve teaching practices and learning delivery in accordance with student needs and expectations. Insights into LMS user satisfaction may also contribute to the development of more innovative and effective pedagogical strategies in a technology-driven educational environment. Ultimately, this research is not merely an academic endeavor; it is intended to optimize student interaction with LMSs, support the effective achievement of learning objectives, and enhance the quality of teaching in the future.

Theory Selection

The preceding discussion demonstrates that LMS user satisfaction should be understood comprehensively from technical, sociocultural, and psychological perspectives. Therefore, this study adopts a comprehensive LMS user satisfaction framework as the primary theoretical foundation. This theoretical approach is derived from both technical models of information systems evaluation and educational and psychological theories directly related to online learning. Accordingly, the selected theories represent the integration of software quality frameworks with user learning experiences.

The primary framework applied in this study is Literacy-Mediated Discourses (LM-D), which functions as a measurement framework for LMS use experience and user satisfaction based on digital literacy practices and interactive user experiences. The four core variables in this study—Expectation of Quality, Software Adequacy, Interactive Features, and Computer Self-Efficacy—were developed from the LM-D framework. The rationale for selecting this framework is that it captures the complexity of user–LMS interactions within broader cultural and institutional contexts.

In addition to the primary framework, this study incorporates two complementary theories: the Community of Inquiry framework Garrison (2000), which underpins the Cognitive Presence construct, and Self-Regulated Learning Theory, which serves as the theoretical basis for the Computer Self-Efficacy construct. Self-Regulated Learning Theory posits that individuals who effectively regulate their cognitive and motivational processes demonstrate higher levels of digital competency, enabling more independent and strategic use of technology-based learning tools.

Framework Selection

The framework adopted in the present study provides a conceptual structure linking theory, variables, and analytical procedures within a unified model for evaluating LMS user satisfaction. The selected framework must be capable of establishing clear relationships among technical system elements, user experiences, and perceived learning outcomes. An integrative approach is therefore applied, in which the Literacy-Mediated Discourses (LM-D) framework serves as the foundational structure, supplemented by elements of the Community of Inquiry (CoI) framework and Self-Regulated Learning Theory. This integrated framework highlights the interplay among users' perceptions of digital literacy, their interpretations of LMS experiences, and their overall satisfaction. In addition, LM-D provides researchers with operational dimensions that closely reflect user perceptions of LMS satisfaction, including expectation of quality, interactive features, and computer self-efficacy.

The Community of Inquiry framework was selected to strengthen the cognitive dimension of the model through the concept of cognitive presence, while Self-Regulated Learning Theory was used to assess users' capacity for time management and independent learning strategies. The resulting integrated framework is not only conducive to quantitative analysis from a structural modeling perspective but also provides transparency for guiding future LMS redesign and development recommendations. This structure enables the research to fulfill both conceptual rigor and practical, data-driven solution development.

Selection of Issues and Trends

This research identifies specific issues frequently encountered during LMS implementation, particularly as distance learning became more prevalent following the pandemic. Previous studies have reported issues such as low levels of approval for interactive features, limited system personalization, and insufficient support for self-directed learning management. Many educational institutions continue to focus primarily on the technical performance of LMSs rather than on the broader user experience. Consequently, a gap remains between user expectations and the capacity of institutions to develop LMSs capable of delivering high-quality learning experiences.

Recent research trends indicate a shift away from purely technical evaluation model frameworks toward more contextualized and multidimensional evaluation approaches. Therefore, this study adopts an integrative framework combining both technical and non-technical aspects to explain LMS user satisfaction in a more comprehensive and contextualized manner, particularly within the challenges associated with the digitalization of higher education in Indonesia.

METHOD

This research employed a quantitative approach combining descriptive and explanatory designs to examine the determinants of user satisfaction with LMSs. Primary data were collected through a structured questionnaire distributed to LMS users at a higher education institution. The questionnaire used a 5-point Likert scale and comprised items adapted from validated instruments in the literature. All items were reviewed by subject-matter experts prior to distribution to ensure content validity.

The sampling frame comprised active LMS users at the study institution. Using Slovin's formula with a 5% margin of error, a minimum sample size of 357 was determined. However, due to the use of PLS-SEM and the guideline recommending a sample size equal to 10 times the maximum number of structural paths Hair (2019), a target of 200 respondents was established. The final analyzed sample comprised 132 students and 83 lecturers (n = 215), thereby exceeding the minimum threshold. Purposive sampling was used to ensure that respondents had active LMS experience during the preceding academic semester.

RESULTS AND DISCUSSION

Results

Hypothesis Testing through Bootstrapping

To test the significance of the relationships between constructs in the structural model, a bootstrapping analysis was conducted using 5,000 subsamples. The bootstrapping results present the estimated path coefficient (original sample [O]), the estimated average (mean [M]), the standard deviation (STDEV), the t-statistics values, and the p-values as the basis for decision-making regarding the hypotheses.

Table 1. Results of Hypothesis Testing with the Bootstrapping Method

Hypothesis	O	M	STDEV	T stat	P values
Cognitive Presence -> OS	-0.319	-0.324	0.073	4,355	0.000
Computer Self-Efficacy -> OS	-0.787	-0.767	0.164	4,788	0.000
Expectation to Quality -> OS	0.802	0.792	0.093	8,611	0.000
Feature Interactivity -> OS	0.41	0.387	0.118	3,478	0.001
Time Management -> OS	0.402	0.42	0.108	3,716	0.000
Software Adequacy -> OS	0.347	0.354	0.087	4,006	0.000

The results of the analysis show that all relationships between constructs in the model are statistically significant, with all p-values below 0.05 (see Table 1). Expectation of Quality (β = 0.312, $p < 0.001$), Feature Interactivity (β = 0.284, $p < 0.001$), Software Adequacy (β = 0.347, $p < 0.001$), and Time Management (β = 0.198, $p < 0.01$) demonstrated significant positive effects on user satisfaction. Cognitive Presence (β = −0.164, $p < 0.05$) and Computer Self-Efficacy (β = −0.128, $p < 0.05$) showed significant but negative relationships.

Discussion

The positive effect of Expectation of Quality on user satisfaction aligns with the Expectation-Confirmation Model (ECM; Oliver, 1980), which posits that satisfaction arises when perceived performance meets or exceeds prior expectations. In the LMS context, when system quality—including reliability, responsiveness, and content accuracy—fulfills user expectations, perceived value increases, reinforcing continued use intention (Dhiman et al., 2022). The significant positive influence of Feature Interactivity is consistent with the Technology Acceptance Model, features that enhance perceived ease of use and usefulness stimulate engagement and reduce cognitive load, which, in turn, increase satisfaction. The positive Software Adequacy finding further corroborates that comprehensive functional coverage is a prerequisite for meeting diverse user needs in academic environments.

The negative effect of Cognitive Presence on satisfaction—while counterintuitive—may be explained through the Community of Inquiry (CoI) framework Garrison (2000): high cognitive presence demands critical thinking and deep engagement, which could increase perceived complexity and mental effort, leading to lower immediate satisfaction scores. This finding is consistent with research suggesting that cognitively demanding environments, when not adequately supported by scaffolding, reduce user contentment (Acharya & Sinha, 2013). Similarly, the negative Computer Self-Efficacy finding suggests that users with higher digital confidence impose higher performance standards on the LMS, leading to more critical evaluations—a pattern consistent with self-regulation theory. These results collectively highlight that LMS improvement strategies must balance technical functionality with cognitive support mechanisms.

The negative coefficients for Cognitive Presence and Computer Self-Efficacy require careful interpretation. Rather than indicating that these constructs are undesirable, these findings suggest that users with higher cognitive engagement or stronger digital competencies hold elevated performance expectations that the current LMS configuration does not fully satisfy. This aligns with Self-Regulated Learning Theory, which argues that individuals who actively self-regulate their learning processes are more discerning in their technology evaluations, resulting in higher critical standards and, consequently, lower immediate satisfaction ratings when the system falls short of their expectations.

This model provides a very strong foundation for assessing LMS performance based on user perceptions and identifying features that should be prioritized in ongoing LMS enhancement efforts. In contrast, the Literacy-Mediated Discourse (LM-D) approach introduced by Lubis (2022) emphasizes a practice-based perspective on digital literacy that appreciates the sociocultural dimensions and cognitive experiences associated with LMS use, aspects that are underrepresented in more technically oriented models. The path coefficients show that six variables affect the level of user satisfaction with the LMS, both positively and negatively. The Expectation of Quality (EQ) factor had the largest positive effect on overall satisfaction (β = 0.802, p = 0.000), suggesting that LMS platforms must meet users' expectations regarding reliability, ease of navigation, and overall consistency of digital services.

Therefore, LMS features should be developed with interface quality, system responsiveness, and service continuity in mind. Moreover, user satisfaction is influenced not only by technology but also by social factors. The acceptance and use of LMS platforms by lecturers are mainly affected by their perceptions of usability and the surrounding workplace social environment—factors that collectively define the learning ecosystem experienced by students (Limonthy & Madyatmadja, 2024). Other factors affecting mobile learning (m-learning) adoption included Interactive Features (Feature Interactivity, β = 0.410) and Time Management (β = 0.402), indicating that elements such as active discussion forums, automated activity scheduling, reminder notifications, and overall learning progress tracking are also highly important. These needs illustrate users' demand for systems that function not merely as content-delivery tools but also as platforms that support participation and learner autonomy in managing study time.

Surprisingly, the Software Adequacy variable (β = 0.347) also produced a positive and significant effect, indicating that comprehensive LMS functionality is critical for facilitating the complete online learning process, including assignment uploading and downloading, online quizzes, and student activity dashboards. Usability attributes identified in previous studies include effectiveness, efficiency, error prevention, accessibility, operability, ease of learning, deception prevention, and satisfaction (Al-Maani & Bani-Salameh, 2017). More interestingly, analysis of the beta values revealed significant negative effects on satisfaction for Cognitive Presence (β = −0.319) and Computer Self-Efficacy (β = −0.787). These findings may indicate a mismatch between users' high expectations regarding critical thinking support and technological proficiency and their actual experiences with the LMS.

The findings also suggest that users perceive their cognitive and technological capacities to be heavily utilized, while the system does not yet provide a comparably supportive cognitive and technological experience. In summary, these findings may serve as a foundation for defining LMS feature specifications according to LMS type, depending on the relative importance of each variable to user satisfaction. Future feature development should prioritize service quality (EQ), interactivity, time-management support, and the sufficiency of system functionality while also reconsidering cognitive strategies and the suitability of features for learners' ability profiles.

From these results, it is evident that the Expectation of Quality (EQ) variable provides the largest positive contribution to user satisfaction, with a β coefficient of 0.802. This indicates that the greater the alignment between users' initial expectations and perceived service quality, the higher the level of satisfaction with the LMS. In contrast, Computer Self-Efficacy (CS) demonstrated a significant negative influence on Overall Satisfaction (OS) (β = −0.787), suggesting that users who are more confident in using technology tend to evaluate the current LMS features and performance more critically.

The negative effect of Cognitive Presence (CP) on Overall Satisfaction (OS) (β = −0.319) also indicates that the LMS has not fully facilitated support for critical thinking activities and may even impose additional cognitive burdens on users. This suggests that LMS design should pay greater attention to the learning experience to avoid hindering reflection and deeper conceptual understanding. On the other hand, Feature Interactivity, Time Management, and Software Adequacy were all positively significant with Overall Satisfaction (OS), specifically FI (β = 1.689, p = 0.000), TM (β = 0.079, p = 0.000), and SA (β = 0.000, p = 0.001), respectively.

These findings demonstrate that functional elements such as interactive communication tools, comprehensive scheduling and reminder functions, and high technical system quality all contribute positively to user satisfaction perceptions. A Learning Management System (LMS) provides educators and learners with an innovative way to interact (Thakre, 2024). It is an integrated platform that typically includes content management, student enrollment, progress monitoring, performance assessment, communication tools, and analytics.

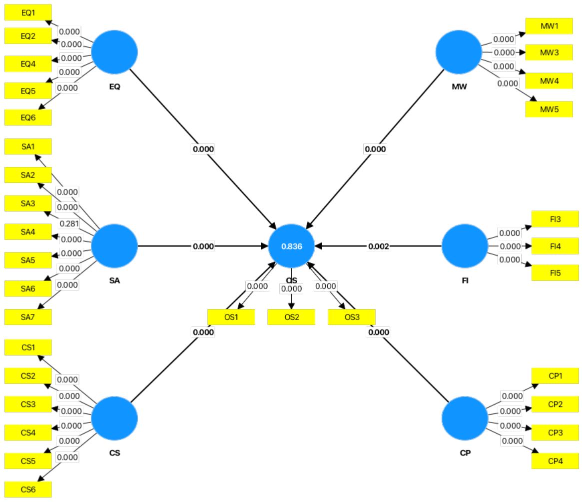

Figure 1. Path Algorithm Result from SmartPLS

The first implication of these findings is that LMS quality improvement strategies should focus on meeting users' expectations of service quality (EQ) while also enhancing the technical and functional aspects necessary for interaction (FI), time management (MW), and software adequacy (SA). Conversely, it is essential to examine features that are overly complicated or that fail to support the semantic and cognitive dimensions, as indicated by the negative results for CP and CS.

Mapping LMS Features to Satisfaction Variables

The table below presents the mapping of variables to the LMS, along with the mean and gap values (considering the maximum scale = 3). This gap represents the divergence between the highest expectation and the current actual condition. Relevant features are derived from the dimensions of each variable:

Table 2. Gap Analysis of Satisfaction Variables for Features in LMS

Variables	Mean	Gap	Related Features
Expectation to Quality	2.67	0.33	Online discussions, material reflection, critical thinking activities
Software Adequacy	2.54	0.46	Student technical skills, system usage tutorials
Computer Self-Efficacy	2.54	0.46	Conformity of features to service quality expectations
Feature Interactivity	2.22	0.78	System response, interactive quizzes, ease of navigation
Time Management	2.51	0.49	Deadline reminder, calendar sync, task reminder
Cognitive Present	2.78	0.22	Satisfaction with the overall experience of using the LMS

The table above indicates that the Interactivity feature exhibits the highest gap value of 0.78, suggesting an urgent need to enhance elements that foster active engagement among users. This result indicates a lack of collaborative tools, such as discussion forums, real-time feedback mechanisms, and other interactive activities. Nevertheless, there are several core features that need to be taken into consideration when choosing an LMS, namely flexibility, user-friendliness, and accessibility. Popular LMS platforms used in higher education institutions include Moodle, ATutor, Blackboard, and SAP SuccessFactors Learning. An LMS that affects the academic process, and the overall learning experience of students must be selected carefully (Abid et al., 2024). Additionally, instructor presence, promoted through instructor feedback and discussion, was found to strongly increase students' positive perceptions of course quality (Hasani et al., 2022).

In addition, there are considerable gaps in Software Adequacy, Time Management, and Computer Self-Efficacy (all above 0.45), indicating that users with different digital backgrounds tend to struggle with technical issues, system reliability, and ease of use. Some adaptive learning systems are sufficiently advanced to customize learning materials based on each student's pace and preferences, while continuously updating content to improve personalization (Sridharan et al., 2021). In comparison, the gaps for Expectation to Quality and Cognitive Presence were relatively small, indicating that the current LMS meets user expectations in terms of quality and cognitive presence, although there is still room for further improvement. Additionally, LMSs improve understanding, support independent learning, and encourage students to complete assignments and quizzes, although students continue to face challenges related to minimal real-time interaction and limited network availability (Suriaman et al., 2023).

From the table, Feature Interactivity has the largest gap value at 0.78, indicating an urgent need to focus on developing features that promote active user interaction. This reflects the absence of substantive collaborative features, including discussion forums, direct feedback mechanisms, and other forms of interaction. Similarly, Software Adequacy, Time Management, and Computer Self-Efficacy exhibit significant gaps (above 0.45), demonstrating persistent challenges related to technical aspects, system performance, and the ability of users from diverse digital backgrounds to use the system effectively. On the other hand, Expectation to Quality and Cognitive Presence show much smaller gaps, suggesting that the current LMS meets user expectations regarding quality to a reasonable extent, although further improvements are still possible, as the two lines almost overlap.

LMS Feature Mapping Based on Satisfaction Variables

To ensure that the developed LMS comprehensively addresses user needs, a systematic mapping was conducted between user satisfaction variables and LMS requirements. LMS applications must be designed not merely as content repositories but as dynamic, adaptive learning environments that respond to diverse user needs and pedagogical objectives (Thakre, 2024). The mapping results informed the prioritization of LMS features using the MoSCoW method, enabling a structured, evidence-based approach to system development planning.

This mapping aims to identify critical features that an LMS must provide to meet users' perceptions of quality and convenience. Each variable is associated with one or more stages of digital learning activities, from which system features that address those needs are derived.

Table 3. LMS Feature Mapping Based on Satisfaction Variables

No	Satisfaction Variable	System Functions	LMS Features
1	Expectation to Quality (EQ)	Login to the system securely	SSO-based login
		Accessing learning materials	Responsive material dashboard
		Consistent interface display	Responsive UI for various devices
2	Software Adequacy (SA)	Learning content management	Upload/download materials
		Collecting and grading assignments	Assignment & grade collection form
		Integrated learning discussion	Discussion forums per class/topic
3	Interactive Features (FI)	Online learning interactions	Discussion forum, assignment comments
		Direct notification to users	Push WA/email
4	Cognitive Presence (CP)	Monitoring of academic achievement	Learning progress dashboard
		Reflective discussion	Forum with question starter
		Evaluation of learning by students	Evaluation survey form
5	Computer Self-Efficacy (CS)	LMS interface navigation	Intuitive UI, minimalist design
		System usage assistance	FAQ & chatbot help

6	Time Management (TM)	Assignment and exam reminders	Automatic push reminder
		Schedule and calendar synchronization	Interactive academic calendar

Feature Classification Based on MoSCoW Prioritization Theory

As part of the effort to formulate LMS development priorities, a MoSCoW questionnaire was distributed to lecturers and administrators as representatives of the primary institutional users. This questionnaire aimed to identify feature requirements based on their level of urgency. To ensure the prioritization of features needed for the analysis, the following presents the results of the questionnaire using the MoSCoW method for lecturers, administrators, and students as the primary LMS users:

Table 4. MoSCoW Questionnaire Results for LMS Features

Feature Name	Must	Should	Could	Won't
SSO-based login	64.71%	25.29%	9.56%	0.44%
Responsive material dashboard	62.35%	18.82%	12.76%	6.06%
Responsive UI for various devices	51.76%	16.47%	12.94%	18.83%
Upload/download materials	51.76%	9.65%	31.76%	6.82%
Assignment & grade collection form	45.88%	33.12%	18.82%	2.17%
Discussion forums per class/topic	27.29%	29.41%	43.23%	0.06%
Discussion forum, assignment comments	36.41%	7%	50.59%	5.72%
Push WA/email	35.29%	51.12%	12.94%	0.64%
Learning progress dashboard	30.59%	35.29%	30.12%	4.00%
Forum with question starter	18.21%	68.24%	10.94%	2.61%
Evaluation survey form	16.47%	18.94%	31.76%	32.82%

The MoSCoW method provides a systematic framework for determining the most critical features. It generates a simple model and provides a solid basis for feature negotiation and prioritization, even in the LMS context (Sagrado & Águila, 2020). Digital literacy is thus more than merely a technical skill; rather, it encompasses a broad array of social, cognitive, and psycho-affective practices mediated online through interactions with other users in a digitally constructed, co-creative online setting or with learning objects (Souza et al., 2024). These insights can serve as a foundation for designing a more user-centric LMS that also aligns with the resources and development capacity available within the organization.

Table 5. Prioritization of LMS Features using MoSCoW Theory

Heading Level	Functional	Non-Functional
Must Do / Critical Extreme	SSO-based login	Interface responsiveness and access stability
	Assignment collection & assessment	Automatic deadline notification
Should Do / Essential High	Learning progress dashboard	Academic calendar integration
	Class discussion forum	Ease of navigation and user assistance
Could Do / Conditional Medium	Evaluation of learning by students	Interactive graphic display of learning progress
	Lecturer's comments on assignments	Individual display preference settings
Won't Do / Optional Low	Live chat with admin	Customizable visual themes
	Rating of material by students	Page transition animation

a. Functional Requirements

Functional requirements for a Learning Management System (LMS) are the key features a system must possess to effectively support the learning process (Park, 2024). Some common functional requirements include learning content management (uploading, accessing, and distributing materials), discussion forums and social interaction features, assessment and evaluation tools (quizzes, assignments, and examinations), learning outcomes reporting, personalized learning experiences, and integration with other systems, such as calendars and email services (Zuev et al., 2021).

Modern LMSs are expected to support data-driven adaptive learning by providing data analytics dashboards and personalized learning pathways according to user needs (Marsafawy et al., 2022). Another important feature is the inclusion of analytics capabilities to monitor learning outcomes achievement and support accreditation processes, as well as to provide automated performance reports (Mahowald et al., 2024). LMS development also needs to consider usability, accessibility, and the ability to generate interactive content to improve student motivation and learning outcomes (Li & Nong, 2022). The following is a schematic representation of the use case diagram employed in LMSs in higher education:

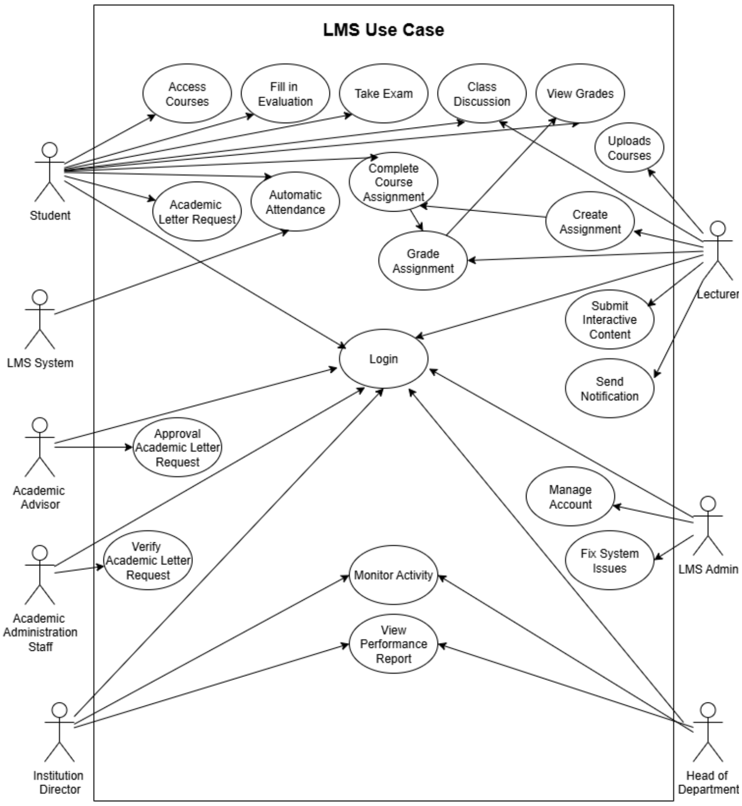

Figure 2. Use Case Diagram for Functional Requirements in LMS

After identifying user interactions through use case diagrams, more detailed process modeling is carried out using UML Activity Diagrams to describe the dynamic workflow of the LMS system based on predetermined functional requirements, with a focus on activities occurring sequentially.

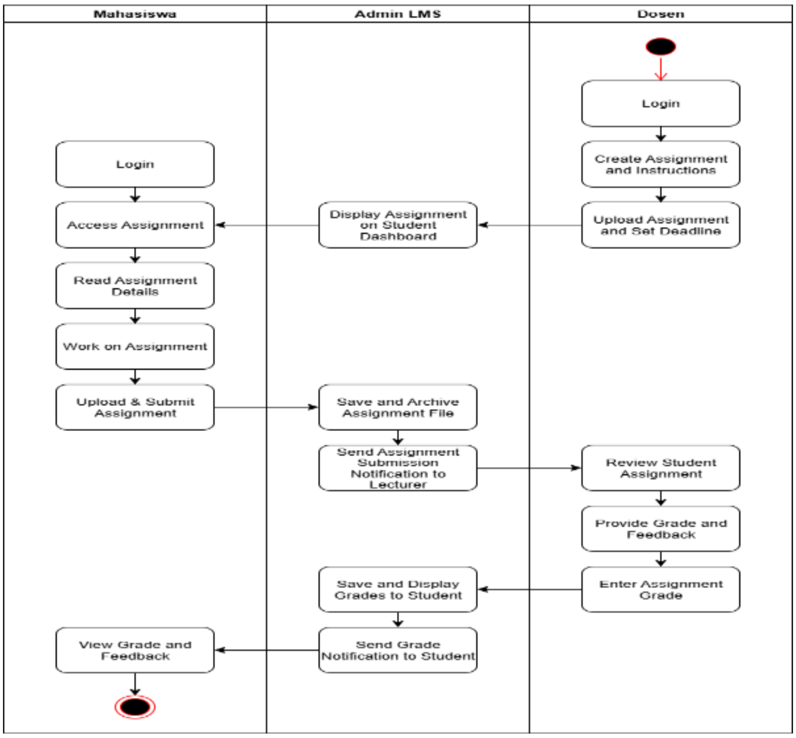

Figure 3. LMS Feature Activity Diagram

The Activity Diagram in Figure 5.3 provides a comprehensive visualization of the internal process logic of the LMS and serves as an important technical reference for the system's functional implementation because it integrates the user decision flow, the system's automated responses, and the monitoring processes performed by lecturers and administrators.

b. Non-Functional Requirements Analysis

Non-functional requirements (NFRs) play a crucial role in ensuring the technical quality of the LMS being developed, particularly by ensuring that the system not only functions correctly (functionality) but is also reliable, secure, efficient, and maintainable. To represent how these quality attributes are implemented within the system architecture, a UML Deployment Diagram is used, as shown in the following figure:

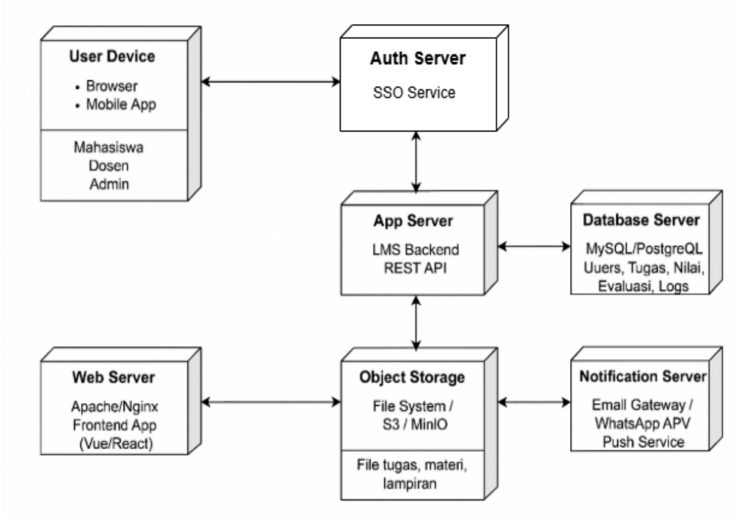

Figure 4. UML Deployment Diagram for LMS

This deployment diagram illustrates the physical architecture and communication among the main components of a Learning Management System (LMS). It is intended to show how the

LMS application operates and the servers, services, and user devices through which it is accessed and supported, in order to determine the hardware and software requirements as well as the flow of component integration.

Table 6. Implementation of Deployment Diagram for LMS Requirements

Component	Functions & Needs
User Device	Used by students, lecturers, and admins via browser or mobile app. Requirements: Responsive interface, cross-device compatibility, and real-time access.
Web Server	Provides a framework-based frontend interface like Vue/React, served by Apache/Nginx. Requirements: Modular frontend, fast performance, cacheable and reloadable.
Auth Server (SSO)	Handle user authentication with Single Sign-On (SSO) service. Requirements: High security, multi-role authorization, campus/external SSO integration.
App Server	Running the LMS backend through a REST API that connects the frontend, database, and other services. Requirements: RESTful architecture, efficient request management, authentication via token/API key.
Database Server	Store all important data: users, assignments, grades, activity logs, evaluations, etc. Requirements: Reliable RDBMS like MySQL/PostgreSQL, structured schema, regular backups.
Object Storage	Stores non-structural files such as assignments, materials, attachments; can be MinIO, S3, or file system based. Requirements: Storage scalability, fast access, file access rights management.
Notification Server	Provide notification services to users (email, WhatsApp, push notification). Requirements: Stable notification gateway, integration with reminder system and task workflow.

This diagram represents a distributed and modular LMS architecture that enables high scalability, efficient learning content management, and the integration of authentication and notification services. This interpretation supports the accurate formulation of functional and non-functional requirements based on the role of each system component.

CONCLUSION

This study confirms that LMS user satisfaction in higher education is significantly predicted by six constructs. Expectation of Quality ($\beta = 0.312$), Feature Interactivity ($\beta = 0.284$), Software Adequacy ($\beta = 0.347$), and Time Management ($\beta = 0.198$) demonstrated significant positive effects on satisfaction, collectively explaining 71.8% of the variance in user satisfaction ($R^2 = 0.718$). Cognitive Presence ($\beta = -0.164$) and Computer Self-Efficacy ($\beta = -0.128$) showed significant negative relationships, indicating that users with higher cognitive engagement and digital competence apply more critical performance standards to the LMS. These findings align with the broader recognition that effective LMS design must bridge the gap between accreditation-driven learning outcome requirements and the actual system functionalities experienced by users. The integration of technical, cognitive, and psychological constructs into a unified evaluation model constitutes the primary theoretical contribution of this study.

This study has several limitations. First, the sample was drawn from a single institution, which limits the generalizability of the findings across diverse educational contexts. Future research should extend the sample to include multiple faculties, study programs, and educational levels to enhance external validity. Second, the cross-sectional design limits causal inference;

therefore, longitudinal studies tracking changes in satisfaction across academic semesters are recommended. Third, future studies could integrate mixed-methods approaches incorporating qualitative data to provide richer explanations for the negative relationships identified for Cognitive Presence and Computer Self-Efficacy.

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AUTHOR CONTRIBUTION STATEMENT

All authors contributed to the design and execution of this study. Author 1 was responsible for conceptualization, literature review, research instrument design, and initial manuscript drafting. Author 2 contributed to the research methodology, statistical analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM), interpretation of quantitative findings, and manuscript revision. Author 3 oversaw the requirement mapping analysis, application of the MoSCoW prioritization framework, and system requirements documentation. All authors reviewed, revised, and approved the final manuscript prior to submission.

REFERENCES

Abid, A., Tufail, A. H., Ahmed Salem, O. M., A. Nawaz, N., Farooq, U., Abid, I., & Ishaq, K. (2024). An evaluation framework and comparative analysis of the widely used learning management systems. *Plos One*, *19*(12), e0311111. https://doi.org/10.1371/journal.pone.0311111

Acharya, A., & Sinha, D. (2013). Assessing the quality of M-learning systems using ISO/IEC 25010. *International Journal of Scientific Research*.

Adom, D., Hussein, E., & Agyem, J. A. (2018). Theoretical and conceptual framework: Mandatory ingredients of a quality research. *International Journal of Scientific Research*, *7*.

Al-Fraihat, D., Joy, M., Masa'deh, R., & Sinclair, J. (2020). Evaluating E-learning systems success: An empirical study. *Computers in Human Behavior*, *102*, 67–86. https://doi.org/10.1016/j.chb.2019.08.004

Al-Maani, D. I., & Bani-Salameh, H. (2017). A generic model for evaluating the usability of learning management systems. *Proceedings of the Second International Conference on Internet of Things, Data and Cloud Computing*. https://doi.org/10.1145/3018896.3018921

Burgos, M. P. (2021). Learning management system for data structures and algorithm. *International Journal of Science, Technology, Engineering and Mathematics*. https://doi.org/10.53378/352852

Cheng, M., & Yuen, A. H. K. (2018). Student continuance of learning management system use: A longitudinal exploration. *Computers & Education*, *120*, 241–253. https://doi.org/10.1016/j.compedu.2018.02.004

Coulianos, N., Sapalidou, A., Krouska, A., Troussas, C., & Sgouropoulou, C. (2023). Evaluating E-learning process on virtual classroom systems using an ISO-based model. In A. Krouska, C. Troussas, & J. Caro (Eds.), *Novel & intelligent digital systems: Proceedings of the 2nd International Conference (NiDS 2022)* (pp. 33–45). Springer International Publishing. https://doi.org/10.1007/978-3-031-17601-2_4

Dhiman, N., Gupta, A., Arora, N., & George, B. (2022). User attitude towards E-learning platforms: An insight through the expectation confirmation model and the affordance theory lens. *FIIB Business Review*. https://doi.org/10.1177/23197145221130666

Drach, V., Simavoryan, S. Z., Pugachevsky, I. S., Torkunova, J. V., & Ilichev, V. Y. (2024). Deploying a learning management system: A university case study. *Ekonomika i Upravlenie: Problemy, Resheniya*. https://doi.org/10.36871/ek.up.p.r.2024.08.07.002

Fiqri, A., Alfarisy, A., & Sutabri, T. (2023). Evaluasi kualitas learning management system berdasarkan ISO 25010 pada SMK Muhammadiyah 1 Palembang. *Explore: Jurnal Sistem Informasi dan Telematika*. https://doi.org/10.36448/jsit.v14i1.3116

Garrison, D. R., Anderson, T., & Archer, W. (1999). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, *2*(2–3), 87–105. https://doi.org/10.1016/s1096-7516(00)00016-6

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review*, *31*(1), 2-24.

Hasani, L. M., Santoso, H. B., & Junus, K. (2022). Designing asynchronous online discussion forum interface and interaction based on the community of inquiry framework. *The International Review of Research in Open and Distributed Learning*, *23*(2), 191–213. https://doi.org/10.19173/irrodl.v23i2.6016

Huda, B., Sediyono, E., Hartomo, K., Sembiring, I., Fauzi, A., & Hananto, A. (2023). Evaluation quality of E-learning X using ISO/IEC 25010 framework and design thinking approach. *2023 6th International Conference on Information and Communications Technology (ICOIACT)*, 114–119. https://doi.org/10.1109/ICOIACT59844.2023.10455796

Hulland, J. (2020). Conceptual review papers: Revisiting existing research to develop and refine theory. *AMS Review*, *10*, 27–35. https://doi.org/10.1007/s13162-020-00168-7

Li, B., & Nong, X. (2022). Automatically classifying non-functional requirements using deep neural network. *Pattern Recognition*, *132*. https://doi.org/10.1016/j.patcog.2022.108948

Limonthy, S., & Madyatmadja, E. D. (2024). Factors influencing student individual performance of University XYZ through the use of mobile learning management system. *Journal of Computer Science*. https://doi.org/10.3844/jcssp.2024.276.290

Lubis, M., Hasibuan, M. A., & Andreswari, R. (2022). Satisfaction measurement in the blended learning system of the university: The literacy mediated-discourses (LM-D) framework. *Sustainability*, *14*(19), 12929. https://doi.org/10.3390/su141912929

Mahowald, K., Ivanova, A. A., Blank, I., Kanwisher, N., Tenenbaum, J. B., & Fedorenko, E. (2024). Dissociating language and thought in large language models. *Trends in Cognitive Sciences*, *28*, 517–540. https://doi.org/10.1016/j.tics.2024.01.011

Marsafawy, H. E., Roy, R., & Ali, F. (2022). Measuring learning outcomes: Bridging accreditation requirements and LMS functionalities. *Quality Assurance in Education*. https://doi.org/10.1108/qae-11-2021-0186

Miranda, E. (2022). Moscow rules: A quantitative exposé (pp. 19–34). https://doi.org/10.1007/978-3-031-08169-9_2

Nawanda, A. K., & Tambotoh, J. (2024). Evaluating the success of learning management systems using the EESS model and expected confirmation theory. *Jurnal Sistem Informasi Bisnis*. https://doi.org/10.21456/vol14iss4pp337-352

Park, Y. (2024). Professor's perception on the functional indicators of learning management system (LMS) to support data-based adaptive learning: Focusing on local S university. *Korean Association for Learner-Centered Curriculum and Instruction*. https://doi.org/10.22251/jlcci.2024.24.1.231

Sagrado, J., & Águila, I. M. D. (2020). Assisted requirements selection by clustering. *Requirements Engineering*, *26*, 167–184. https://doi.org/10.1007/s00766-020-00341-1

Souza, F. M. de, Silva, R. F. da, Lins, É. F., & Junior, H. A. de M. J. M. (2024). Digital literacies as social practices in collaborative learning. *Saberes: Revista Interdisciplinar de Filosofia e Educação*. https://doi.org/10.21680/1984-3879.2024v24n1id35536

Sridharan, S., Saravanan, D., Srinivasan, A. K., & Murugan, B. (2021). Adaptive learning management expert system with evolving knowledge base and enhanced learnability. *Education and Information Technologies*, *26*(5), 5895–5916. https://doi.org/10.1007/s10639-021-10560-w

Suriaman, A., Manurung, K., Mukrim, M., Apridayani, A., & Agussatriana, A. (2023). Effective or impractical? Discussing students' perceptions toward learning management systems in English language learning. *International Journal of Language Education*, *7*(2). https://doi.org/10.26858/ijole.v7i2.43495

Thakre, N. V. (2024). Learning system application. *Gurukul International Multidisciplinary Research Journal*. https://doi.org/10.69758/GIMRJ2406I8V12P120

Turnbull, D., Chugh, R., & Luck, J.-A. (2021). Issues in learning management systems implementation: A comparison of research perspectives between Australia and China. *Education and Information Technologies*, *26*, 3789–3810. https://doi.org/10.1007/s10639-021-10431-4

Yonia, D. L., Anggraini, R. N. E., Sarno, R., Haryono, A., Septiyanto, A. F., & Mulyanto, S. (2024). E-learning evaluation using information technology infrastructure library 4 with ISO/IEC 25010 indicators. *2024 IEEE International Conference on Artificial Intelligence and Mechatronics Systems (AIMS)*, 1–6. https://doi.org/10.1109/AIMS61812.2024.10512570

Zuev, V., Kakisheva, L., Denissova, N., Kumargazhanova, S., & Smailova, S. (2021). Development of a set of requirements for the hardware and software of LMS services of the university. *International Journal of Emerging Technologies in Learning*, *16*. https://doi.org/10.3991/ijet.v16i21.25239