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Design and Development of a Learning Management System with Cognitive-Level Performance Analytics for Jimalalud National High School

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Abstract
This study aimed to design, develop, and evaluate a customized Learning Management System (LMS) with cognitive-level performance analytics based on Bloom's Taxonomy for senior high school students at Jimalalud National High School. A developmental-evaluative research design was employed, combining system creation processes with descriptive and evaluative methods. Fourteen teachers and 200 students participated in surveys, interviews, and pilot testing to provide insights on needs, usability, and effectiveness.

Teachers accessed the Learning Resource Portal (LRP) maintained by the Schools Division of Negros Oriental to obtain instructional materials, which supported lesson preparation. Both teachers and students identified the need for a more user-friendly, mobile-responsive system that integrates interactive assessments, item-level performance reports, assessment progression tracking, flexible submission options, and resources accessible to multiple stakeholders, including students, teachers, and parents.

In response, the LMS was developed to incorporate these features. Pilot-testing showed high satisfaction in terms of usability, instructional support, engagement, and accessibility. Cognitive-level performance analytics allowed teachers to identify learning gaps and adjust instruction, while students could monitor their own progress and understand their strengths and weaknesses.

The study recommends adopting the LMS, providing structured training for teachers and students, and establishing continuously feedback mechanisms to enhance system functionality and pedagogical effectiveness.

Keywords: Learning Management System (LMS), Cognitive-Level Performance Analytics, Bloom's Taxonomy, Student Performance Tracking, Interactive Assessment, Item-Level Analysis, Learning Analytics, Educational Technology, Senior High School

1. Introduction

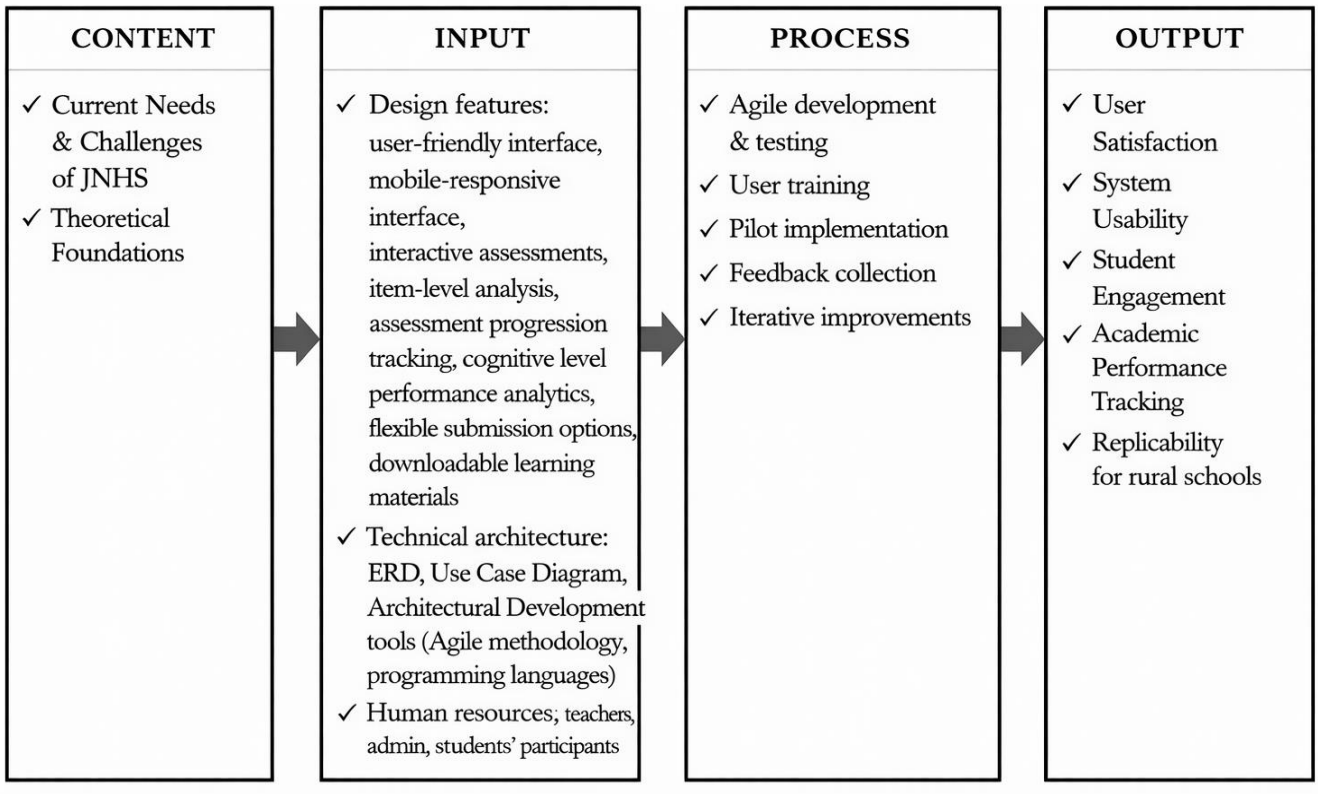
The Department of Education (DepEd) in the Philippines has long promoted the integration of technology to improve outcomes and instructional efficiency. Despite these efforts, many public schools, particularly

in rural areas, lack access to functional, context-appropriate Learning Management Systems (LMS). While teachers at Jimalalud National High School can access the Learning Resource Portal (LRP) of the Schools Division of Negros Oriental, the platform primarily provides downloadable instructional materials and does not support interactive assessments, systematic performance tracking, or cognitive-level analytics. Consequently, teachers rely on fragmented tools and manual processes to monitor student learning, while students have limited opportunities for self-paced and data-informed study.

To address these challenges, this study sought to design, develop, and evaluate a customized LMS tailored to the needs of senior high school students. The system provides a centralized, mobile-friendly platform that supports interactive assessments, secure examinations, item-level analysis, assessment progression tracking, cognitive-level performance analytics based on Bloom's Taxonomy, and flexible submission options. By incorporating these features, the LMS allows teachers to adjust instruction according to student performance and enables learners to monitor their progress, identify strengths and weaknesses, and engage more actively in their learning.

The development and evaluation of the LMS were guided by established educational frameworks. The Technology Acceptance Model (TAM) ensured the system is perceived as useful and easy to use, while Constructivist Learning Theory informed instructional design to promote active learning and reflection. Bloom's Taxonomy served as the foundation for cognitive-level tagging, and the CIPP evaluation model guided systematic assessment of context, inputs, processes, and outcomes. Through the integrated use of these frameworks the LMS addresses technological, pedagogical, and evaluative needs in a coherent and practical manner.

Figure 1: Schema of the Study



2. Literature Review

Learning Management Systems (LMS) are increasingly used in Philippine secondary education, yet their capacity for learner analytics remains limited. Borabo et al. (2024) noted that platforms such as Moodle and Google Classroom are mainly used for content delivery and communication, with few features for tracking student performance. Filipino senior high school students prefer LMS platforms that are user-friendly, mobile-responsive, and interactive, emphasizing ease of navigation and engagement tools (Alayacyac et al., 2024). Local studies indicate that teachers value LMS for lesson delivery and collaboration but recommend improvements in feedback mechanisms, usability, and performance monitoring (Balase & Paglinawan, 2025).

Research shows that LMS usability affects engagement, self-efficacy, and academic performance. Inoncillo (2024) found that perceived LMS effectiveness enhances teacher self-efficacy and work engagement. Cruz et al. (2025) reported that predictive analytics from LMS log data can correlate with student outcomes. Department of Education reports also suggest that LMS use improves parental involvement, student motivation, and study habits (Ballon et al., 2021). International evidence supports these findings: user satisfaction and engagement predict perceived learning gains (Simelane Mnisi, 2023; Panergayo & Aliazas, 2023). These observations align with the Technology Acceptance Model (TAM), where perceived ease of use and usefulness influence adoption and performance.

Integrating Bloom's Taxonomy into LMS assessments allows item-level tagging of cognitive skills, supporting personalized instruction and progression monitoring (Anderson & Krathwohl, 2001; Lee et al., 2025; Sajja et al., 2023). Learning analytics dashboards can provide actionable insights, though most existing systems focus only on descriptive data (Susnjak et al., 2022). Cognitive-level analytics enable teachers to identify learning gaps, track student progress, and align instruction with higher-order thinking skills.

Effective LMS design requires attention to usability, instructional alignment, and analytics. Studies highlight the importance of user-centered, iterative development processes that incorporate teacher and student feedback to enhance engagement (Balase & Paglinawan, 2025; Cruz et al., 2025). Evaluating software quality in terms of functionality, reliability, usability, efficiency, maintainability, compatibility, and security supports sustainability and adoption (Sipin, 2024). Despite widespread LMS use, Philippine secondary schools rarely implement cognitive-level analytics, progression tracking, or parent dashboards (Borabo et al., 2024; Alayacyac et al., 2024). This study addresses these gaps by designing a context-specific LMS for Jimalalud National High School, integrating Bloom's Taxonomy-based analytics, interactive assessments, secure testing tools, and multi-stakeholder dashboards to support both learning and pedagogical decision-making.

3. Methodology

This study employed a developmental-evaluative research design, combining the design and development of a school-based Learning Management System (LMS) with descriptive-evaluative strategies to assess its usability, instructional effectiveness, and impact on student engagement. The LMS was specifically created to meet the instructional needs of Jimalalud National High School – Senior High School, a DepEd school in Negros Oriental, where students and teachers had varying levels of familiarity with digital

learning. Respondents included the senior high school principal, fourteen teachers, and two hundred students who took part in the pilot implementation. The principal contributed both administrative guidance and practical insights, while teachers and students provided feedback on usability, instructional support, and engagement. This combination of perspectives allowed the study to evaluate the system comprehensively, considering both management and classroom experiences.

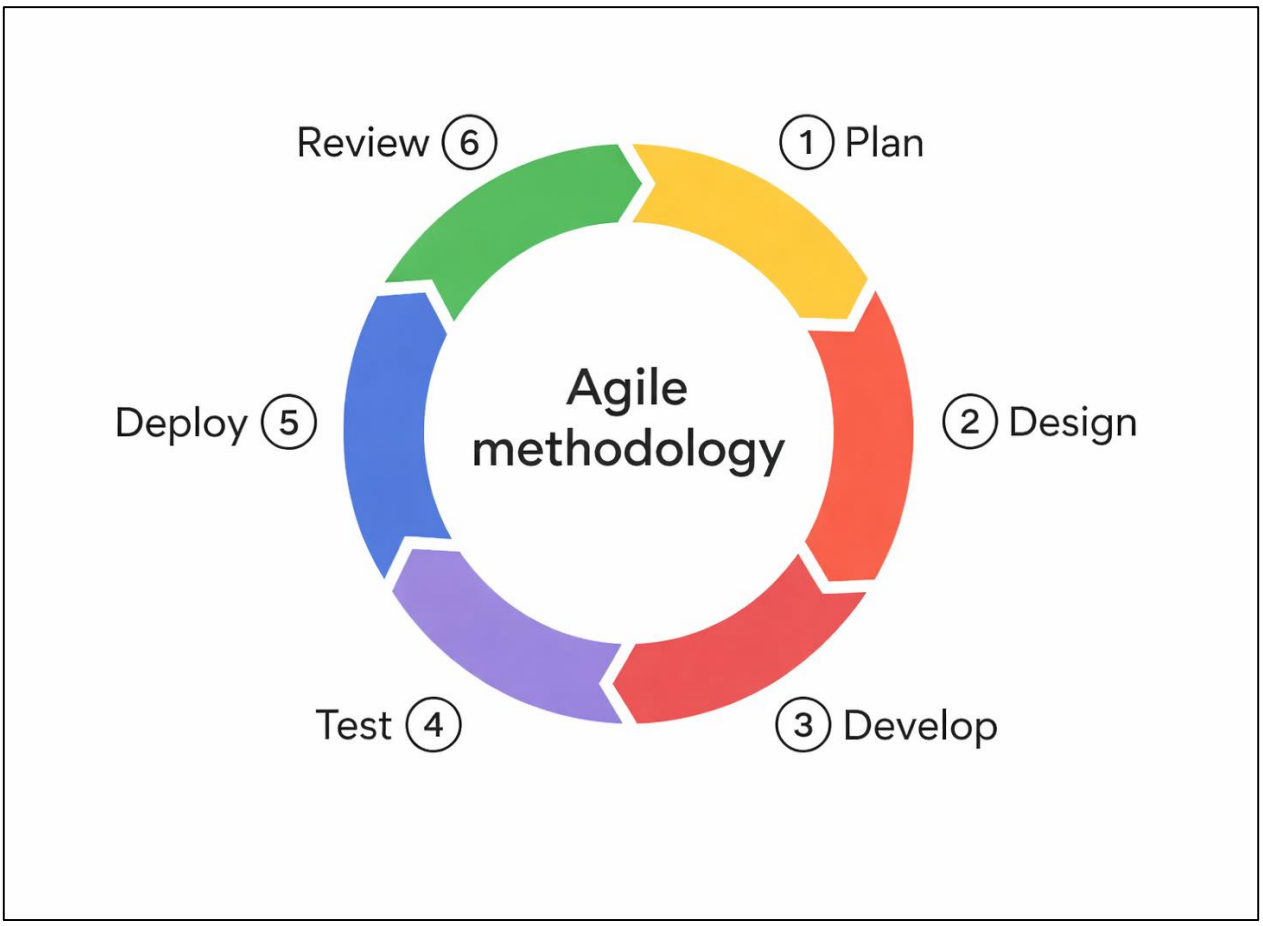
Table 1: Distribution of Respondents

Groups	Number of Respondents	%
SHS Principal/Teachers	15	6.98
SHS Students	200	93.02
Total	**215**	**100.00**

Data were collected primarily through structured surveys assessing usability, instructional effectiveness, engagement, and seven core software quality attributes: functionality, reliability, usability, efficiency, maintainability, portability, and security using a 5-point Likert scale. Open-ended questions and comments were used as supplementary sources to provide additional insights, particularly regarding respondents' preferred LMS features, design elements, and suggestions for each quality attribute. Participants were selected through purposive sampling, briefed on the study's purpose, and provided informed consent. Quantitative data were analyzed using descriptive statistics and multiple regression to examine the influence of usability, instructional support, and engagement on students' academic performance, while qualitative feedback from open-ended questions was analyzed to complement the survey findings and provide deeper understanding of user preferences.

The Learning Management System (LMS) was developed using the Agile methodology, emphasizing iterative planning, design, development, testing, deployment, and review. In the planning phase, teachers, students, and the school administrator identified system needs, prioritized features, and defined the LMS scope, using surveys, questionnaires, and discussions to determine instructional, administrative, and cognitive-level requirements. During the design phase, requirements were translated into system architecture diagrams, Input-Process-Output models, context diagrams, data flow diagrams, use case diagrams, class diagrams, sequence diagrams, and activity diagrams, complemented by prototypes and wireframes to visualize interface layout and navigation. Development implemented core modules with PHP and MySQL for the back end and HTML, Tailwind CSS, and JavaScript for the front-end, including user management, course tools, assessments, and a cognitive-level analytics engine delivering mastery profiles, learning trajectories, and Bloom's Taxonomy-based recommendations. Testing verified functionality, performance, responsiveness, and security, with issues addressed to ensure stability and usability. Deployment configured the production environment, migrated the system, conducted a pilot rollout, created user accounts, and provided training. The review phase gathered feedback from teachers, students, and administrators on usability, instructional support, engagement, and academic performance, guiding refinements in interface design, analytics, mobile compatibility, and feature enhancements.

Figure 2: Phases of Agile Methodology



4. Results and Discussions

The evaluation of the existing Learning Resource Portal indicated that while the system provides essential access to instructional materials, certain functional and structural aspects may benefit from further enhancement. Teachers reported moderate levels of usability, portability, and reliability, suggesting that the platform is generally accessible but may require optimization to better support interactive instruction and performance monitoring. These findings served as a baseline reference in identifying areas where the proposed LMS could provide additional instructional and analytic support.

The preferences of teachers and students regarding the features and design elements of the proposed LMS are presented in Table 2. The results show that Performance and Progress Analytics ranked first, indicating a strong demand for data-driven insights to support instructional decision-making and self-monitoring of learning. Access to Learning Materials and Modules and Quizzes and Interactive Tools followed, reflecting the importance of organized content delivery and structured assessment. Features related to monitoring, security, usability, and accessibility were also emphasized, demonstrating that respondents value both pedagogical effectiveness and system functionality. Other features such as notifications and file submission options were still considered important but were viewed as supplementary rather than core system requirements. Overall, the rankings suggest that stakeholders prioritize analytics, instructional organization, and meaningful assessment tools in the design of the LMS.

The LMS was developed using an iterative prototyping approach, allowing continuous refinement based on stakeholder feedback. The system included teacher, student, administrator, and parent accounts, with emphasis on cognitive-level performance analytics. Pilot implementation was conducted in selected Grade 11 and 12 classes. Minor navigation issues were observed but were manageable. Overall, teachers and students responded positively, particularly to the analytics feature and user-friendly interface.

The evaluation of the developed LMS in terms of usability, instructional effectiveness, and student engagement is presented in Tables 3, 4, and 5. Both teachers and students rated the system very highly across all dimensions, with composite means falling within the "Strongly Agree" range. These results indicate that the LMS is perceived as user-friendly, instructionally supportive, and engaging. Teachers particularly emphasized the value of the cognitive-level performance analytics in monitoring student progress, while students highlighted the clarity of interface design and the support for independent learning. These findings are supported by the software quality evaluation (Table 6), where students rated the LMS highly in security, portability, usability, and reliability, further demonstrating its effectiveness and overall quality. The consistently high ratings across respondent groups suggest that the system successfully addresses the instructional and usability gaps identified in the baseline assessment.

Multiple regression analysis was conducted to examine the influence of the perceived usability, instructional effectiveness, and student engagement on the academic performance (Tables 7 - 9). The regression model was statistically significant, $F(3, 201) = 7.52$, $p < .001$, indicating that the predictors collectively explain variations in academic performance. The model accounted for 10.1% of the variance ($R^2 = .101$), suggesting a modest explanatory power. Among the predictors, usability emerged as a statistically significant predictor ($\beta = .19$, $p = .039$), indicating that ease of navigation and interface clarity positively influence perceived academic outcomes. Instructional effectiveness ($p = .209$) and student engagement ($p = .061$) demonstrated positive but non-significant relationships. These findings suggest that while all three factors contribute to academic performance, usability plays the most critical role in shaping students' perceived learning outcomes within the LMS environment.

Table 2: Respondents' Preferences for a Functional LMS

Features and Design Elements	Ranking
Performance and Progress Analytics	1
Access to Learning Materials / Modules	2
Quizzes, Assessments, and Interactive Tools	3
Attendance Tracking & Learner Monitoring	4
Timer / Exam Security Features	5
User-Friendly Interface & Navigation	6
Mobile Access & Offline Mode	7
Communication Tools (Messaging / Chat / Voice)	8
Notifications / Alerts / Reminders	9
Submission & File Attachment Features	10

Table 3: Usability Evaluation of the LMS

Indicators	Mean	SD	Interpretation
1. The LMS is easy to navigate.	4.93	0.267	Strongly Agree
2. The interface is user-friendly and intuitive.	5.00	0.000	Strongly Agree
3. Instructions and labels in the LMS are clear and understandable.	4.93	0.267	Strongly Agree
Composite Mean (Teachers)	**4.96**	**-**	**Strongly Agree**
1. The LMS is easy to navigate.	4.69	0.660	Strongly Agree
2. The interface is user-friendly and intuitive.	4.63	0.719	Strongly Agree
3. Instructions and labels in the LMS are clear and understandable.	4.71	0.607	Strongly Agree
Composite Mean (Students)	**4.68**	**-**	**Strongly Agree**

Table 4: Instructional Effectiveness Evaluation of the LMS

Indicators	Mean	SD	Interpretation
1. The LMS effectively supports the delivery and organization of my instructional materials.	4.64	0.497	Strongly Agree
2. The LMS provides opportunities for independent learning and student self-paced progress.	4.79	0.426	Strongly Agree
3. The LMS helps me monitor students' learning progress effectively.	4.93	0.267	Strongly Agree
4. The cognitive-level performance analytics provide valuable insights for improving instruction.	4.79	0.426	Strongly Agree
5. The LMS improves the overall effectiveness of my teaching.	4.79	0.426	Strongly Agree
Composite Mean (Teachers)	**4.96**	**-**	**Strongly Agree**
1. The LMS helps me understand and follow my lessons better.	4.40	0.727	Strongly Agree
2. The LMS allows me to learn independently and at my own pace.	4.71	0.940	Strongly Agree
3. The LMS helps me track my own learning progress.	4.67	0.572	Strongly Agree
4. The LMS provides feedback or analytics that help me improve my learning.	4.67	0.676	Strongly Agree
5. Using the LMS improves my overall learning experience.	4.64	0.688	Strongly Agree
Composite Mean (Students)	**4.61**	**-**	**Strongly Agree**

Table 5: Engagement Evaluation of the LMS

Indicators	Mean	SD	Interpretation
1. Students are more responsive and engaged during LMS-based activities compared to traditional methods.	4.79	0.426	Strongly Agree
2. The interactive features of the LMS help sustain students' interest.	4.64	0.745	Strongly Agree
3. Students appear more motivated to complete tasks and activities when using the LMS.	4.57	0.756	Strongly Agree
Composite Mean (Teachers)	**4.69**	**-**	**Strongly Agree**
1. I am more responsive and engaged during LMS- based activities compared to traditional lessons.	4.57	0.706	Strongly Agree

2. The interactive features of the LMS (e.g., quizzes, discussions) help keep me interested in learning.	4.62	0.654	Strongly Agree
3. I feel more motivated to complete tasks and activities when using the LMS.	4.62	0.699	Strongly Agree
Composite Mean (Students)	**4.60**	**-**	**Strongly Agree**

Table 6: Summary of Students' Ratings on Software Quality Attributes of the LMS

Quality Attributes	Mean / Scale	Description
Functionality	3.72 / Much Functional	Largely functional with minor, non-critical issues; core LMS features such as assignment submission, accessing materials, and communication tools work effectively.
Reliability	4.00 / Moderately Reliable	Performs reliably most of the time; occasional minor failures may occur, such as brief connectivity or loading issues, but do not significantly disrupt learning.
Usability	4.00 / Easy	Simple to use with minimal guidance; intuitive navigation, clear layout, and accessible instructions enhance the user experience.
Efficiency	3.75 / Very Efficient	Performs tasks with acceptable speed and resource usage; helps students manage study time effectively, though minor improvements in organizing materials and administrative tasks are suggested.
Maintainability	3.83 / Easy	Maintenance and updates are straightforward; students can update personal information and assignments easily, though support for technical issues and accessing previous submissions can be enhanced.
Portability	4.03 / Mostly Supported	Works well across multiple devices and platforms, allowing flexible learning anytime and anywhere; offline access and app compatibility require further improvement.
Security	4.38 / Very Secure	Strong protection against threats and vulnerabilities; personal and academic data are kept safe, though adding alerts for suspicious activity could further enhance security.

Table 7: Model Summary of the Regression Predicting Academic Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.318	0.101	0.087	14.92

Table 8: ANOVA Summary of the Regression Model

Source	Sum of Squares	Df	Mean Square	F	Sig.
Regression	5,021.84	3	1,673.95	7.52	.000
Residual	44,745.66	201	222.61		
Total	49,767.50	204			

Table 9: Regression Coefficients for the Predictors of Academic Performance

Predictor	B	Std. Error	Beta	T	Sig.
(Constant)	21.84	8.42	—	2.59	.010
Usability	4.12	1.98	.19	2.08	.039
Instructional Effectiveness	2.67	2.11	.12	1.26	.209
Student Engagement	3.85	2.05	.17	1.88	.061

4.1. Findings

1. Teachers utilized the Learning Resource Portal (LRP) maintained by the Schools Division of Negros Oriental to access and download instructional materials, which supported lesson preparation. At the time, no LMS existed in the school that integrated performance analytics, interactive assessments, and multi-stakeholder access.
2. Teachers and students ranked LMS features in order of importance, with performance and progress analytics as the highest priority, followed by access to learning materials/modules, quizzes, assessments, and interactive tools, attendance tracking and learner monitoring, timer/exam security features, user-friendly interface and navigation, mobile access and offline mode, communication tools (messaging, chat, voice), notifications and alerts, and submission and file attachment features.
3. The LMS was developed following an agile-inspired process through six phases: plan, design, develop, test, deploy, and review, incorporating four user accounts into the system: teacher, student, administrator, and parent. Pilot testing with Grade 11 and 12 classes showed positive responses, particularly to the cognitive-level performance analytics and user-friendly interface, with only minor navigation issues observed.
4. Teachers and students strongly agreed that the LMS is highly usable, instructionally effective, and engaging, with composite means ranging from 4.60 to 4.96. Supplemental evaluation using seven software quality attributes indicated that the system is generally functional (3.72), moderately reliable (4.00), easy to use (4.00), very efficient (3.75), easy to maintain (3.83), mostly supported across devices (4.03), and very secure (4.38), demonstrating overall effectiveness, quality, and suitability for supporting learning.
5. The regression model significantly predicted academic performance ($F = 7.52$, $p < 0.001$), explaining 10.1% of the variance ($R^2 = 0.101$). Among the predictors, usability had a significant positive effect on academic performance ($B = 4.12$, $\beta = 0.19$, $t = 2.08$, $p = 0.039$), while instructional effectiveness ($B = 2.67$, $\beta = 0.12$, $t = 1.26$, $p = 0.209$) and student engagement ($B = 3.85$, $\beta = 0.17$, $t = 1.88$, $p = 0.061$) had positive but non-significant effects.

5. Conclusions and Recommendations

The existing Learning Resource Portal (LRP) provides teachers with access to instructional materials, serving as a foundation for organizing resources. Teachers and students prioritize LMS features such as performance and progress analytics, interactive assessments, access to learning materials, and user-friendly interfaces, which are essential for effective teaching and learning. The developed LMS successfully integrates these prioritized features, accommodates multiple user accounts, and receives positive feedback from pilot testing for usability, cognitive-level performance analytics, and navigation. The system is highly usable, instructionally effective, and engaging, demonstrating quality, reliability, and suitability for supporting learning. Furthermore, usability significantly contributes to academic performance, indicating that a well-designed, interactive LMS can enhance learning outcomes, support data-informed instruction, and facilitate self-directed and collaborative learning.

The following recommendations are proposed to maximize the LMS's effectiveness, ensure continuous improvement, and further support teaching and learning outcomes.

1. Adopt the newly developed LMS and secure formal approval from JNHS administration and the Schools Division Office (SDO).
2. Integrate more key features to enhance instructional support, usability, and engagement, and include these refinements in the division-level proposal.
3. Conduct structured training for teachers, students, and parents to ensure effective and consistent LMS use, following SDO guidelines.
4. Continuously collect user feedback to enhance functionality and user experience, with regular monitoring and evaluation reports submitted to the school and SDO.

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