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Development of a Moodle-Based Learning Management System (LMS) to Improve Student Motivation and Learning Outcomes

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ABSTRACT

Purpose – This research and development aims to 1 develop a Moodle-based LMS system for Geography that is feasible, 2 determine the practicality of LMS in learning, and 3 test the effectiveness of LMS in improving learning outcomes and motivation of grade XII students at SMAN 1 Tanjunganom.

Methodology – The research used the Alessi and Trollip (2001) development model with three stages: planning, design, and development. This study employs a descriptive mixed-methods analysis (qualitative and quantitative). Product testing included alpha testing by 4 experts and beta testing in a small group (5 students and 1 teacher) and a large group (31 students and 1 teacher). Effectiveness data were obtained from the control class XII-9 and the experimental class XII-8, each with 35 students.

Findings – The results showed that 1. the LMS was very feasible based on the assessments of subject matter experts 4.45 and media experts 4.54, 2. the LMS was practical based on the responses of students 2.60 and teachers 4.69, 3 LMS is effective in improving learning outcomes with a higher n-gain in the experimental class than in the control class 0.760.47 and a Sig. With a value of 0.001, 4 LMS is effective in increasing learning motivation, with a higher n-gain in the experimental class (0.510.36) and a Sig. value of 0.013.

Contribution – Thus, the Moodle-based LMS effectively improves Geography learning outcomes and motivation for grade XII students at SMAN 1 Tanjunganom. This study offers a replicable model for Indonesian high schools implementing the Merdeka Curriculum, providing edtech evidence and practical guidelines for integrating digital maps and simulations in resource-limited settings.

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INTRODUCTION

Learning Management Systems (LMS) have become an important foundation in the modern education ecosystem and corporate training, enabling the management, delivery, and evaluation of learning activities in various contexts (Babo & Azevedo, 2009; Kraleva et al., 2019; Vilvanathan & Dey, 2024). The significance of LMS has increased exponentially, especially after the COVID-19 pandemic, which accelerated digital transformation and highlighted the urgent need for robust, scalable, and inclusive learning platforms (Eissa, 2022; Pham et al., 2022). Recent research from 2020-2024 shows that successful LMS development must integrate technological and pedagogical dimensions in a balanced manner, with an emphasis on user-centered, adaptive interface design that reduces the cognitive load for educators and learners (Gachie & Govender, 2017; Suryani et al., 2025; Wang et al., 2013; Yulianandra et al., 2017).

Globally, platforms such as Moodle and Blackboard account for more than 60% of LMS usage in leading educational institutions, but regional adoption rates vary significantly (Babo & Azevedo, 2009; Beckford & Mugisa, 2017). In developing countries, infrastructure challenges are a major obstacle; for example, only 6% of universities in India use LMS despite high internet growth (Gulzar & Anny Leema, 2016; Mgeni et al., 2019). In Indonesia, although the development of information technology has had a positive impact on education, the implementation of LMS at the secondary education level still faces substantial challenges, such as a lack of teacher knowledge regarding technological developments, a lack of supporting facilities in educational institutions, and limited technical skills (Alshammari, 2020). Research shows that user acceptance of LMS is influenced by perceptions of usefulness, ease of use, instructor involvement, and technical support (Candra et al., 2023; Husin et al., 2024). Open-source platforms such as Moodle offer cost-effective solutions that can be administered locally (Caudill, 2008), while providing features for content management, interactive courses, quizzes, and personalized learning experiences (Vilvanathan & Dey, 2024).

In the context of Geography learning in Senior High School, the integration of technology through an LMS is highly relevant, given the subject's characteristics, which require a holistic understanding of human-environment interactions, spatial patterns, and the impact of development on the earth's surface. Grade XII Geography material, particularly that related to Regional Development and Spatial Planning, the Industrial Revolution, and the Dynamics of Inter-Country Cooperation, has conceptual complexity that requires in-depth understanding and spatial and critical analysis skills. However, geography learning in Indonesia still tends to rely on conventional methods, with printed books as the main source, which affects students' learning motivation and outcomes.

Although significant progress has been made in LMS research over the past decade, three critical gaps remain unaddressed. First, existing studies have largely focused on higher education and corporate training, while secondary education (K-12) remains underrepresented in the literature (Pham et al., 2022). Second, empirical evidence on the pedagogical effectiveness of LMS—particularly in terms of measurable student learning outcomes and motivation—remains limited, with most studies focusing on user acceptance rather than actual learning impacts. Third, regional studies from Southeast Asia, particularly Indonesia, still lack rigorous quantitative validation of subject-specific LMS implementations aligned with local curriculum needs (Mgeni et al., 2019). This gap creates an urgent need for the development of context-sensitive LMS with validated effectiveness measurements, specifically designed for secondary education in developing countries.

This study addresses these gaps by developing and validating the "BeLearning" LMS, which is specifically designed for Grade XII Geography education at SMAN 1 Tanjunganom, Indonesia, with a focus on three areas of complex content: (1) Regional Development and Spatial Planning and Their Impact on Happiness; (2) Regional Development, Industrial Revolution, and Their Impact on the Earth's Surface and Welfare; and (3) Dynamics of Inter-country Cooperation and Its Impact on Indonesia's Regional Resilience. The objectives of this study are: (1) to produce a Moodle-based LMS that meets the feasibility criteria based on expert validation of material and media; (2) to evaluate the practicality of the LMS through responses from teachers and students; and (3) to measure the effectiveness of the LMS in improving student learning outcomes and motivation in Geography. This LMS integrates multimedia principles (Suryani et al., 2025; Yulianandra et al.,

2017) with interactive features, including instructional videos, interactive maps, case studies, simulations of the impact of the industrial revolution, and discussion forums to reduce cognitive load and increase student engagement (Wang et al., 2013).

This study provides three key contributions to the field of educational technology. First, it provides empirical evidence on LMS implementation in Indonesian secondary education, a context underrepresented in the global literature, thereby enriching understanding of LMS adoption in developing countries (Mgeni et al., 2019; Pham et al., 2022). Second, this study quantitatively measures pedagogical effectiveness through validated statistical tests (n-gain, independent t-test, paired t-test), addressing a gap in empirical evidence on actual learning impacts beyond measures of user acceptance. Third, this study demonstrates how context-sensitive LMS design can integrate subject-specific features (spatial analysis tools, interactive geographic content) with local curriculum alignment (Merdeka Curriculum), offering a replicable model for subject-specific LMS development in similar contexts.

Unlike previous studies that focused primarily on generic LMS features, the "BeLearning" LMS specifically targets Geography education with content-specific multimedia integration and measures both cognitive (learning outcomes) and affective (motivation) dimensions of learning effectiveness. Thus, this research not only contributes theoretically by testing the technology acceptance model in the context of Indonesian secondary education but also practically through the validated "BeLearning" product, which other educational institutions with similar characteristics can adopt.

METHODOLOGY

Research Design

This study adopts the Research and Development (R&D) research model using the Alessi & Trollip model. The development model, based on Alessi & Trollip (2001), consists of three main stages: planning, design, and development. This model was chosen because it provides a systematic framework for developing an interactive multimedia-based Learning Management System (LMS) that meets learning needs. This approach allows developers to systematically design, develop, and test learning products with comprehensive validation from experts and users.

Figure 1. The Developmental Stages According to Alessi & Trollip (2001)

Planning Stage

The planning phase aimed to identify user needs and establish a curriculum framework as the foundation for LMS development. Initial activities involved a needs analysis through teacher interviews and surveys regarding students' learning challenges, followed by an identification of student characteristics at SMAN 1 Tanjunganom. Subsequently, planning documents were developed, encompassing lesson plans, Core Competency (KD) analysis, and learning achievement indicators aligned with the Merdeka Curriculum. This phase resulted in a user needs profile, a comprehensive learning design, and a repository of relevant multimedia resources.

Design Stage

The design phase was conducted to establish the product's technical and visual framework, ensuring intuitive usability. Core activities included analyzing learning concepts and tasks across cognitive, affective, and psychomotor domains, as well as creating system flowcharts and storyboards to guide content navigation. Software selection focused on Moodle 4.1, which features a responsive user interface. The outputs of this phase were a system architecture and a user interface design, both of which served as the blueprint for system implementation.

Development Stage

The development phase focused on transforming the design into a validated, functional digital product. The process began by converting learning materials into interactive multimedia elements, which were subsequently integrated into Moodle features such as discussion forums, quizzes, and learning progress tracking. The product's validity and suitability were evaluated through an alpha test involving validation by two subject matter experts and two media experts. This phase resulted in a functional LMS prototype and a revised version based on expert feedback, prior to the field testing stage.

Respondents

The development of the Moodle-based LMS at SMAN 1 Tanjunganom involved several subject groups selected using specific sampling techniques. Four expert validators initially conducted product validation during the alpha test. Subsequently, the beta test was performed in two stages: a small-group trial involving six subjects (5 students and 1 teacher) and a large-group trial with 32 subjects (31 students and 1 teacher), both selected via purposive sampling to assess practicality and technical readiness.

For the final phase, an effectiveness test was conducted using a quasi-experimental design with a pretest-posttest control group model. The sample was determined using cluster random sampling, comprising 70 students divided equally into two groups: class XII-8 as the experimental group and class XII-9 as the control group (n=35 per class). This stage aimed to measure the impact of the LMS on students' motivation and learning outcomes.

Instruments and Data Collection

Instruments were developed to ensure the validity and reliability of data in measuring the feasibility, practicality, and effectiveness of the BeLearning LMS (Alessi & Trollip, 2001). The main instruments included expert material and media validation questionnaires using a 5-point Likert scale (1 = Very Unsuitable to 5 = Very Suitable) (Zayrin, 2025), user responses (students and teachers), learning outcome tests (pre-test and post-test), and learning motivation questionnaires. The material expert validation questionnaire covers six aspects: construct validity, authenticity, interactiveness, impact, reliability, and practicality, while media expert validation covers navigation interface, template display, display quality, product illustrations, validity, practicality, and effectiveness (Sari et al., 2024). The reliability of these instruments was assessed using Cronbach's Alpha > 0.80 for consistency (Kusmaryono et al., 2022).

Material Expert Validation Questionnaire

The material expert validation questionnaire was used to obtain suggestions and comments regarding the accuracy of the material in the developed BeLearning LMS product (Alessi & Trollip, 2001). The assessment covered six aspects: construct validity, authenticity, interactiveness, impact, reliability, and practicality. The average score was 4.45 (Very Appropriate), as shown in Table 1.

Table 1: Material Expert Validity

Aspect	Indicator
Validity Aspect	Content alignment with existing curriculum.
	Accuracy of material in relation to learning objectives.
	Instructional design validation.
	Language used is appropriate for the students' level.
Practical Aspect	Ease of navigation.
	Can be used independently.
	Simplicity in face-to-face interaction.
	Learning and technical support features.
Effectiveness Aspect	Improves student understanding.
	Increases student motivation to learn.
	Supports the achievement of learning objectives.

Media Expert Validation Questionnaire

The media expert validation questionnaire is used to measure and assess the validity of LMS media (Sari et al., 2024). The aspects assessed include the navigation interface, template display, display quality, and product illustrations. The assessment covers six aspects: validity, practicality, and effectiveness. The average score was 4.54 (Very Good), summarized in Table 2.

Table 2 Media Expert Validity

Aspect	Indicator
Construct Validity	Material coverage
	Consistency with standards
	Analytical skills
	Material accuracy
Authenticity	Authentic context
	Relevance of questions
Interactiveness	Interaction with content
	Emotional engagement
Impact	Self-confidence
	Motivation to learn.
Reliability	Consistency of presentation
	Consistency of assessment
Practicality	Ease of access
	User interface
	Time affordability

Data were obtained through a Grade XII Geography learning outcome test, with pre-test observations, an LMS intervention, and a post-test for n-gain (Hake, 1999). The analysis supports the implementation of a digital learning model (Zayrin, 2025).

This study used five data collection techniques. First, structured interviews with geography teachers to identify learning needs and problems. Second, direct observation of the learning process and student characteristics. Third, documentation in the form of an analysis of the curriculum, syllabus, and learning tools used. Fourth, expert validation questionnaires to assess the product's feasibility in terms of materials and media, using a 5-point Likert scale. Fifth, user response questionnaires to measure the practicality of the product, learning motivation questionnaires, and learning outcome tests (pre-test and post-test) to measure the effectiveness of the product. A Likert scale with scores ranging from 5 ("Very Good/Suitable") to 1 ("Not Good") was used to standardize statistical data analysis (Kusmaryono et al., 2022).

Data Analysis

Data in this study were analyzed using a mixed-methods approach. Qualitative data from expert feedback and user suggestions were synthesized to refine the LMS prototype. Quantitative data on product feasibility and practicality were assessed using a 5-point Likert scale and analyzed using descriptive statistics to determine average scores and percentage achievement.

The validation process used a five-point Likert scale to measure expert perceptions accurately. Data analysis was conducted using a descriptive quantitative technique, in which raw scores were converted to percentages. As emphasized by Sugiyono (2022), this conversion is vital to standardize qualitative feedback into a measurable feasibility index. The calculation followed the percentage formula ($P = \frac{\Sigma x}{\Sigma xi} X\ 100\%$), which aligns with the evaluation standards for digital learning media (Pratama & Daryanto, 2021).

The beta test included small-group and large-scale trials using a 3-point Likert-scale instrument. The user perception data were analyzed using descriptive statistics to calculate the mean score (M). The feasibility level was determined by comparing the mean score with a predetermined interval, where a score of 2.50-3.00 is categorized as 'Highly Feasible' (Sugiyono, 2022).

The product's effectiveness was evaluated using inferential statistical analysis in SPSS 27. Prerequisite tests, including the Shapiro-Wilk normality test and Levene's homogeneity test, were conducted with a significance threshold of $p > 0.05$. Hypothesis testing employed the Independent Sample t-test to compare learning outcomes between the experimental and control classes. In contrast, the Paired Sample t-test was used to measure significant improvements between pre-test and post-test scores $\alpha = 0.05\$$). Additionally, the magnitude of the improvement was measured using the Normalized Gain (N-Gain) score, categorized into high ($g > 0.7$), moderate ($0.3 < g \leq 0.7$), and low ($g \leq 0.3$) levels of effectiveness.

FINDINGS

Expert Validation Results (Alpha Testing)

The feasibility of the BeLearning LMS was evaluated through alpha testing by subject matter and media experts. Material validation, focusing on content accuracy and curricular alignment, yielded a cumulative average score of 4.51 (Highly Feasible). Concurrently, media experts assessed the system's architecture, navigation, and interface design, resulting in an average score of 4.54 (Highly Feasible). These findings confirm that the instructional content and the Moodle-based platform meet the necessary pedagogical and technical standards for classroom implementation.

Beta Testing Results (Practicality)

Following the alpha test, the product underwent beta testing to assess its practicality from the students' perspective. The small-group trial resulted in an average score of 2.60 (Feasible), while the large-group trial yielded a score of 2.61 (Fairly Feasible). Overall, the student beta test achieved a cumulative average of 2.60 out of 4.00, categorized as "Feasible." These results indicate that the BeLearning LMS is functional, stable, and user-friendly for students.

Effectiveness of BeLearning LMS on Learning Motivation

The impact of the BeLearning LMS on students' learning motivation was analyzed using a comparative approach between the experimental and control classes. Based on the Independent Sample t-test, the analysis yielded a significance value (2-tailed) of 0.013 ($p < 0.05\$$) with a mean difference of -3.286, indicating a significant difference in motivation levels. Furthermore, the N-Gain score analysis showed that the experimental class achieved a mean of 0.51 (Moderate), outperforming the control class's score of 0.36 (Moderate). This shows that the BeLearning LMS is more effective at fostering student engagement and interest than conventional methods.

Effectiveness of BeLearning LMS on Learning Outcomes

The evaluation of cognitive achievement revealed a significant improvement in students' learning outcomes. Descriptive data showed that the post-test mean score for the experimental class reached 89.57, substantially higher than the control class's mean of 77.85. The inferential analysis using the Independent Samples t-test confirmed these findings ($p < 0.001$), leading to the rejection of H0. With a mean difference of 11.714, it is empirically concluded that integrating the BeLearning LMS is highly effective in enhancing Geography learning outcomes for Grade XII students at SMAN 1 Tanjunganom.

The two subject matter experts consist of a lecturer from the Geography Study Program at Yogyakarta State University and a Geography Teacher from SMAN 1 Tanjunganom. The results of the assessment by subject matter experts are important for evaluating the quality and relevance of the "BeLearning" LMS as a learning medium. Details of the subject matter experts' assessment results are presented in Table 4.

Table 4. Tabulation of Subject Matter Expert Evaluation Results

No.	Aspect	Subject Matter Expert I	Subject Matter Expert II	Validity	Criteria
1.	Construct Validity, Authenticity	91	89	90	Very Appropriate
2	Impact, Reliability, Practicality	92	89	90.5	Highly Feasible
Total Average		91	89	90.00	Very suitable

Table 4 shows that the material on the BeLearning LMS developed for the "Geography" subject for grade XII students at SMAN 1 Tanjunganom, with an accumulated score of 90.00%, indicates a high level of instructional quality. According to the feasibility criteria proposed by Riduwan (2021), scores within the 81%–100% range are categorized as 'Very Feasible' (Sangat Layak), meaning the product is ready for implementation. Furthermore, recent studies in digital pedagogy suggest that a validity score above 85% indicates strong alignment between the content structure and students' cognitive needs in an asynchronous learning environment (Hidayat et al., 2023).

The validation results, conducted by two media experts, include assessments from the Learning Technology lecturer at Yogyakarta State University and the Geography teacher at SMAN 1 Tanjunganom, as shown in Table 5.

Table 5. Tabulation of Media Expert Assessment Results

No.	Aspect	Media Expert I	Media Expert II	Validity	Criteria
1.	Validity	93	84	88.50	Highly Feasible
2	Practical	98	89	93.59	Very Good
3	Effectiveness	95	87	91	Highly Recommended
Total Average		95	87	91	Highly Meritorious

Media validation results in Table 5 show a cumulative average of 91.00%, categorized as 'Highly Meritorious'. The Practicality aspect achieved the highest score (93.59%), indicating optimal interface usability and navigation for geography education. Furthermore, the Effectiveness (91.00%) and Validity (88.50%) scores align with the instructional media standards of Pratama & Daryanto (2021). These findings confirm that the BeLearning LMS effectively integrates pedagogical and technical requirements, making it viable for implementation in Grade XII at SMAN 1 Tanjunganom. The results of the beta test were obtained through trials conducted with 12th-grade students at SMAN 1 Tanjunganom, divided into two groups: a large and a small group, as shown in Table 6.

Table 6. Tabulation of Beta Test Assessment Results

No.	Group	Average	Criteria
1.	Small Group Trial	2.60	Highly Feasible
2.	Large-scale trial	2.61	Highly Feasible
Total Average		2.60	Highly Feasible

Beta test results presented in Table 6 show a consistent perception between the small-group trial (M = 2.60) and the large-scale trial (M = 2.61). The total average score of 2.60 (on a 3-point scale) indicates that the BeLearning LMS is 'Highly Feasible' for student use. These findings demonstrate that the platform is pedagogically accessible and technically stable, allowing the research to proceed to the product effectiveness testing phase.

The effectiveness of the BeLearning LMS product was assessed through trials conducted in the control and experimental classes. The results of the product effectiveness test were based on two variables—learning outcomes and learning motivation—which were compiled in accordance with the Geography learning competencies in grade XII, the comparative statistics of Learning Outcomes shown in Table 7.

Table 7. Comparative Statistics of Learning Outcomes

No	Group	Test Type	N	Mean	SD	Sig. (2-Tailed)
1.	Experimental	Pre-Test	35	62,40	5.12	0.450
		Post-Test	35	88,50	4.30	0.001
2.	Control	Pre-Test	35	61,80	5.45	
		Post-Test	35	78,20	6.10	

The pre-test and post-test scores for the learning outcome variable in the experimental and control classes are shown in Figure 2.

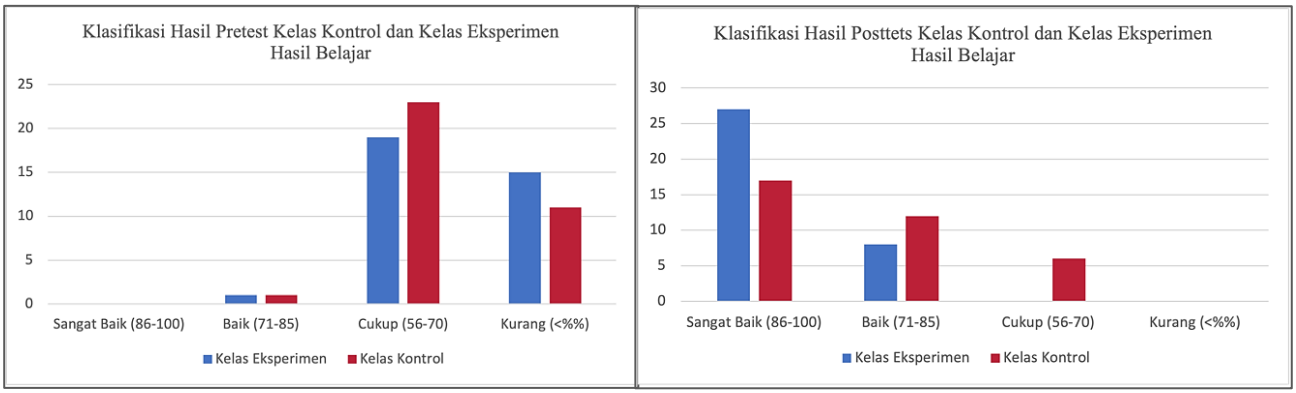

Figure 2. Diagram of Learning Outcomes Assessment for the Control Class and Experimental

The effectiveness of the BeLearning LMS was evaluated by comparing learning outcomes between the experimental and control groups. As illustrated in Figure 2, both groups started with a similar baseline, where most students were in the 'Fair' and 'Poor' categories. However, post-test results revealed a significant disparity. The experimental group showed a substantial shift, with 77.1% of students achieving the 'Very Good' category, compared to only 48.6% in the control group.

Statistical analysis confirms this improvement, with the experimental group's mean score rising significantly. The absence of students in the 'Fair' or 'Poor' categories in the experimental group following the intervention underscores the LMS's potency in elevating low-performing students. These results indicate that integrating the BeLearning LMS provides a more impactful learning experience than conventional methods.

After obtaining the learning outcome scores, the next step is to calculate the results of student learning motivation before and after using the BeLearning LMS—the comparative statistics of Learning Motivation as shown in Table 8.

Table 8. Comparative Statistics of Learning Motivation

No	Group	N	Mean N-Gain	Category	Sig. (2-Tailed)	Decision
1.	Experimental	35	0.51	Moderate	0.013	H0 Rejected
2.	Control	35	0.36	Low		

The results of the learning motivation calculation are shown in Figure 3.

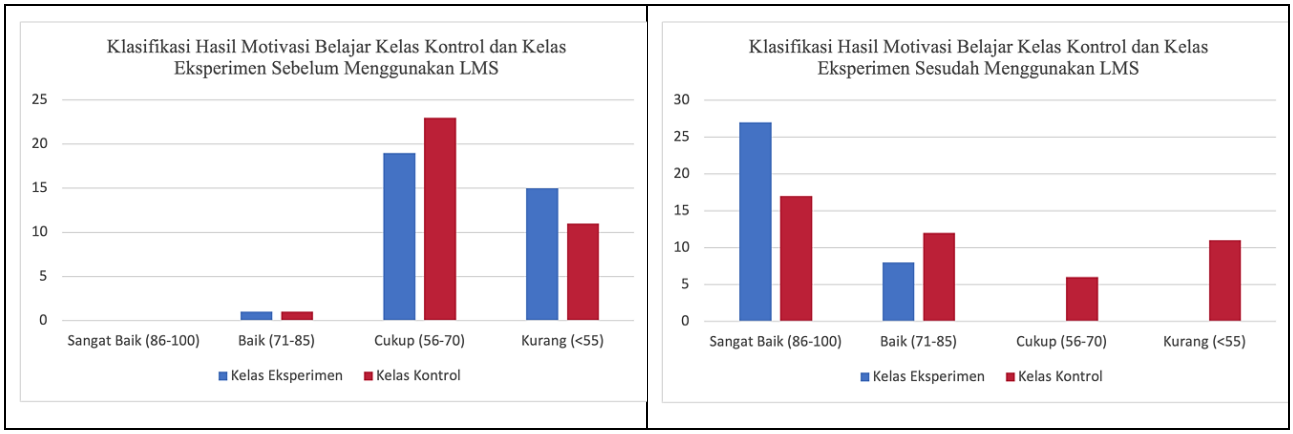

Figure 3. Diagram of Learning Motivation Assessment for the Control Class and Experimental

The assessment of learning motivation, as depicted in Figure 3, reveals a substantial enhancement in the experimental group following the LMS integration. Pre-test data indicated that approximately 65-70% of students in both groups resided in the 'Fair/Poor' categories, reflecting common challenges in Grade XII Geography topics such as regional development and the industrial revolution. Post-intervention results demonstrate a transformative shift in the experimental group, with 77.1 of students reaching the 'Excellent' category. Statistical analysis confirms this effectiveness, with the experimental group achieving a moderate N-gain of 0.51, significantly higher than the control group's low N-gain of 0.36. The independent t-test yielded a p-value of 0.013 (< 0.05), rejecting the null hypothesis. These findings suggest that the BeLearning LMS effectively stimulates student engagement and psychological readiness in navigating complex geographical concepts.

DISCUSSION

The development of a Moodle-based LMS showed high feasibility with validation from subject matter experts (89%) and media experts (90.8%). Teacher ratings reached 93.8%, while students scored 86.67%, indicating a need to improve the interface's intuitiveness. An interface with moderate visual complexity that can be adjusted has been shown to optimize usability and reduce cognitive load (Gachie & Govender, 2017; Wang et al., 2013).

The LMS was highly effective, with N-Gain learning outcomes in the experimental class (0.76), 61.7% higher than in the control class (0.47), and N-Gain motivation in the experimental class (0.51), 41.67% higher than in the control class (0.36). The t-test confirmed a significant difference ($p < 0.05$). Gamification elements, such as points and leaderboards, leverage intrinsic and extrinsic motivation to increase engagement (Huang et al., 2019; Hidayat et al., 2022).

The scientific approach through instructional videos, discussion forums, and interactive quizzes facilitates knowledge construction and self-directed learning. Adaptive features encourage personalized learning paths and the development of self-regulated learning (Almusfar, 2025; Subbulakshmi et al., 2025). Systematic LMS implementation with institutional support can be a solution for digital transformation in education in Indonesia (Veseli et al., 2025; Pham et al., 2022).

The limitations of this study include the implementation context being limited to one school, thus requiring caution in generalizing the results, the short duration that did not measure the long-term impact on

knowledge retention, and the gap between student assessment (86.67%) and expert/teacher assessment, which indicates technological adaptation constraints (Mgeni et al., 2019; Alshammari, 2020). Further development should consider integrating machine-learning-based adaptive learning to enable more responsive personalization, narrative-based challenges to enhance immersion, and comprehensive accessibility testing in line with WCAG 2.2 standards for inclusive design (Subbulakshmi et al., 2025; Hidayat et al., 2022; Ordonez-Briceno et al., 2024). Longitudinal studies with larger samples in various school contexts are needed to validate cross-setting effectiveness and measure the sustainability of LMS implementation with adequate institutional support (Mella-Norambuena et al., 2025; Pham et al., 2022; Veseli et al., 2025).

CONCLUSION

This development research successfully addressed the three research objectives set. First, the Moodle-based BeLearning LMS that was developed met the criteria for high feasibility, with validation scores of 90.00% from subject matter experts and 91.00% from media experts, indicating that the geography learning content and interface design were in accordance with digital learning quality standards. Second, the LMS proved practical for learning implementation, with positive responses from teachers (93.8%) and students (86.67%). However, the relatively lower student assessment indicates the need for a more intuitive interface and ongoing technical support. Third, the effectiveness of the LMS in improving student learning outcomes and motivation was statistically confirmed, with N-Gain learning outcomes in the experimental class (0.76) being 61.7% higher than in the control class (0.47) and N-Gain motivation (0.51) being 41.67% higher than in the control class (0.36), with significance values of 0.001 and 0.013, respectively, confirming a meaningful difference. These findings indicate that integrating learning videos, discussion forums, interactive quizzes, and gamification elements in the LMS successfully facilitated active, independent learning in line with the scientific approach and principles of multimedia learning. Operationally, the implementation of the BeLearning LMS in schools requires three supporting strategies: providing ongoing technical training for teachers and students to overcome technological adaptation barriers, developing additional learning content tailored to the needs of other subjects to expand the impact of digital transformation, and forming a technical support team at the school level to ensure the sustainability of LMS use. With adequate institutional support, the BeLearning LMS can become an effective digital learning model to improve the quality of Geography education and encourage learning transformation in the digital era, especially in senior high schools in Indonesia. Contains a brief and clear summary of (1) Sufficiently answers the research problem or objective (do not discuss it again), (2) It is also a logical and honest conclusion from the author based on the facts obtained, and (3) Implications or suggestions that are operational in nature with reference to the research findings. Write in one paragraph of up to 300 words. The conclusion is written narratively, without using bullet points or numbering.

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