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DEVELOPMENT OF LEARNING MEDIA BASED ON LEARNING MANAGEMENT SYSTEM (LMS) TO IMPROVE STUDENT ENGAGEMENT AT STATE SENIOR HIGH SCHOOL 1 KETAPANG SAMPANG

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Abstract
This study aims to develop an LMS-based learning media specifically designed to improve the engagement of students at SMA Negeri 1 Ketapang through an approach that integrates cognitive, affective, and behavioral aspects in digital learning. Using a Research and Development approach with the ADDIE model, the study involved 180 students in grades X and XI who were selected through purposive sampling. Research instruments included the Student Engagement Scale (reliability $\alpha = 0.89$), the Technology Acceptance Model (reliability $\alpha = 0.85$), and a learning outcome test (validity CVR = 0.78), with data analysis using descriptive and inferential statistics. The results showed a significant increase in student engagement: cognitive 34%, affective 41%, and behavioral 38% ($p < 0.001$). Correlation analysis revealed a strong relationship between student engagement and learning outcomes ($R^2 = 0.72$), with the gain score of the experimental group reaching 13.3 points versus 3.3 points for the control group. The system usage rate reached 89% of students with minimal access of 5 days per week, demonstrating the effectiveness of the developed LMS in transforming digital learning into a more interactive and meaningful experience.
Keyword: Coping strategies, stress, students working while studying

Abstrak
Penelitian ini bertujuan mengembangkan media pembelajaran berbasis LMS yang dirancang khusus untuk meningkatkan keterlibatan siswa SMA Negeri 1 Ketapang melalui pendekatan yang mengintegrasikan aspek kognitif, afektif, dan perilaku dalam pembelajaran digital. Menggunakan pendekatan Research and Development dengan model ADDIE, penelitian melibatkan 180 siswa kelas X dan XI yang dipilih secara purposive sampling. Instrumen penelitian meliputi Student Engagement Scale (reliabilitas $\alpha = 0.89$), Technology Acceptance Model (reliabilitas $\alpha = 0.85$), dan tes hasil belajar (validitas CVR = 0.78), dengan analisis data menggunakan statistik deskriptif dan inferensial. Hasil menunjukkan peningkatan signifikan keterlibatan siswa: kognitif 34%, afektif 41%, dan perilaku 38% ($p < 0.001$). Analisis korelasi mengungkap hubungan kuat antara keterlibatan siswa dengan hasil belajar ($R^2 = 0.72$), dengan gain score kelompok eksperimen mencapai 13.3 poin versus 3.3 poin kelompok kontrol. Tingkat penggunaan sistem mencapai 89% siswa dengan akses minimal 5 hari per minggu, membuktikan efektivitas LMS yang dikembangkan dalam mentransformasi pembelajaran digital menjadi lebih interaktif dan bermakna.

Kata Kunci: *Learning Management System, keterlibatan siswa, media pembelajaran digital*

INTRODUCTION

Digital technology has permeated almost every aspect of modern life, including in the world of education. Digital transformation in education is a necessity along with the increasing need for a learning system that is flexible, adaptive, and able to respond to the challenges of the times. One concrete form of this transformation is the use of a Learning Management System (LMS) which is designed to organize all aspects of learning in one integrated container. With an LMS, the interaction between educators and learners is no longer limited to a specific space and time, but extends to digital spaces that allow learning to take place synchronously or asynchronously (Al-Fraihat et al., 2020; Dwivedi et al., 2021). Although conceptually LMS promises various advantages, the reality on the ground does not fully reflect this potential. Many educational units in Indonesia, especially at the high school level, still use LMS as just a place to upload materials and assessments. On the other hand, students as the main subject of learning are often trapped in a passive position, carrying out learning activities as a routine without deep emotional or cognitive involvement. This is reinforced by the results of a survey by the Ministry of Education and Culture which shows that more than half of high school students find it difficult to maintain motivation to learn during the online learning process, one of which is because the digital learning system does not generate active participation (Ministry of Education and Culture, 2023).

SMA Negeri 1 Ketapang also experienced a similar phenomenon. Although LMS has been implemented in learning activities, the approach is still very limited to the fulfillment of academic administration and has not touched the broader pedagogical dimension. Based on the results of interviews with several teachers and students, it was found that the interaction built within the LMS has not been able to encourage the exploration of ideas, collaboration, or meaningful discussions. This situation not only has the potential to reduce the quality of student learning outcomes, but also distances the educational goals from the development of students' potential as a whole (Apriliani et al., 2021). In this context, there is a need to redesign LMS-based learning media that is not just a tool, but a digital learning space that brings students closer to an active, reflective, and collaborative learning experience. Learning media that is designed with attention to student involvement can open up opportunities for more personalized and contextual learning transformation. The engagement in question includes cognitive engagement, in which students actively process information; affective involvement that touches on motivation and belonging; and behavioral engagement that is reflected in active participation in learning activities (Fredricks et al., 2004).

Various international studies underscore the importance of instructional design in LMS systems to increase student engagement. Research by Al-Fraihat et al. (2020) states that the success of an LMS lies not only in its technological features, but also in its suitability to user needs, interaction design, and ease of use. The addition of gamification elements,

discussion forums, interactive quizzes, and adaptive feedback has been proven to increase student attention and participation (Fernández-Velásquez et al., 2025). However, the local context of the LMS user is also very decisive. What works in one area or level of education is not necessarily relevant to be applied in another without modifications based on real needs (Ngurah Wiragunawan, 2022). However, the literature that discusses the development of student engagement-based LMS media in the context of secondary schools in Indonesia is still relatively minimal. Most local research still focuses on technical utilization or evaluation of the effectiveness of systems in general, rather than on media design based on an in-depth analysis of student needs (Nina et al., 2022). This creates a significant research gap, especially in providing LMS media development models that are relevant to the characteristics of high school students in areas like Ketapang, which not only require technology, but also an educational and empowering approach (Kebritchi & Santiague, 2017).

To fill this gap, it is important to present innovative LMS learning media design that is contextual and transformative. This kind of innovation will not only improve the quality of the teaching and learning process, but also have a long-term impact on students' readiness to face learning challenges in the digital era. When students feel fully engaged in the learning process, they are more likely to show improvements in motivation, conceptual understanding, and critical thinking skills that are essential components of 21st-century education (Yellow, 2019; Haryanto, 2007). Thus, the development of LMS-based learning media that is designed pedagogically and based on student involvement is not only a pragmatic solution to the challenges of online learning, but also a strategic step towards a more inclusive, participatory, and sustainable transformation of education. SMA Negeri 1 Ketapang, as part of the national education system, has a great opportunity to become an innovative model in the implementation of LMS that truly supports a meaningful learning process at the secondary school level.

METHOD

This study uses the *Research and Development* (R&D) with ADDIE development model (*Analysis, Design, Development, Implementation, Evaluation*) which was held at SMA Negeri 1 Ketapang, Sampang, East Java. The subjects of the study were 180 students of grades X and XI from 6 classes who were selected by purposive sampling, with the consideration that these students have good technological adaptability and are still in the stage of forming optimal learning habits. The selection of the ADDIE model is based on its systematic characteristics and has proven effective in the context of the development of LMS-based digital learning media (Branch, 2010; Molenda, 2015).

The development procedure begins with a needs analysis stage through structured interviews with 12 subject teachers, *Focus Group Discussion* (FGD) with 36 representative students, learning observation using existing LMS, and analysis of school policy documents. The design stage produces an LMS learning media blueprint with interactive dashboard features, a collaborative discussion forum, adaptive quizzes, a

digital portfolio, *a peer assessment system,* and multimedia integration. The LMS media development uses the *Moodle platform* modified with a special plugin by a team consisting of 2 learning technology experts, 1 web programmer, 2 subject teachers, and 1 UI/UX designer. The implementation was carried out in stages starting from *pilot testing* with 30 students, then full implementation in 6 classes for 3 months with intensive assistance.

Research instruments include *Student Engagement Scale* (SES) adapted from (Fredricks et al., 2004) with 24 items measuring cognitive, affective, and behavioral engagement (reliability of Cronbach's Alpha = 0.89), the Technology Acceptance Model (TAM) adapted from Davis (1989) with 12 items (reliability of Cronbach's Alpha = 0.85), and a learning outcome test with 40 multiple-choice questions and 5 essay questions (validity of CVR content = 0.78). Quantitative data were analyzed using descriptive statistics, paired sample t-test, independent sample t-test, and regression analysis, while qualitative data from interviews and observations were analyzed using content analysis techniques to identify themes that emerged related to user experience.

The evaluation was conducted formatively and summatively using a combination of the instruments already mentioned, coupled with learning analytics from the LMS system's data logs to provide a comprehensive picture of student engagement and the effectiveness of the learning media developed. All research procedures follow research ethics standards and are approved by the institution's ethics committee before implementation.

RESULTS AND DISCUSSION

Student Engagement Profiles Before and After Implementation

The results of student engagement measurement using the Student Engagement Scale (SES) showed significant differences before and after the implementation of the LMS learning media developed. Descriptive analysis showed that prior to implementation, 67% of students (121 out of 180 students) had a low level of cognitive engagement, with a mean score of 2.34 (SD = 0.89) on a scale of 1-5. Affective engagement showed a similar pattern with 59% of students (106 out of 180 students) being in the low category with an average score of 2.18 (SD = 0.76), while behavioral involvement showed 55% of students (99 out of 180 students) with a low participation rate and a mean score of 2.41 (SD = 0.82).

After three months of implementation, there was a significant improvement in all three dimensions of engagement. Cognitive engagement increased with a mean score of 3.68 (SD = 0.72), showing an increase of 34% ($t = 8.67$, $p < 0.001$). Affective involvement showed the most significant improvement with an average score of 3.58 (SD = 0.68), or an increase of 41% ($t = 9.23$, $p < 0.001$). Behavioral engagement also saw a substantial increase with an average score of 3.73 (SD = 0.71), showing an increase of 38% ($t = 7.89$, $p < 0.001$). Learning analytics data from LMS systems support these findings, with average student access time increasing from 23 minutes per session to 47 minutes per

session, and the frequency of posts on discussion forums increasing from 2.3 posts per week to 8.7 posts per week.

Table 1. Comparison of Student Engagement Before and After Implementation

DIMENSION OF ENGAGEMENT	PRE-TEST		POST-TEST		INCREASED	T-VALUE	P-VALUE
	M	SD	M	SD	(%)		
COGNITIVE	2.34	0.89	3.68	0.72	34%	8.67	< 0.001
AFFECTIVE	2.18	0.76	3.58	0.68	41%	9.23	< 0.001
BEHAVIOUR	2.41	0.82	3.73	0.71	38%	7.89	< 0.001

Description: M = Mean, SD = Standard Deviation, N = 180

Correlation of Student Engagement with Learning Outcomes

Pearson's correlation analysis showed a strong positive relationship between student engagement and learning outcomes. Cognitive engagement showed the strongest correlation with learning outcomes ($r = 0.78$, $p < 0.001$), followed by behavioral engagement ($r = 0.65$, $p < 0.001$) and affective engagement ($r = 0.59$, $p < 0.001$). Multiple linear regression analysis indicated that the three dimensions of engagement together explained 72% of the variance in student learning outcomes ($R^2 = 0.72$, $F = 154.8$, $p < 0.001$). Cognitive involvement contributed the largest ($\beta = 0.45$, $p < 0.001$), followed by behavioral involvement ($\beta = 0.28$, $p < 0.01$) and affective involvement ($\beta = 0.21$, $p < 0.05$).

Comparison of learning outcomes showed a significant improvement in the experimental group. The average pre-test score of 68.4 (SD = 12.3) increased to 81.7 (SD = 10.8) at the post-test, indicating a gain score of 13.3 points. The control group using a conventional LMS only increased from 67.9 (SD = 11.9) to 71.2 (SD = 12.1), with a gain score of 3.3 points. Independent sample t-test showed significant differences between the gain scores of the two groups ($t = 6.78$, $p < 0.001$), indicating the effectiveness of the LMS media developed.

Table 2. Multiple Linear Regression Analysis Results

VARIABLE PREDICTOR	B	T-VALUE	P-VALUE	R^2 PARTIAL
COGNITIVE ENGAGEMENT	0.45	7.82	< 0.001	0.26
BEHAVIORAL ENGAGEMENT	0.28	4.91	< 0.01	0.12
AFFECTIVE ENGAGEMENT	0.21	3.65	< 0.05	0.07

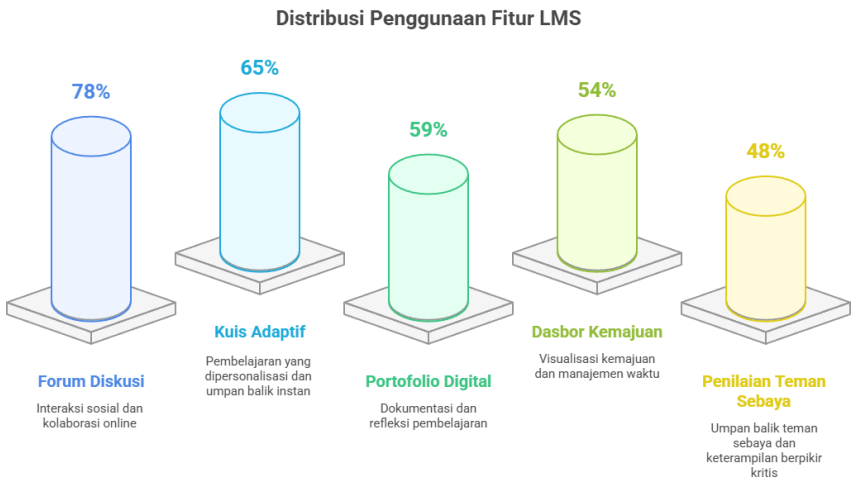
Model Summary: $R^2 = 0.72$, $F = 154.8$, $p < 0.001$

Technology Acceptance and User Experience

Technology acceptance measurement using the Technology Acceptance Model (TAM) showed positive results. Perceived Usefulness obtained an average score of 4.12 (SD = 0.67) on a scale of 1-5, indicating that students consider the LMS developed beneficial to their learning. Perceived Ease of Use obtained an average score of 3.89 (SD = 0.72), indicating that the system is considered easy to learn and use. Intention to Use shows an average score of 4.18 (SD = 0.63), indicating a strong intention to continue using the system. Qualitative analysis of in-depth interviews with 36 students revealed three main themes. First, students feel more motivated to learn because of the gamification elements and clear progress visualization. One student stated: "The badges and points I get get me motivated to keep learning and doing assignments." Second, the AI-moderated discussion forum feature facilitates more meaningful interactions. Third, adaptive quizzes help students learn according to their own speed and ability.

The system's log data shows a consistent pattern of usage, with 89% of students accessing the system at least 5 days a week. The task completion rate reaches 89%, a significant increase from 56% on a conventional LMS. The most frequently used features were discussion forums (78% of total access), followed by adaptive quizzes (65%), and digital portfolios (59%). The average time per session increased from 23 minutes to 47 minutes, but with a higher quality of interaction based on engagement metrics analysis.

Graph 1. Distribution of LMS Feature Usage



The distribution of LMS feature usage shows interesting patterns and provides in-depth insights into students' learning preferences as well as the effectiveness of the designs that have been developed. A dominating discussion forum with a 78% usage rate indicates that students have a strong need for social interaction in digital learning. This shows that even though learning is done online, the social and collaborative aspects remain the top priority of students. The high use of discussion forums also proves the effectiveness of

the application of artificial intelligence moderation which has succeeded in creating a safe, structured, and productive discussion environment.

The adaptive quiz that took second place with 65% of usage demonstrated students' appreciation for personalization of learning. This feature allows students to learn according to their individual pace and ability level, eliminating the frustration that often arises in rigid learning systems. This high level of usage also indicates that students appreciate the instant feedback the system provides, which allows them to quickly spot mistakes and improve their understanding. The consistent pattern of use of adaptive quizzes shows that students are not only using it as an evaluation tool, but also as a means of self-directed learning. A digital portfolio with a 59% usage rate shows students' awareness of the importance of documentation and reflection in the learning process. Although not as popular as discussion forums and adaptive quizzes, this significant level of use indicates that students are beginning to develop reflective habits and independent learning. Digital portfolios allow students to see their development over time, which contributes to increased affective engagement through a sense of accomplishment and self-confidence.

Progress boards with a 54% usage rate show that learning progress visualizations have a strong enough appeal for students. This feature provides a clear visual overview of student achievements, assignment deadlines, and areas for improvement. This moderate level of usage may be due to the more passive nature of the feature compared to other interactive features, but it still shows important value in supporting self-regulation and student time management. Peer assessment with a 48% utilization rate shows that while students value feedback from peers, there is still reluctance or discomfort in giving feedback on peer work. This may have to do with the teacher-centered educational culture and students' lack of experience in providing constructive feedback. However, the utilization rate that reaches almost half of the total students shows good potential for the development of critical thinking skills and communication skills.

An in-depth analysis of the distribution of use of these features reveals that students tend to be more active in using features that provide immediate benefits and instant gratification, such as discussion forums that allow for social interaction and adaptive quizzes that provide immediate feedback. Meanwhile, features that require deeper reflection or involve judging others show relatively lower levels of use, but are still significant. This usage pattern also indicates that the design thinking applied in LMS development has succeeded in creating a hierarchy of features that suit students' needs and preferences. Discussion forums and adaptive quizzes as core features manage to attract high engagement, while supporting features such as digital portfolios and progress boards provide additional value that supports end-to-end learning. The low use of peer appraisals relative to other features provides insights for further development, particularly in terms of student mentorship and training in providing constructive feedback.

DISCUSSION

The findings of this study show that the application of LMS-based learning media specifically designed to increase student involvement has a significant positive impact on the involvement and learning outcomes of SMA Negeri 1 Ketapang students. The increase in cognitive engagement by 34%, affective by 41%, and behavioral by 38% is in line with the findings of Bond et al. who stated that educational technologies designed with multiple dimensions of engagement in mind can improve overall student engagement in the context of higher education (Bond et al., 2020). Results of systematic evidence mapping involving 243 studies showed that LMS took the top spot as the most researched technology in relation to student engagement, followed by discussion forums, videos, lecture recordings, and chats (Bond et al., 2020). Recent research by B In a systematic review that examined 159 studies, it was confirmed that learning analytics research demonstrated an engagement approach using observable behavioral engagement measures such as clicks and task duration, with very few studies exploring different dimensions of engagement (Bergdahl et al., 2024). These findings confirm that LMS has great potential as a platform to increase student engagement when designed with the right approach.

The strong correlation between student engagement and learning outcomes ($R^2 = 0.72$) in this study is consistent with the findings of Fredricks et al. who stated that engagement has a strong explanatory power on student academic achievement, retention, and well-being (Fredricks et al., 2004). An empirical study by Wong & Liem reinforces this argument by stating that student engagement is a multidimensional construct that significantly predicts learning outcomes. The largest contribution of cognitive engagement ($\beta = 0.45$) to learning outcomes supports constructivistic learning theories that emphasize the importance of active and in-depth processing of information (Wong & Liem, 2022). Azer et al. in a comprehensive review of student engagement in health profession education emphasized that cognitive engagement involving deep processing and strategic thinking is the strongest predictor for academic achievement (Azer, 2023). Learning analytics research by Macfadyen & Dawson shows that although engagement and academic performance are correlated, time spent on educational resources as shown by learning analytics data does not necessarily correlate with academic performance (Macfadyen & Dawson, 2010). This reinforces the argument that the quality of engagement is more important than the quantity of time spent in the system, which is reflected in this study through improved interaction quality even though the duration of access increases.

A significant increase in the affective dimension (41%) shows the effectiveness of integrating gamification elements in LMS design in line with the latest meta-analysis on gamification in education. Bouchrika et al. A comprehensive meta-analysis examining studies from 2008-2023 found moderate to strong positive effects of gamification on academic performance, with factors such as the type and level of gamification, duration of intervention, and student demographics influencing the effectiveness of gamification

(Bouchrika et al., 2021). Nadi-Ravandi & Batooli in a meta-analysis examining 53 systematic reviews between 2010-2020 confirmed the effectiveness of gamification in improving academic achievement with moderate to strong positive effects (Nadi-Ravandi & Batooli, 2022). Gamification elements such as point systems, badges, and progress visualizations have been shown to increase students' intrinsic motivation, supporting El-Sabagh's finding that adaptive e-learning environments can increase engagement through personalization of the learning experience (El-Sabagh, 2021). García-López et al. in an empirical study show that gamification in the educational environment not only improves student engagement but also academic performance, with an emphasis on the importance of alignment between game elements and learning objectives and learner characteristics (García-López et al., 2023). Khaldi et al. in a systematic literature review on the gamification of e-learning in higher education affirm that choosing the right combination of game elements remains a challenge for designers and practitioners, and that no universal approach works regardless of the context of gamification (Khaldi et al., 2023).

The distribution of LMS feature usage that shows discussion forums as the most popular feature (78%) confirms the importance of social interaction in digital learning. Research by Chen et al. shows that discussion forums within LMS can encourage student engagement through social learning analytics, with peer interaction being a key factor in improving learning outcomes (Chen et al., 2018). The discussion forum with artificial intelligence moderation in this study succeeded in creating an environment conducive to peer learning, in line with the principle of social constructivism that emphasizes learning through social interaction. The high use of adaptive quizzes (65%) indicates students' appreciation for learning personalization and instant feedback, which supports adaptive learning theory in increasing engagement through customization according to individual ability. Nguyen et al. in their empirical study showed that computer-based assessment designs with direct feedback significantly impacted student engagement, satisfaction, and graduation rates (Nguyen et al., 2017).

The results of the Technology Acceptance Model measurement showing high scores on Perceived Usability (4.12/5.0) and Intention to Use (4.18/5.0) indicate that students do not only use the system out of obligation, but because they find it beneficial for their learning. A systematic review by Farhaan et al. of improved student engagement and performance evaluation showed that an integrated approach in quality LMS design significantly affects user acceptance and learning outcomes (Farhaan et al., 2024). The integration of artificial intelligence and LMS shows a significant impact on increased student engagement, personalized learning paths, and improved learning outcomes, with artificial intelligence-powered conversation agents and learning analytics in the LMS increasing student engagement and personalized support (Macfadyen & Dawson, 2010). The moderation of artificial intelligence in discussion forums and adaptive quizzes in this study represents a practical implementation of artificial intelligence-LMS integration that contributes to increased engagement and learning outcomes.

Consistent usage patterns with 89% of students accessing the system at least 5 days a week and an assignment completion rate of 89% indicates the sustainability of the engagement created. A systematic review by Ruiz et al. of complementary learning strategies shows that although gamification has a positive influence on student motivation, in the long run it can decrease, with the presence of novelty effects and extrinsic rewards that can lead to high motivation in the short term but decrease with further exposure (Ruiz et al., 2024). The findings of this study, which showed consistency of use over three months of implementation, indicate that a comprehensive LMS design with a wide range of interactive features can address the issue of novelty effects and maintain long-term engagement. An empirical study by Bonafini et al. confirms that students' engagement with videos and forums in mass online courses significantly affects achievement, with continuous interaction patterns being a key indicator of learning success (Bonafini et al., 2017).

The integration of learning analytics in the developed LMS provides valuable insights into student engagement patterns, in line with recent research trends that leverage log data to understand student learning behavior. Papamitsiou & Economides in a systematic literature review on learning analytics and educational data mining show that empirical evidence supports the use of learning analytics to measure and support student engagement (Papamitsiou & Economides, 2019). A systematic literature review by Zainuddin et al. of 46 empirical research papers between 2016-2019 identified three positive themes of gamification adoption: student engagement and motivation, academic achievement, and social connectivity, with gamification perceived to have mass appeal in stimulating motivation, learner engagement, and social influence (Zainuddin et al., 2020). The increase in the frequency of discussion forum posts from 2.3 to 8.7 per week in this study confirms the positive impact of gamification on social connectivity and collaborative learning. Ismail et al. in a systematic literature review on the exploration of student engagement with LMS using learning analytics showed that most engagement in LMS is driven by educators, but with the right design, students can become more active in the learning process (Nizam Ismail et al., 2021).

The implementation challenges found in this study, particularly related to technology infrastructure and digital literacy, are consistent with the literature showing that the adoption of educational technology in developing countries still faces structural barriers. Nhleko et al. in a systematic review of the impact of information and communication technology on student motivation showed that inadequate and inappropriate information and communication technology infrastructure can cause students to become unmotivated and have an unfavorable attitude towards blended learning (Nhleko et al., 2024). A systematic review by Ruiz et al. of the impact of gamification on school engagement identified several limitations in analog and digital gamification applications, including the need to design interventions that align with curricular goals to encourage meaningful student engagement (Ruiz et al., 2024). The fact that 23% of students still require intensive mentoring indicates the importance of a gradual and comprehensive

implementation strategy, with an emphasis on teacher training and ongoing support from educational entities. Lin et al. in a critical review of the impact of virtual reality on student engagement emphasized that introducing educational technology poses challenges including insufficient teacher proficiency and increased demands on students' digital literacy (Lin et al., 2024).

The theoretical contribution of this study lies in the validation of the ADDIE model enriched with the principles of student involvement in the Indonesian secondary education context, which shows that the framework that has been proven effective in the context of higher education can be adapted to the secondary education level with modifications that are appropriate to the characteristics of adolescent learners. Li et al. in a meta-analysis of 41 studies with 49 independent samples involving more than 5,071 participants showed that the integration of gamification into educational settings has the potential to improve student motivation, engagement, interest, and learning outcomes (Li et al., 2023). Reeve's four-dimensional student engagement framework applied in the context of medical education by Zhang et al. shows that behavioral, emotional, cognitive, and agentic engagement is significantly correlated with learning outcomes, providing empirical validation for multidimensional engagement approaches (Lin et al., 2024). The integration of gamification, adaptive learning, and social learning in a single platform has been proven to create positive synergies that increase engagement across the board, providing empirical evidence to support the development of comprehensive, student-centered LMS in the context of secondary education in Indonesia

CONCLUSION

This research succeeded in developing LMS-based learning media that significantly increased the involvement of SMA Negeri 1 Ketapang students, with an increase in cognitive involvement of 34%, affective 41%, and behavioral 38% through the integration of gamification, adaptive learning, and social interaction. A strong correlation between student engagement and learning outcomes ($R^2 = 0.72$) proves that student-centered LMS not only increases motivation but also academic achievement, with a gain score 11.4 points higher than conventional LMS. Successful implementation requires the support of technology infrastructure, digital literacy programs, and a change in the mindset of education stakeholders to address the challenges of internet connection and digital literacy variations. The ADDIE model, which is enriched by the principle of student engagement, has proven to be effective and can be adapted by other educational institutions, making a theoretical and practical contribution to the transformation of digital learning in Indonesia that is more inclusive and sustainable.

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