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LMS-BIDAK AS A DIGITAL LEARNING INNOVATION: EXAMINING THE ROLE OF USABILITY IN ENHANCING STUDENTS' LEARNING MOTIVATION AND CREATIVE THINKING

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Abstract

The integration of Learning Management Systems (LMS) in higher education has gained strategic importance, especially in the post-pandemic context. Nevertheless, empirical investigations into the effectiveness of locally developed LMS platforms such as BIDAK (Read, Identify, Discuss, Act, Conclude) in fostering university students' learning motivation and creative thinking remain limited. This study aims to examine the impact of LMS-BIDAK usability on students' motivation and creative thinking abilities within a higher education environment. Addressing a notable gap in the literature, the research highlights the scarcity of studies focused on the usability dimension of locally designed LMS platforms in Indonesian tertiary education. The novelty of this research lies in its contextual application of LMS-BIDAK and the use of a quantitative approach employing Partial Least Squares Structural Equation Modelling (PLS-SEM). The results reveal that LMS-BIDAK usability significantly influences learning motivation ($t = 26.438$; $p = 0.000$) and creative thinking ($t = 75.755$; $p = 0.000$), with R^2 values of 0.636 and 0.783, respectively. These findings underscore the critical role of system usability in enhancing the quality of digital learning experiences. The study implies that educational technology developers and policymakers must prioritise user-centred design to optimise student engagement and support the development of 21st-century competencies.

Keywords: LMS-BIDAK, learning motivation, creative thinking.

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INTRODUCTION

In the past, learning processes relied heavily on printed textbooks, manual libraries, and teachers as the primary sources of information (Haq et al., 2022), but in the era of the Fourth Industrial Revolution, education has shifted toward digital-based systems that enable broader access to information and support more effective learning (König et al., 2020; Arlinwibowo et al., 2020; Sefriani et al., 2021). Consequently, the concept of literacy has evolved significantly, no longer limited to reading and writing but encompassing the ability to comprehend, utilize, and respond to information from diverse sources (Hendriyani et al., 2022; Guerrero et al., 2024; Kurniaman et al., 2024), with strong connections to technological use for problem-solving, collaboration, and multimodal communication, making literacy a critical competency for the present and future (Pilgrim et al., 2013). In this context, rapid digital technology development has transformed education, particularly through the adoption of Learning Management Systems (LMS) in higher education, which function not merely as content repositories but as interactive environments shaping cognitive and affective learning experiences; however, their effectiveness depends not on availability but on usability, defined by ease of use, efficiency, and user satisfaction (Lund, 2001). This study is grounded in several theoretical frameworks, including the Technology Acceptance Model (TAM), which emphasizes perceived ease of use and usefulness as determinants of technology adoption (Bond et al., 2020), Self-Determination Theory (SDT), which highlights autonomy, competence, and relatedness as drivers of motivation (Deci & Ryan, 2000), and Constructivist Learning Theory, which posits that knowledge is constructed through interaction and problem-solving (Chiu, 2010); collectively, these frameworks explain how a highly usable LMS can reduce cognitive barriers, enhance motivation, and facilitate higher-order thinking processes such as creative thinking characterized by fluency, flexibility, originality, and elaboration.

While a substantial body of literature has examined the implementation of Learning Management Systems (LMS), several critical gaps remain, as most prior studies have focused on globally developed platforms such as Moodle or Blackboard with limited attention to locally developed LMS, particularly in higher education contexts in developing countries like Indonesia (Al-Fraihat et al., 2020; Adarkwah, 2021; Nisak, 2024), and have generally evaluated LMS effectiveness in broad terms without explicitly positioning usability as a central determinant of learning outcomes, despite evidence that usability significantly influences satisfaction, engagement, and system success (Joo et al., 2018; Revythi & Tselios, 2017; Yawan, 2025; Montes et al., 2024). Additionally, empirical studies that simultaneously examine the relationships among usability, learning motivation, and creative thinking within a unified Structural Equation Modeling (SEM) framework remain limited, even though digital learning environments are known to foster both motivation and higher-order thinking skills (Ouyang & Scharber, 2017; Lee, 2023; Shabani, 2022; Aminah, 2024), and few studies have explored

LMS designs grounded in specific pedagogical models such as the BIDAK learning flow (Read, Identify, Discuss, Act, Conclude) in relation to student engagement and creativity (Pratama, 2025). Addressing these gaps, this study investigates the effect of LMS-BIDAK usability on students' learning motivation and creative thinking in higher education using a Partial Least Squares Structural Equation Modeling (PLS-SEM) approach, thereby offering an integrative and contextually grounded contribution; in line with the broader transformation of higher education driven by digital technology (Rahayu, 2023; Solihat & Hendarsyah, 2022), LMS not only provides access to learning materials but also holds potential to enhance motivation and creative thinking (Cahyaningsih et al., 2023), although its effectiveness depends on design features that promote active engagement, which LMS-BIDAK structured around the BIDAK learning flow seeks to address by emphasizing intrinsic motivation and positioning technology as a facilitative medium to support autonomous learning among primary school teacher education students (Pratiwi, 2023; Retnoasih, 2023).

Several studies have indicated that creative thinking skills among university students remain in the low to moderate range, with variation across study programmes and instructional approaches (Shabani, 2022; Juliangkary et al., 2023). Fitriani et al. (2021) reported that only approximately 35% of students in their study demonstrated high proficiency in creative thinking indicators such as fluency, flexibility, originality, and elaboration (Tang & Wang, 2022; Lee, 2023). Research by Nugroho and Arifin (2022) further revealed that most students were not yet capable of generating original ideas, tending instead to rely on linear thinking when solving problems, with an average creative thinking score of only 60 out of 100. Internationally, a comparative study by Setiawan et al. (2020) found that only 27% of Indonesian students achieved high-level performance on STEM-based creative thinking tests, compared to their Malaysian counterparts. These findings are supported by Wijaya et al. (2021), who noted that traditional teaching methods such as lectures and rote memorisation continue to dominate Indonesian higher education, hindering the development of students' creative potential (Söbke & Reichelt, 2018). Furthermore, the World Economic Forum (2020) identified creative thinking as one of the top ten essential skills for the modern workforce, yet it remains a major challenge in higher education, particularly in developing countries.

Student motivation in reading literacy is a critical factor influencing text comprehension, learning engagement, and overall academic success, yet empirical evidence indicates that motivation levels remain relatively low, with approximately 57% of students categorized as having moderate motivation and only 18% demonstrating high motivation (Putri & Lestari, 2021), while intrinsic motivation is particularly limited as around 63% of students report reading primarily to complete assignments rather than from genuine interest or literacy awareness (Ramadhan & Nurhayati, 2022); internationally, Schiefele et al. found that students with higher reading motivation achieved better comprehension outcomes and that more than 70% of those with strong reading interest demonstrated advanced cognitive

strategy use, a finding supported by Taboada et al. who showed that motivation-based instructional strategies can increase reading motivation by up to 25%, underscoring the importance of context-based and interest-driven approaches. In parallel, previous studies indicate that Learning Management Systems (LMS) can enhance both motivation and creative thinking, such as research by Sudianto et al. demonstrating the effectiveness of project-based learning via Moodle in fostering creativity and autonomy, and Sukatiman et al. showing that mobile applications can stimulate creative thinking; however, limited research has specifically examined LMS designs integrating project-based and collaborative approaches like LMS-BIDAK, highlighting the need for further investigation into its effectiveness in improving students' motivation and creativity in higher education contexts.

The novelty of this study lies in the development and implementation of LMS-BIDAK as a digital learning innovation that integrates the BIDAK instructional sequence with project-based and collaborative approaches to enhance students' learning motivation and creative thinking skills, distinguishing it from conventional LMS platforms by emphasizing active engagement through challenging and collaborative tasks, while also providing empirical evidence to address the limited literature on innovative LMS effectiveness in Indonesian higher education and offering practical implications for improving learning quality. Based on this rationale, the study is guided by three research questions concerning the extent to which LMS-BIDAK usability influences students' learning motivation and creative thinking, as well as the strength of its predictive power within the structural model, leading to two hypotheses: H1 posits that LMS-BIDAK usability has a positive and significant effect on students' learning motivation, and H2 posits that LMS-BIDAK usability has a positive and significant effect on students' creative thinking skills.

METHODS

Research Design

This study employs a quantitative approach using Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine the relationships among LMS-BIDAK usability, learning motivation, and creative thinking. Although the initial design referred to a one-group time series with pre-test and post-test measurements, the present analysis focuses on structural relationships rather than temporal changes, thereby positioning the study as a cross-sectional explanatory design (Sugiyono, 2018). Data collected from a single experimental group were analyzed to test hypothesized relationships and assess measurement validity and structural paths using PLS-SEM. In practice, participants first completed a pretest to measure baseline levels of creative thinking and reading motivation, followed by treatment through LMS-BIDAK across several sessions, and concluded with a posttest to evaluate potential changes. While this design allows observation of trends before and after the intervention, the

interpretation in this study emphasizes the strength and significance of relationships among constructs rather than differences between pretest and posttest scores, ensuring methodological alignment with the analytical technique (Fraenkel, Wallen & Hyun, 2012; Creswell, 2014).

Table 1. One Group Time Series Design

Pre-tests	Treatment	Post-tests
T1	X1	T3
T2	X2	T4

T1, T2: Initial tests (Pre-tests) were conducted before the treatment was administered.
X1, X2: Treatment involved reading literacy instruction using the LMS-BIDAK platform.
T3, T4: Final tests (Post-tests) were carried out after the treatment.

Research Target/ Subject

The study employed purposive sampling to select participants who met criteria aligned with the research objectives, ensuring they had sufficient exposure to LMS-BIDAK for valid evaluation. The sample consisted of 310 undergraduate students, including 71 from Universitas Riau and 239 from Universitas Islam Riau, all enrolled in the Primary School Teacher Education (PGSD) program. Participants were required to be actively involved in courses using LMS-BIDAK, have completed LMS-based activities such as accessing materials, discussions, and assignments, and have at least one semester of experience (14–16 weeks). These criteria ensured adequate familiarity, supporting reliable assessment of usability, motivation, and creative thinking outcomes.

Instruments, and Data Collection Techniques

The two institutions were selected based on curriculum alignment, literacy teaching approaches, and readiness to implement LMS, along with prior experience in digital learning, ensuring appropriate contexts for evaluating LMS-BIDAK across diverse settings. The study measured three constructs: usability, learning motivation, and creative thinking. Usability was assessed using the USE Questionnaire (30 items), motivation through adapted Self-Determination Theory instruments (20 items), and creative thinking via Torrance-based measures (16 items). All items used a five-point Likert scale. Instruments were validated through expert judgment and pilot testing (n = 30), with reliability confirmed ($\alpha \geq 0.70$). The SEM model met convergent, discriminant validity, and reliability criteria.

Table 2. Instrument Grid for Usability Testing

No.	Indicator	Statement
1.	Utility	It helps me to be more effective
		It helps me to be more productive
		This is useful
		It gives me more control over the activities in my life.

		It makes the things I want to accomplish easier to do. It saves me time when I use it it meets my needs. it does everything i expected it to do
2.	Ease of use	Easy to use Practical to use It is user friendly It requires as few steps as possible to accomplish what I want to do with it. Flexible Using it is easy I can use it without written instructions. I didn't notice any inconsistencies when I used it. Both occasional and regular users will love it. I can recover from mistakes quickly and easily. I can use it successfully every time
3.	Ease of learning	I learned to use it quickly I can easily remember how to use it It's very easy to learn to use it I quickly became skilled with it
4.	Satisfaction	I am satisfied with that I would recommend it to a friend Very fun to use It functions as intended That's awesome It is considered necessary to have it It is convenient and satisfying to use

The learning motivation assessment instrument serves as an indicator of the effectiveness of the BIDAK Learning Flow LMS. Motivation reflects the level of comfort experienced during the learning process. The learning motivation questionnaire employed in this study utilises a Likert scale. The framework of the learning motivation instrument is presented in Table 3.

Table 3. Assessment Grid of Learning Motivation

Aspect	Sub Aspects	Statement
Self-motivation	Self-confidence	Believe in your own abilities.
	Ability to carry out tasks	Perform learning tasks in reading according to the instructions in the LMS.
	Desire to read	Complete a given reading and desire to understand the text.
Motivational drive arising from basic needs	Curiosity about learning concepts	Active in using various learning strategies to understand learning in reading literacy learning.

	Active in reading literacy learning	Active in carrying out activities of identifying, discussing, taking action and concluding the reading literacy learning process
Cognitive abilities	Able to connect with other understanding concepts	Carrying out creative thinking processes and problem solving in understanding a reading.
	Ability to link concepts between meetings	Constructing new knowledge based on their previous understanding.
Students' affective/emotional aspects	Participation in learning	Take the reading literacy learning process seriously by carrying out tasks independently.
Conducive learning environment	Comfort in the study room	Gain satisfaction in using LMS and reading texts that are interesting to read.

To measure reading literacy skills in relation to the aspect of creative thinking, particularly in addressing problems requiring creativity, it is essential to recognize that creative thinking leads to the generation of original ideas, commonly referred to as creativity. The assessment framework for creative thinking is presented in Table 4.

Table 4. Creative Thinking Assessment Grid

Aspect	Sub Aspects	Statement
Fluency	Formulating Answers	Answer questions with a number of facts in the reading text.
	Expressing ideas	Create ideas/hypotheses, according to what is read.
	Criticizing objects	Criticize errors in a reading topic.
Flexibility	Interpret	Providing a point of view on a topic in the reading.
	Looking for alternative answers	Thinking about how to solve the problem.
	Categorize	Categorize things based on different sections or categories.
Originality	Plan new things	Establishing new problems in understanding information in the text.
Elaboration	Troubleshooting with detailed procedures	Seeking deeper meaning about a problem, and developing ideas or thoughts.
	Testing	Trying to make something new.

Data Analysis Technique

Data analysis was conducted using SEM-PLS with SmartPLS, comprising two components: the measurement (outer) model and the structural (inner) model. The outer model evaluated relationships between indicators and latent variables using confirmatory

factor analysis with the MTMM approach, assessing convergent and discriminant validity. Convergent validity was determined by factor loadings (≥0.70, with 0.50–0.60 acceptable), while discriminant validity was assessed through cross-loadings and comparison of the square root of AVE with inter-construct correlations. Reliability was examined using Cronbach's Alpha and Composite Reliability (≥0.70), confirming that all constructs met the required validity and reliability standards for further analysis (Ghozali & Latan, 2015; Hair et al., 2017; Henseler et al., 2015).

RESULTS AND DISCUSSION

LMS-BIDAK has undergone a prototype feasibility test focused on the user interface for both lecturers and students. The first step for both parties involves registering via the link https://lms-bidak.thaifahmp.id/ by creating an account through the registration process. After registration, users can log in to their respective LMS-BIDAK accounts. Lecturers can then create virtual classrooms (courses) and utilise various features such as pre-tests and post-tests for assessment purposes. In addition, lecturers can upload course materials and grant students access to join the created classes. The use of LMS-BIDAK is intended to facilitate interaction between lecturers and students in the learning process. A more detailed explanation of these steps is illustrated in Figure 1.

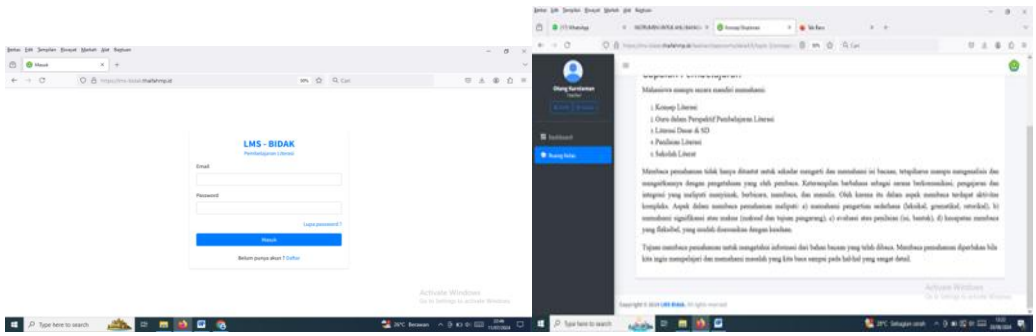

Figure 1. LMS-BIDAK Login Page

After lecturers complete the registration process and create courses for their classes, the course content is then filled in according to the stages outlined in the table above. Next, students register to join their respective classes by following these procedures: first, they access the LMS-BIDAK website; second, they register for an account; third, they log in to their LMS-BIDAK account; fourth, they join the designated course; fifth, they wait for confirmation of acceptance from the lecturer; sixth, they complete the pre-test and post-test; and finally, they participate in the course materials provided within the class.

Large-Scale Impact Test

The influence analysis was conducted using SmartPLS version 4.0.9 by modeling three variables: LMS-BIDAK usability (X), motivation (Y1), and creative thinking (Y2). The

sample consisted of 310 students, including 239 from UIR and 71 from UNRI. Variable coding was defined and presented in Table 5. The analysis proceeded through several stages, beginning with measurement model evaluation to assess validity and reliability. The validity test aimed to ensure that all constructs met the required criteria for further analysis, confirming their suitability for subsequent structural model testing.

Table 5. Research Variables and Variable Codes

No.	Variables	Variable Code
Usability		X
1.	Utility	X1
2.	Ease of Use	X2
3.	Ease of Learning	X3
4.	Satisfaction	X4
Motivation to learn		Y1
1.	Self Desire	Y1.1
2.	Need Drive	Y1.2
3.	Cognitive	Y1.3
4.	Affective / Emotional	Y1.4
5.	Conducive Learning Environment	Y1.5
Creative Thinking		Y2
1.	Smoothness	Y2.1
2.	Flexibility	Y2.2
3.	Authenticity	Y2.3
4.	Elaboration	Y2.4

Convergent Validity

Convergent validity assesses the extent to which indicators of a latent variable are strongly correlated and accurately represent the intended construct. It is evaluated in the measurement model by examining factor loadings and Average Variance Extracted (AVE). Indicators are considered valid if they have loading factors ≥ 0.60 and AVE values > 0.50, indicating adequate construct representation and reliability. This analysis ensures that all items significantly contribute to their respective constructs. The results of the outer model test, including outer loading values, were obtained using SmartPLS version 4.0.9.

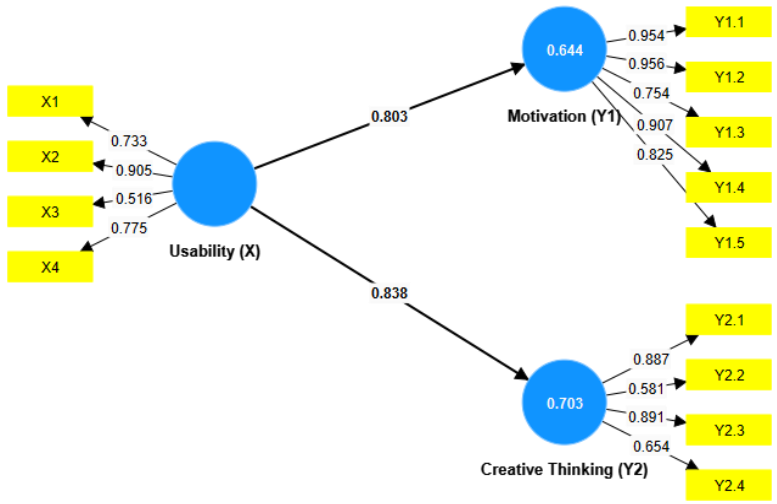

Figure 2. Results of Outer Loading Test

Figure 2 presents the results of the outer loading test, which reached ≥ 0.60, indicating adequacy, and the AVE values exceeding 0.5 demonstrate good results. In the outer loading test for variable X, among the four indicators, one indicator (X3) showed a loading below 0.60, with a result of 0.516 ≤ 0.60. Similarly, for variable Y2, one of the four indicators (Y2.2) also fell below 0.60, with a result of 0.581 ≤ 0.60. Meanwhile, all five indicators for variable Y1 exceeded the 0.60 threshold. The re-estimation results are presented in Table 6.

Table 6. Loading Factor Values of All Constructs

	Creative Thinking (Y2)	Motivation (Y1)	Usability (X)
X1			0.807
X2			0.913
X4			0.700
Y1.1		0.958	
Y1.2		0.959	
Y1.3		0.744	
Y1.4		0.909	
Y1.5		0.818	
Y2.1	0.895		
Y2.3	0.911		
Y2.4	0.649		

Referring to the re-estimated loading factor values presented in Table 6, all items within the constructs have met the standard criteria for convergent validity, as the factor loadings exceed 0.6. Therefore, the constructs are considered valid.

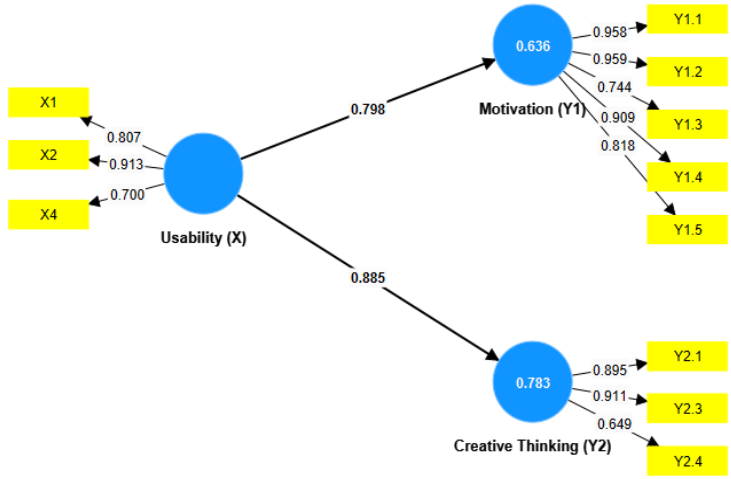

Figure 3. Results of the Re-Estimation of the Outer Loading Test

Convergent validity ensures that indicators are strongly correlated with their respective constructs and adequately represent the intended concept within the measurement model. In PLS-SEM, it is assessed using factor loadings (≥ 0.60) and Average Variance Extracted (AVE ≥ 0.50) (Hair et al.; Henseler et al.). The results show that most indicators meet these thresholds, with only a few slightly below but still acceptable after re-estimation, indicating adequate convergent validity. This confirms that the constructs are well-represented and reliable, providing a strong basis for structural analysis (Chin, 2010; Ringle et al., 2012).

Discriminant Validity

Discriminant validity refers to the cross-loading factor values, which are useful for determining whether a construct has adequate discriminant validity. This is indicated when each indicator has a higher loading value on the construct it is intended to measure compared to its loading values on other constructs. The results of the cross-loading factor test are presented in Table 7.

Table 7. Cross Loading Values

	Creative Thinking (Y2)	Motivation (Y1)	Usability (X)
X1	0.833	0.577	0.807
X2	0.782	0.734	0.913
X4	0.505	0.635	0.700
Y1.1	0.765	0.958	0.877
Y1.2	0.766	0.959	0.875
Y1.3	0.311	0.744	0.386
Y1.4	0.573	0.909	0.691
Y1.5	0.332	0.818	0.450
Y2.1	0.895	0.877	0.956
Y2.3	0.911	0.452	0.684
Y2.4	0.649	0.058	0.384

Discriminant validity was assessed to ensure that each construct is empirically distinct by examining cross-loadings, the Fornell–Larcker criterion, and the Heterotrait–Monotrait ratio (HTMT) (Henseler et al.; Hair et al.). Discriminant validity is achieved when the square root of AVE exceeds inter-construct correlations and HTMT values are below 0.85. The results indicate that all constructs meet these criteria, confirming adequate discriminant validity. Despite some relatively high cross-loading values, the overall measurement model is valid and suitable for further structural analysis.

Composite Reliability

To measure the reliability of a construct in PLS-SEM using the SmartPLS application, composite reliability is used. In the initial exploratory stage, a value between 0.60 and 0.70 is considered acceptable.

Table 8. Composite Reliability Test Results

	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
Creative Thinking (Y2)	0.781	0.903	0.864	0.684
Motivation (Y1)	0.931	0.991	0.945	0.777
Usability (X)	0.735	0.760	0.851	0.659

In this table, it can be seen that all variable values in the reliability tests using Cronbach's alpha and composite reliability are greater than 0.70. Therefore, it can be concluded that the tested variables are valid and reliable, allowing for the structural model testing to be conducted.

R-Square (R^2)

R-Square is used to measure the predictive power of the structural model. R-Squares indicate whether the influence of certain exogenous latent variables on the endogenous latent variables is substantial. The R-Square results are presented in Table 9.

Table 9. R-Square Results

	R-square	**R-square adjusted**
Creative Thinking (Y2)	0.783	0.783
Motivation (Y1)	0.636	0.636

Based on the reliability test results, all Cronbach's Alpha and Composite Reliability values exceed the threshold of 0.70, indicating that the instruments demonstrate strong internal consistency and meet the required reliability criteria for structural model analysis (Hair et al., 2019); therefore, all variables can be considered both valid and reliable, allowing further

analysis to proceed with adequate methodological confidence. In addition, the predictive power of the model, assessed using R-Square (R^2), shows that the Creative Thinking variable has an R^2 value of 0.783, meaning that 78.3% of its variance is explained by Usability, while 21.7% is influenced by other factors outside the model, and the Motivation variable has an R^2 value of 0.636, indicating that 63.6% of its variance is explained by Usability, with the remaining 36.4% attributed to external variables. These values indicate strong to substantial predictive power, consistent with Chin (1998), where R-Square values above 0.67 are categorized as substantial. Moreover, these findings align with previous studies, such as Fitria et al. (2021), which found that ease of use in digital learning platforms enhances learning motivation, and Sari and Setyawan (2020), which demonstrated that user-friendly interfaces facilitate creative thinking by reducing technical barriers, thereby confirming that the results are both statistically robust and empirically supported.

Hypothesis Testing

To determine whether a hypothesis is accepted or rejected, it can be assessed by examining the significance values between constructs, t-statistics, and p-values. Through this approach, measurement estimates and standard errors are no longer calculated based on statistical assumptions but are instead derived from empirical observations. In the bootstrap resampling method used in this study, a hypothesis is accepted if the t-value is greater than 1.96 and/or the p-value is less than 0.05; in that case, the alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected.

Table 10. T-Statistic Results

	Original sample (O)	Sample mean (M)	Standard deviation	T statistics (O/STDEV)	P values
Usability (X) -> Creative Thinking (Y2)	0.885	0.886	0.012	75.755	0.000
Usability (X) -> Motivation (Y1)	0.798	0.800	0.030	26.438	0.000

Hypothesis testing was conducted using a significance-based approach through bootstrap resampling, where hypotheses are accepted if t-statistics > 1.96 and p-values < 0.05 (Hair et al.). The results indicate that usability significantly affects creative thinking ($t = 75.755$; $p = 0.000$) and learning motivation ($t = 26.438$; $p = 0.000$), confirming that all hypotheses are accepted. These findings demonstrate that LMS-BIDAK usability enhances students' motivation and creative thinking, consistent with prior studies such as Al-Fraihat et al. and Adarkwah, and can be theoretically explained by the role of usability in reducing cognitive load and promoting engagement, thereby facilitating higher-order thinking processes (Ouyang & Scharber, 2017; Lee, 2023; Sukatiman et al., 2024). From a pedagogical

perspective, these results emphasize that effective digital learning depends not only on content delivery but also on user-centered system design that supports cognitive processes, requiring developers and educators to prioritize usability principles—such as simplicity, consistency, and accessibility—and integrate structured models like BIDAK to foster 21st-century skills, particularly creative thinking and self-directed learning; however, the study is limited by its cross-sectional design, restricted sample scope, and exclusion of variables such as self-efficacy and digital literacy, suggesting that future research should adopt longitudinal designs, broader samples, and additional variables to provide a more comprehensive understanding of digital learning effectiveness.

CONCLUSION

This study confirms that the usability of LMS-BIDAK significantly influences students' learning motivation and creative thinking in higher education. It positions usability not merely as a technical feature but as a pedagogical construct that enhances cognitive engagement and supports higher-order thinking when integrated with the structured BIDAK learning flow. The findings highlight that well-designed, user-centered LMS environments characterized by clear navigation, intuitive interfaces, and interactive features can effectively foster meaningful learning and 21st-century competencies. However, the results should be interpreted with caution due to the cross-sectional design and limited regional sample, which may affect generalizability. Overall, this study underscores the importance of aligning system design with instructional frameworks to optimize digital learning outcomes.

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