EDUCATIONAL : Jurnal Inovasi Pendidikan & Pengajaran
Vol. 5 No. 4, November 2025
E-ISSN : 2775-2593
P-ISSN : 2775-2585
Online Journal System : https://jurnalp4i.com/index.php/educational

SYNERGY OF LECTURERS' DIGITAL COMPETENCIES AND STUDENT AI LITERACY IN IMPROVING LEARNING RECOVERY IN STUDENT SMEs

Ririn Aulia[1], Sutiyono[2], Taridi[3], Arya Sura Prathama[4]
Buddhist Education Department, Jinarakkhita Buddhist College, Lampung, Indonesia[1,2,3,4]
e-mail: ririn.aulia@sekha.kemenag.go.id

ABSTRAK

Upaya pemulihan pembelajaran pascapandemi di perguruan tinggi Buddhis menghadapi tantangan berupa ketidakseimbangan antara kemampuan digital pendidik dan kesiapan teknologi mahasiswa, khususnya pada organisasi kemahasiswaan. Kondisi tersebut mendorong perlunya kajian mengenai bagaimana kompetensi digital dosen dan literasi kecerdasan buatan (AI) mahasiswa saling berkontribusi dalam mempercepat pemulihan pembelajaran. Penelitian ini menggunakan desain survei kuantitatif eksplanatori untuk menganalisis hubungan kausal kedua variabel dengan melibatkan 93 dosen pembina dan mahasiswa UKM yang diukur melalui kuesioner daring berskala Likert lima poin. Setelah memastikan validitas, reliabilitas, dan kelayakan model, analisis jalur digunakan untuk menguji pengaruh langsung maupun tidak langsung masing-masing variabel. Hasil penelitian menunjukkan bahwa kompetensi digital dosen dalam merancang, mengelola, dan memfasilitasi pembelajaran berbasis teknologi berkontribusi signifikan terhadap peningkatan keterlibatan dan kemampuan adaptasi mahasiswa. Selain itu, literasi AI mahasiswa terbukti memperkuat kemampuan berpikir kritis, kesadaran etis, dan regulasi diri selama proses belajar. Interaksi keduanya membentuk ekosistem pembelajaran digital yang responsif, inklusif, dan mendukung percepatan pemulihan pembelajaran. Secara keseluruhan, penelitian ini menegaskan bahwa penguatan kompetensi digital pendidik yang diintegrasikan dengan peningkatan literasi AI mahasiswa menjadi fondasi penting untuk membangun lingkungan pembelajaran yang tangguh serta berkelanjutan, sekaligus memberikan dasar empiris bagi kebijakan transformasi digital di perguruan tinggi.
Kata Kunci: *Kompetensi Digital, Literasi AI, Pemulihan Pembelajaran, Pendidikan Tinggi, Teknologi Pendidikan*

ABSTRACT

Efforts to restore post-pandemic learning in Buddhist higher education institutions face challenges arising from the imbalance between educators' digital competencies and students' technological readiness, particularly within student organizations. This situation underscores the need to examine how lecturers' digital competence and students' artificial intelligence (AI) literacy jointly contribute to accelerating learning recovery. This study employed an explanatory quantitative survey design to analyze the causal relationship between the two variables, involving 93 supervisory lecturers and student organization members who responded to a five-point Likert-scale online questionnaire. After ensuring validity, reliability, and overall model feasibility, path analysis was conducted to assess both the direct and indirect effects of each variable. The findings reveal that lecturers' digital competence in designing, managing, and facilitating technology-based learning significantly enhances students' engagement and adaptability. Moreover, students' AI literacy strengthens their critical thinking, ethical awareness, and self-regulation throughout the learning process. The interaction between these factors creates a responsive and inclusive digital learning ecosystem that supports the acceleration of learning recovery. Overall, the study emphasizes that integrating the enhancement of educators' digital competence with the development of students' AI literacy

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EDUCATIONAL : Jurnal Inovasi Pendidikan & Pengajaran
Vol. 5 No. 4, November 2025
E-ISSN : 2775-2593
P-ISSN : 2775-2585
Online Journal System : https://jurnalp4i.com/index.php/educational

forms a crucial foundation for building a resilient and sustainable learning environment, while also providing empirical support for digital transformation policies within higher education.
Keywords: *Digital Competence, AI Literacy, Learning Recovery, Higher Education, Educational Technology*

INTRODUCTION

After the COVID-19 pandemic, higher education institutions worldwide continued to encounter substantial challenges in restoring learning outcomes that were significantly disrupted during extended school closures. These challenges compelled systems across nations to initiate learning recovery as a structured strategy aimed at rebuilding instructional quality and elevating learners back to the expected competency levels through targeted interventions, strengthened pedagogical practices, and equitable access to learning resources (UNESCO, UNICEF, USAID, FCDO, & World Bank, 2022). The recovery agenda further emphasizes the importance of transformation-oriented learning approaches that integrate continuous assessment, reinforce foundational skills, and provide psychosocial support to sustain student engagement. As countries began transitioning into post-pandemic educational reforms, the urgency of addressing long-term learning loss became a critical priority for all levels of schooling.

In Indonesia, national initiatives such as the Independent Curriculum, supported by various digital transformation policies, represent a strategic response to closing competency gaps that emerged during the pandemic (Kemendikbudristek, 2021). These policy reforms are intended to strengthen learning continuity, enhance pedagogical flexibility, and accelerate the integration of technology across different educational levels. However, the transition toward digitally oriented learning environments also brings new demands for higher education institutions, particularly those with cultural or spiritual foundations. Such institutions must simultaneously navigate technological advancements and maintain the integrity of their contextual and philosophical identities, creating a unique set of challenges in adopting digital learning frameworks.

The success of learning recovery in this digital era is closely tied to the technological readiness and pedagogical capacity of lecturers, who play a crucial role in designing adaptive, ethical, and learner-centered instructional ecosystems. Lecturer digital competence includes the ability to integrate digital technologies into the planning, implementation, evaluation, and safeguarding of the learning process within higher education settings. International frameworks such as DigCompEdu, UNESCO ICT-CFT, ISTE Standards for Educators, and Jisc Digital Capabilities conceptualize digital competence as encompassing skills in platform management, multimedia content creation, interactive facilitation, and the application of ethical and cybersecurity principles (Redecker & Punie, 2017; Ilomäki et al., 2016; Spante et al., 2018). Research also indicates that digital competence includes the mastery of data protection, access management, and cyber readiness, which are essential for ensuring safe and effective digital learning environments (Eliza et al., 2024).

In Indonesia, the implementation of SPADA Indonesia has provided clearer operational guidelines for managing online learning, enabling measurable evaluation of lecturers' performance in LMS planning, content delivery, assessment practices, and student monitoring (Violla & Fernandes, 2021). These guidelines serve as a structured reference for ensuring that technology-enhanced learning aligns with institutional standards and student needs. The integration of such systems not only supports the continuity of digital learning but also contributes to strengthening digital accountability among lecturers. Consequently, lecturer

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digital competence emerges as a central factor in shaping the quality, responsiveness, and sustainability of learning recovery processes.

Alongside lecturer readiness, students' ability to recover from learning disruption is profoundly shaped by their level of artificial intelligence (AI) literacy, especially as AI becomes more embedded in academic workflows. Student AI literacy refers to the ability to understand foundational AI concepts, engage with AI tools appropriately, critically evaluate AI-generated information, and apply ethical reasoning when interacting with automated systems (Long & Magerko, 2020; Ng et al., 2021). Evidence from cross-national studies demonstrates that variations in AI literacy among students highlight the necessity of embedding AI-related competencies into higher education curricula to promote responsible digital behaviour and stronger academic preparedness (Mansoor et al., 2024). Ethical principles such as transparency, fairness, accountability, and risk awareness serve as the core of AI governance and are integral to evaluating students' knowledge, application skills, ethical sensitivity, and critical thinking (Nist, 2023; Mills et al., 2024; Veldhuis et al., 2025).

Despite extensive scholarship on digital competence and AI literacy, research that examines the integration of both domains in supporting learning recovery remains scarce. Most previous studies explore these constructs independently, leaving a critical gap in understanding how the synergy between digitally competent lecturers and AI-literate students can shape improved post-pandemic learning outcomes. This gap is even more pronounced in Buddhist higher education institutions or religious-based SMEs, where digital adoption intersects with institutional values and cultural practices, creating unique opportunities and constraints. Therefore, this study aims to analyse: (1) the extent to which lecturers' digital competence influences the learning recovery of SME students, (2) whether students' AI literacy mediates or moderates this relationship, and (3) how the synergy between both variables explains variations in learning recovery outcomes providing theoretical contributions to digital learning recovery models and practical insights for strengthening post-pandemic readiness.

RESEARCH METHOD

This study applied a quantitative explanatory method to examine the influence of lecturers' digital competence and students' AI literacy on learning recovery within Buddhist higher education institutions. The population consisted of supervisory lecturers and active UKM members, from which 93 respondents were selected using stratified random sampling to ensure proportional representation based on academic, social, and spiritual classifications. Data were collected through an online questionnaire designed with a five-point Likert scale and constructed from validated indicators for measuring digital competence, AI literacy, and learning recovery. Prior to use, the instrument underwent statistical validation using Pearson correlation and reliability testing with Cronbach's Alpha to ensure that all items met acceptable measurement standards. These procedures ensured that the dataset reflected accurate and consistent responses suitable for subsequent analysis.

The data collection process involved identifying eligible participants, distributing the online questionnaire, and checking the completeness and accuracy of responses before proceeding to analysis. Data analysis was carried out using SPSS version 26, with path analysis employed to assess both direct and indirect relationships among variables. To verify the appropriateness of the analytical model, classical assumption tests were conducted, including assessments of normality, multicollinearity, linearity, and heteroscedasticity. In addition, specific methodological steps such as proportional sampling across UKM categories and indicator-based scoring for each construct were implemented to enhance accuracy in evaluating the contribution of each predictor. These analytical procedures enabled a comprehensive

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Vol. 5 No. 4, November 2025
E-ISSN : 2775-2593
P-ISSN : 2775-2585
Online Journal System : https://jurnalp4i.com/index.php/educational

examination of how lecturer digital competence and student AI literacy jointly support learning recovery in the post-pandemic context.

RESULT AND DISCUSSION

Result

Descriptive Statistics

Descriptive statistics were examined to provide an initial overview of the tendencies of the three main variables: lecturer digital competence, student AI literacy, and learning recovery. These data help illustrate the general condition of respondents before conducting deeper inferential analysis. The overall mean scores of each variable indicate positive tendencies that suggest a moderate level of technological readiness among both lecturers and students. To present these tendencies clearly, Table 1 summarises the mean, standard deviation, and categorical interpretation of each variable.

Table 1. Descriptive Statistics of Research Variables

Variable	Mean	SD	Category
Digital Competence	3.25	0.47	Medium–High
Student AI Literacy	3.47	0.51	Medium–High
Learning Recovery	3.54	0.44	Medium–High

The descriptive results in Table 1 confirm that all three variables fall within the medium-to-high category, reflecting a generally supportive environment for digital and AI-integrated learning. These tendencies provide the foundation for analysing how each variable contributes to post-pandemic learning recovery. With this baseline understanding, subsequent statistical tests can be interpreted more accurately and contextually.

Validity and Reliability Testing

After analysing the descriptive tendencies, instrument quality testing was conducted to ensure that all measurement items met the standards of validity and reliability. Validity testing indicated that all item correlations exceeded the minimum acceptable value, demonstrating that the indicators functioned properly. Reliability testing was then performed using Cronbach's Alpha to determine the internal consistency of the instruments. The results of this reliability test are presented in Table 2.

Table 2. Summary of Instrument Reliability

Variable	Number of Items	Cronbach's Alpha
Digital Competence	11	0.749
Student AI Literacy	14	0.771
Learning Recovery	11	0.782

The results in Table 2 show that all constructs have Cronbach's Alpha values above 0.70, indicating strong internal consistency across all indicators. This means that the instrument is statistically dependable and can be used confidently in the subsequent analytical stages. With the instrument validated and reliable, the study moves forward to classical assumption testing to determine the feasibility of regression analysis.

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E-ISSN : 2775-2593
P-ISSN : 2775-2585
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Classical Assumption Testing

Classical assumption tests were carried out to ensure that the dataset met regression prerequisites such as normality, multicollinearity, homoscedasticity, and linearity. Normality testing confirmed that the residuals were approximately normally distributed, supporting the suitability of the regression model. Multicollinearity testing showed all tolerance and VIF values within acceptable ranges, indicating no risk of multicollinearity between predictors. Homoscedasticity and linearity were assessed using the residual scatterplot presented in Figure 1.

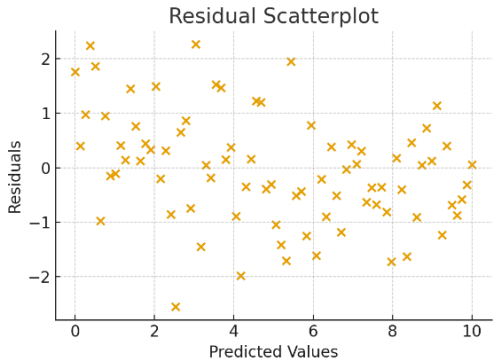

Figure 1. Residual Scatterplot of the Regression Model

The scatterplot in Figure 1 demonstrates a random distribution of residuals without clear patterns, satisfying both the linearity and homoscedasticity assumptions. This indicates that the relationship between variables is consistent across the predicted values and that the regression model is suitable for further inferential analysis. With all assumptions met, the analysis proceeds to examine the direct effects of each variable through simple regression.

Simple Regression Results

Simple regression analyses were conducted to examine how each predictor individually influences learning recovery. This approach helps identify the strength of the direct relationship before analysing combined effects. The results of the simple regression tests are summarised in Table 3, showing the respective R and R^2 values for each predictor. These values indicate how much variance in learning recovery is explained by each variable independently.

Table 3. Summary of Simple Regression Analyses

Predictor	R	R^2	Interpretation
Digital Competence	0.811	0.658	Strong effect
Student AI Literacy	0.539	0.290	Moderate effect

As shown in Table 3, lecturer digital competence contributes a substantial 65.8% to the variation in learning recovery, marking it as a strong predictor. Student AI literacy also shows a meaningful influence with 29% explained variance, highlighting its role in supporting students' post-pandemic academic adjustment. These findings confirm that both variables have significant individual effects and justify further examination of their combined impact through multiple regression.

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E-ISSN : 2775-2593
P-ISSN : 2775-2585
Online Journal System : https://jurnalp4i.com/index.php/educational

Multiple Regression Results

Multiple regression analysis was employed to assess the joint influence of lecturer digital competence and student AI literacy on learning recovery. This analysis allows for evaluating whether the combination of predictors improves explanatory power beyond their individual contributions. The statistical summary of the model is presented in Table 4, which includes the R, R^2, adjusted R^2, and significance values.

Table 4. Multiple Regression Model Summary

Model	R	R^2	Adjusted R^2	Sig.
1	0.835	0.698	0.691	.000

The results in Table 4 indicate that the combined predictors explain 69.8% of the variance in learning recovery, which is higher than their individual contributions. This demonstrates a strong synergistic effect, meaning that learning recovery is most effectively enhanced when both lecturer digital competence and student AI literacy operate together. The significance level of $p < .001$ confirms that the model is statistically valid and offers meaningful insights into digital learning readiness in post-pandemic Buddhist higher education.

Discussion

The findings of this study indicate that lecturer digital competence plays a central role in shaping the quality and direction of learning recovery within student SMEs. The significant influence observed in the analysis demonstrates that digitally competent lecturers are more capable of constructing structured learning workflows, facilitating interaction, and sustaining student engagement across diverse technological environments. These results are consistent with the six dimensions of DigCompEdu, which emphasise the importance of pedagogical design, digital resource curation, assessment practices, and learner empowerment as foundations for effective digital learning (Redecker & Punie, 2017). In small learning communities such as student SMEs, these competencies become even more crucial because activities depend heavily on project coordination, peer collaboration, and iterative reflection, all of which rely on organised digital facilitation.

In addition to the structural role of lecturer competence, the study confirms that digital feedback mechanisms contribute significantly to the acceleration of learning recovery. The analysis shows that when lecturers provide timely and clear feedback through digital tools, students are more motivated to review, refine, and improve their work. This conclusion aligns with evidence from national research which demonstrates that constructive and consistent feedback has a measurable impact on student engagement and academic improvement in Indonesian higher education (Suhardiana 2024). Within the recovery context, feedback becomes more than an evaluative practice; it evolves into a formative dialogue that supports students' emotional readiness, learning persistence, and confidence in managing complex academic tasks.

Self-regulated learning (SRL) also emerges as a critical mechanism underlying students' recovery progress. The results suggest that when digital environments are structured and supported by lecturer guidance, students develop stronger SRL habits, such as planning, monitoring, and reflecting on their learning processes. These findings are in line with Panadero's (2017) synthesis, which highlights that SRL acts as an internal recovery engine that enables learners to regain autonomy after major disruptions. The integration of digital planners,

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reflective journals, and other technology-supported tools strengthens these routines, helping students sustain productive learning habits that continue beyond the immediate recovery phase.

Student AI literacy further enhances the recovery process by enabling learners to use AI tools selectively, critically, and ethically. The study shows that students with higher AI literacy demonstrate superior abilities in generating ideas, organising tasks, validating AI outputs, and avoiding uncritical dependence. These findings support Long and Magerko's (2020) conceptualisation of AI literacy, and are reinforced by recent empirical work showing how AI competencies contribute to students' critical thinking and learning adaptability (Chiu et al., 2024). Moreover, evidence from AIED research demonstrates that AI applications profiling, prediction, adaptive learning, and intelligent tutoring help diagnose learning problems early and personalise learning pathways (Zawacki-Richter et al., 2019), reinforcing the positive relationship found in this study.

However, the findings also echo concerns raised in prior scholarship about the ethical and pedagogical risks associated with AI integration. Zawacki-Richter et al. (2024) caution that increased reliance on AI may introduce challenges related to data privacy, algorithmic bias, and weakened critical thinking if not mediated by adequate literacy and ethical awareness. The patterns observed in the present study support this view, as students who demonstrated lower AI literacy tended to rely more heavily on AI-generated outputs without verification. This highlights the importance of embedding ethical sensitivity, verification routines, and reflective use of AI into learning environments to ensure that AI functions as a tool for enhancement rather than substitution.

The synergy between lecturer digital competence and student AI literacy is one of the most striking outcomes of this research. The results reveal that when lecturers provide structured digital orchestration, and students simultaneously engage with AI tools critically and reflectively, a reciprocal cycle of feedback, iteration, and refinement emerges. This dynamic interaction mirrors arguments from AIED and digital pedagogy research, which emphasize that technology-supported learning reaches its full potential only when human and technological competencies reinforce each other (Long & Magerko, 2020). In the context of learning recovery, this synergy produces deeper engagement, more rapid improvement, and greater student autonomy.

This alignment is consistent with global frameworks such as ISTE (2024) and the UNICEF (2022) *Educators' Digital Competence Framework*, both of which emphasize the need to develop learning ecosystems that are digitally innovative, ethically grounded, and learner-centered. These frameworks reinforce the argument that recovery is not merely about restoring lost academic time but about transforming learning into a more resilient, reflective, and future-ready process. The present study adds empirical support to this perspective by demonstrating that structured digital practices from lecturers and critical AI engagement from students jointly shape the quality of recovery outcomes.

Overall, the results of this study underscore that learning recovery in higher education must be understood as a systemic process that integrates pedagogical design, feedback, self-regulation, digital competence, and AI literacy. The findings not only reaffirm established theoretical propositions but also extend the literature by providing empirical evidence from the underexplored context of Buddhist higher education and student SMEs. This contribution is particularly significant because few studies have examined the combined influence of lecturer digital competence and student AI literacy within small, values-oriented academic communities. The study therefore offers a novel perspective by demonstrating how the interplay between these competencies fosters a more sustainable, adaptive, and ethically responsible recovery trajectory.

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EDUCATIONAL : Jurnal Inovasi Pendidikan & Pengajaran
Vol. 5 No. 4, November 2025
E-ISSN : 2775-2593
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CONCLUSION

The results of this study demonstrate that learning recovery within higher education particularly in student SMEs depends strongly on the interplay between Lecturer Digital Competence and Student AI Literacy. When lecturers possess solid digital pedagogical abilities, they are able to organise learning processes more coherently, facilitate interaction in digital environments, and deliver timely, meaningful feedback that strengthens students' academic progress. At the same time, students with adequate AI literacy are better positioned to interpret information critically, utilise AI tools responsibly, and engage in reflective learning that deepens their understanding. This synergy creates an adaptive and ethically grounded learning ecosystem capable of supporting recovery that is not only rapid but also transformative in nature.

Despite the value of these findings, several limitations must be recognised. The study was conducted within a relatively small institutional setting and involved a limited number of student SMEs, which may constrain the extent to which the results can be generalised to broader higher education contexts. The cross-sectional nature of the design also limits the ability to infer long-term causal relationships or developmental changes in students' digital and AI competencies. Furthermore, variations in participants' prior exposure to digital tools and AI systems may have influenced the consistency of their responses. These constraints highlight the need for cautious interpretation of the outcomes, especially when considering broader educational ecosystems with more diverse infrastructures and learner backgrounds.

Based on the findings and limitations, several recommendations can be drawn for future practice and research. Higher education institutions are encouraged to strengthen professional development programs that enhance lecturers' digital competence, particularly in digital instructional design, feedback practices, and ethical technology integration. Universities should also embed AI literacy into curricula through experiential, reflective, and ethically oriented learning activities that cultivate responsible and critical use of AI tools. Future research could adopt longitudinal or mixed-method approaches to explore developmental patterns, learning behaviours, and qualitative dimensions of digital-ethical engagement that are not fully captured by quantitative measures. By advancing these efforts, higher education can build resilient, future-ready learning environments in which digital competence and AI literacy jointly enhance sustainable learning recovery.

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