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Evaluating Learning Management System Adoption Effectiveness for Educators and Students in Batam Higher Education

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Abstract

The rapid expansion of digital technology and online platforms is reshaping higher education, driving widespread adoption of Learning Management Systems (LMS) and synchronous ICT tools for teaching and learning. As institutions increasingly rely on these technologies, it is essential to understand their effectiveness in supporting educational transformation rather than simply digitizing traditional practices. This study investigates the perceived integration and impact of LMS and ICT tools among students and educators across six universities, using the Technological Pedagogical Content Knowledge (TPACK) framework. A quantitative survey of 579 respondents assessed seven TPACK domains with reliable measurement instruments. Descriptive statistics, t-tests, correlation, and regression analyses were employed to compare perspectives and identify key predictors of successful technology integration. Results reveal that both groups express positive views of LMS and ICT, with all TPACK constructs rated above 3.8. Educators report higher self-assessed competencies, particularly in technological and pedagogical domains, although the differences are statistically significant but practically minor. Strong correlations among TPACK factors and regression modeling highlight Technological Pedagogical Knowledge and Technological Content Knowledge as the most important predictors of effective integration, underscoring the importance of system supported pedagogical design and content delivery rather than simple content digitization. Despite robust infrastructure and readiness, the findings suggest that LMS and ICT are primarily used to support rather than truly transform learning experiences. The study contributes to educational information systems literature by providing empirical evidence on user perceptions and the need for a system design strategies to achieve more innovative, student centric, technology-enhanced education in Batam.

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INTRODUCTION

Advancements and innovations in technology are unavoidable, and as such, they have affected various aspects of our daily life, including innovative methods adopted for education and training. (Kant et al., 2021). The digital age has transformed the delivery of education, with the Learning Management System, alongside other Information and Technology Tools (ICT), emerging at the forefront of this change. A learning management system offers a single, centralized platform for delivering educational content, communicating between educators and students, and managing learning activities in various formats. They play an important role both in face-to-face and virtual teaching and learning, especially in the higher education context (Al-Mamary et al., 2024; Fibriasari et al., 2023). These technological advancements have made the learning and teaching process more dynamic and interactive, fundamentally altering the relationship between instructors and learners while enhancing the overall value of education (Turnbull et al., 2022).

The transition towards online and hybrid learning was further accelerated by the COVID-19 pandemic, which forced educational institutions to adopt digital platforms abruptly (Htet et al., 2023; Suwarno, 2022). LMS and synchronous platforms such as Zoom, Google Meet, and Microsoft Teams became the backbone of instructional delivery (Reich, 2021). Even in the post-pandemic period, educational institutions continue integrating LMS and ICT tools into their practices to support offline and online learning environments (Khoza & Mpungose, 2022). However, this accelerated shift also revealed challenges. Studies found that although LMSs are effective for delivering content, educators often struggle to use them to foster active collaboration and deeper learning (Quesada et al., 2023; Simon et al., 2024). Issues such as digital literacy gaps, limited technical support, and resistance to change can hinder successful LMS adoption (Alqahtani & Rajkhan, 2020; Mahyoob, 2020). Meanwhile, students continue to express a preference for real-time interaction, suggesting that, without synchronous support, LMS alone may fail to replicate the engagement and immediacy of traditional classroom settings (Ayubi & Retnowardhani, 2025; Richards & Thompson, 2023).

These issues suggest that the success of LMS and ICT implementation in higher education is not determined only by its availability, but rather by how it is integrated into the teaching and learning process. Research increasingly indicates that the root of online. Learning challenges lie in insufficient pedagogical integration of technology (Al-Fraihat et al., 2020; Chai et al., 2020). Therefore, the Technological Pedagogical Content Knowledge (TPACK) framework has become an essential foundation for evaluating and improving digital teaching practices. TPACK emphasizes that effective use of LMS and ICT requires synergy between technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) (Mishra & Koehler, 2006)

Without this synergy, LMSs risk functioning merely as digital repositories rather than platforms that truly enhance learning (Brown et al., 2020). This is particularly important in the context of higher education in Batam City, where varying levels of digital literacy among students can pose challenges to effective learning.

Recent studies demonstrated that the TPACK framework provides a structured and effective approach for integrating technology into teaching. For example, Selvanathan et al. (2023) it was shown that applying TPACK in blended learning significantly improves instructional coherence and student learning outcomes. Similarly, (Huq Shamim et al., 2024) found that lecturers' perceptions of ICT-based teaching within the TPACK model strongly support interactive and constructive classroom engagement.

However, a notable gap exists in existing literature, where most studies focus on educators' experiences and competencies, with limited attention to how students perceive the integration of technology, pedagogy, and content. This creates a critical research gap in the online learning environment, where student perspectives are equally important in assessing the effectiveness of digital teaching. As such, assessing the effectiveness of these technologies from both perspectives through the TPACK lens is necessary to ensure that technology becomes a driver of innovation rather than a substitute for traditional teaching. Thus, this study aims to examine how LMS and synchronous ICT tools are integrated in higher education in Batam City by comparing students' and lecturers' perceptions across the TPACK components. This study not only assesses the adaptability of teaching methods, the delivery of content, and the effectiveness of learning, but also pinpoints the least successful aspects of LMS and ICT integration, highlighting current implementation issues. The results are anticipated to provide evidence-based insights that help refine digital

teaching methods, improve collaborative and interactive online learning experiences, and assist higher education institutions in making informed strategic decisions about technology-enhanced learning environments.

RESEARCH METHODS

This research (Figure 1) adopts a quantitative comparative design to analyze the different perceptions between two groups, which consist of the students and educators' group, regarding the effectiveness of the implementation based on the seven constructs of the TPACK framework. Prior to data collection, a literature review was conducted to identify relevant measurement indicators for the constructs consistent with previous studies on LMS, ICT, and TPACK in higher education. The result of this literature review serves as a guide in the development of the conceptual model and research tool.

Sample size calculation was performed using G*Power 3.1, targeting a medium effect size (f^2) of 0.15, a power of 0.95, and an error (α) of 0.05. Given six variables, the calculation determined that N = 146 is required for the multiple regression model, and a separate a priori power analysis for independent-samples t-tests suggested minimum group sizes of 88 respondents each. In practice, a total of N = 579 valid responses were collected across six major higher education institutions in Batam, comprising N = 390 students and N = 189 lecturers. This study uses non-probability convenience sampling, selecting participants directly from those with firsthand experience with LMSs and synchronous ICT in educational settings. As noted by Etikan, (2016), convenience sampling is appropriate when participants possess the necessary characteristics and facilitate extensive involvement within the target group. Furthermore, this research specifically targeted higher education institutions that actively use LMS, meaning not all universities in Batam were included in the study, and only universities that have already integrated LMS into their academic processes were chosen to ensure that the responses gathered reflect genuine experiences with LMS and ICT integration.

The data were obtained through an online questionnaire consisting of the seven constructs of the TPACK model, measuring Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and overall TPACK, which were adapted from the validated instrument developed by Huq Shamim et al. (2024) as an indicator of perceived learning effectiveness. In this study, these constructs act as a comprehensive framework to evaluate LMS effectiveness. Technological Knowledge (TK) assesses the users' fundamental proficiency in operating the LMS platform, while Pedagogical Knowledge (PK) evaluates the adaptability of the teaching strategies employed to foster student engagement. Content Knowledge (CK) measures the clarity and mastery of the subject matter being delivered digitally. The intersecting domains, Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK), evaluate how effectively educators align their teaching methods with digital materials, use technology to clarify complex subjects, and select appropriate LMS features to enhance their pedagogical approach, respectively. Finally, the TPACK construct measures the integration of all three foundational elements to create a successful digital learning environment, as detailed in Table 1. The items were evaluated on a 5-point Likert scale, with options ranging from 1 (strongly disagree) to 5 (strongly agree). Table 1 summarizes the number of indicators for each construct along with representative measurement dimensions adapted from previous studies on LMS and ICT in higher education.

Table 1. Construct Used in Instrument

Construct	Code	Items
Technological Knowledge	TK	6
Pedagogical Knowledge	PK	5
Content Knowledge	CK	3
Pedagogical Content Knowledge	PCK	3
Technological Content Knowledge	TCK	3
Technological Pedagogical Knowledge	TPK	4
Technological Pedagogical Content Knowledge	TPACK	4

The survey was shared digitally via institutional communication channels, including student and lecturer email groups and WhatsApp networks, across six universities in Batam. Participation was voluntary, anonymous, and restricted to those with previous experience in LMS and ICT learning or teaching to ensure the relevance of the responses. The collected data were analyzed using descriptive and inferential statistics. Descriptive analysis was used to examine mean responses for each construct to evaluate the perceived implementation of LMS and ICT. Independent samples t-tests were

conducted to identify differences in perceptions between students and lecturers. Pearson correlation analysis was applied to examine relationships among the seven TPACK constructs. Classical assumption tests were performed before multiple linear regression to ensure the validity of the regression models. Linearity and homoscedasticity were tested through scatterplots of standardized residuals against standardized predicted values. Residual independence was evaluated using the Durbin–Watson statistic. Normality of residuals was examined using normal probability plots (P–Plots) and histograms of standardized residuals. Multicollinearity was assessed using the Variance Inflation Factor (VIF) and tolerance values; VIF < 10 and tolerance> 0.10 were considered acceptable. Finally, multiple linear regression was used to determine the extent to which TK, PK, CK, PCK, TCK, and TPK predict the overall TPACK integration in learning. All analyses were conducted using SPSS version 25, and results were evaluated based on probability value (p), standardized coefficients (β), and coefficient of determination (R^2) to support interpretation.

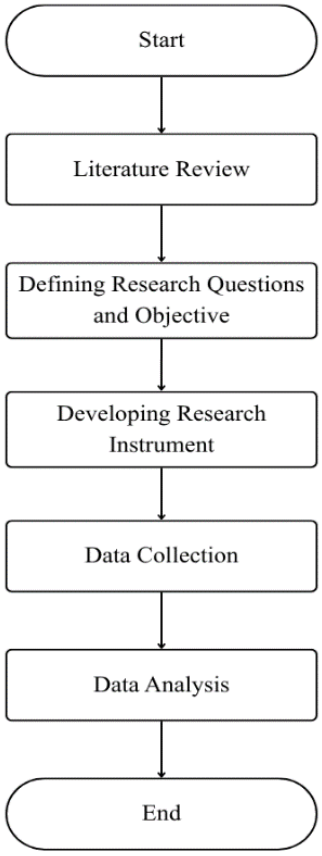

Figure 1. Research flow

RESULT AND DISCUSSION

All measurement constructs in this study are confirmed to be reliable, as indicated by Cronbach's alpha values well above the 0.7 threshold for each TPACK.

Table 2. Reliability Analysis

Construct	Students (α)	Lecturers (α)
TK	0.895	0.914
PK	0.892	0.886
CK	0.759	0.875
PCK	0.803	0.840
TCK	0.834	0.856
TPK	0.891	0.902
TPACK	0.876	0.886

Statistical significance of differences between students and educators is assessed using p-values from independent-samples t-tests, with values below 0.05 considered significant and representing genuine differences in perceptions. Further, relationships between the various TPACK constructs are interpreted using correlation coefficients (r values offer insight into the integrative effects of technological, pedagogical, and content knowledge within the LMS, mirroring IS literature that highlights the importance of information, system, and service quality in shaping user satisfaction and net benefits (Al-Fraihat et al., 2020; Aripradono et al., 2025). These combined criteria support the reliability of the data, group comparisons, and associations reported in the following sections, which are robust, reliable, and statistically meaningful.

Both students (M = 3.96) and educators (M = 4.08) rated Pedagogical Knowledge (PK) positively, and the difference was statistically significant (p = 0.030; see Table 3). However, the effect size was small (Cohen's d = 0.16), suggesting that while lecturers rated their ability to adapt teaching strategies slightly higher, the magnitude of the difference is modest.

Table 3. Mean, SD, and t-Test Results

	Students (Mean ± SD)	Lecturers (Mean ± SD)	t-value	p-value
TK	4.21 ± 0.84	4.38 ± 0.46	-3.13	0.002
PK	3.96 ± 0.92	4.38 ± 0.46	-2.17	0.030
CK	4.04 ± 0.92	4.22 ± 0.50	-2.99	0.003
PCK	3.79 ± 1.00	3.88 ± 0.49	-1.35	0.178
TCK	3.89 ± 0.95	3.98 ± 0.51	-1.43	0.152
TPK	3.78 ± 0.97	3.92 ± 0.54	-2.04	0.042
TPACK	3.82 ± 0.98	3.86 ± 0.48	-0.55	0.582

This suggests that educators perceive themselves as capable of adapting teaching strategies to promote student engagement using LMS and synchronous tools such as Google Meet or Microsoft Teams. However, students' slightly lower rating suggests that interaction and engagement through LMS could still be improved. This supports IS perspectives that user experience and interaction quality are essential for system effectiveness. (Fantiro et al., 2025) found that while teachers often integrate ICT confidently, pedagogical creativity determines whether students feel engaged. Similarly, (Ruijuan et al., 2023) showed that online learning success depends on the extent to which instructors design active and collaborative learning experiences rather than simply digitizing lectures. Hence, while Batam educators demonstrate competent pedagogical adaptation, enhancements to LMS interactivity and feedback mechanisms could improve overall system utility and user satisfaction.

Students rated Content Knowledge (CK) at M = 4.04, slightly lower than educators (M = 4.22), and the difference was statistically significant (p = 0.003; see Table 3). This suggests that educators believe they are more effective in integrating ICT for content delivery than students perceive them to be. This discrepancy reflects differences in evaluation standards, where educators may focus on the accuracy and organization of digital materials, whereas students assess effectiveness based on clarity, comprehension, and engagement. This highlights the importance of information quality and its impact on perceived system effectiveness. Interactive, multimedia-enriched learning resources can enhance information quality, thereby improving user satisfaction and learning outcomes (Mulyono et al., 2025). Therefore, further improvement can be made by adopting an interactive, multimedia-based learning resource that better supports engagement, comprehension, and application.

Pedagogical Knowledge (PK) differed significantly between groups (p = 0.030), whereas Pedagogical Content Knowledge (PCK) did not (p = 0.178), indicating modest perception gaps regarding ICT-mediated teaching strategies. The small effect size for PK suggests a limited practical difference. This aligns with IS findings that system quality and user interaction influence perceived effectiveness of technology-mediated processes (Nguyen, 2021). In Batam's higher education context, while educators effectively integrate pedagogical principles digitally, improving learner-centric engagement through LMS interfaces could enhance system utility.

Table 4. Correlation Among TPACK Constructs

Student Group							
	1	**2**	**3**	**4**	**5**	**6**	**7**
(1)TK	1						
(2)PK	0.48	1					
(3)CK	0.39	0.44	1				
(4)PCK	0.42	0.50	0.75	1			
(5)TCK	0.62	0.50	0.38	0.31	1		
(6)TPK	0.65	0.48	0.45	0.35	0.72	1	
(7)TPACK	0.59	0.45	0.72	0.30	0.70	0.73	1
Lecturer Group							
	1	**2**	**3**	**4**	**5**	**6**	**7**
(1)TK	1						
(2)PK	0.39	1					
(3)CK	0.38	0.44	1				
(4)PCK	0.41	0.47	0.70	1			
(5)TCK	0.59	0.33	0.46	0.45	1		
(6)TPK	0.60	0.44	0.48	0.49	0.67	1	
(7)TPACK	0.51	0.37	0.34	0.34	0.61	0.57	1

Correlation analysis consistently demonstrated strong, positive connections among all seven TPACK constructs. This suggests that respondents who reported higher levels in one competency also tended to report higher levels in related competencies. Such patterns may reflect the interconnected nature of technological, pedagogical, and content knowledge in digitally mediated teaching environments, highlighting the importance of considering them as interdependent dimensions in understanding digital teaching practices. For students, the most significant correlations were found between Content Knowledge (CK) and Pedagogical Content Knowledge (PCK) (r = 0.745), as well as between Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) (r =

0.715). This pattern is consistent (Li & Zhu, 2022), who report that higher perceptions of information quality and system functionality tend to be associated with more positive views of content delivery and interactive system features.

Among educators, similarly strong connections were noted: CK and PCK (r = 0.702) and TPK and TCK (r = 0.696). These findings underscore the importance of mutually reinforcing system attributes, such as reliability, user-centered design, and support features in creating effective, technology-mediated instructional experiences for all user groups. In this context, the findings are consistent with the view that successful adoption of advanced LMS may involve both the development of individual competencies and supportive system qualities that ensure robust, integrated use and satisfaction.

Before interpreting the predictive models, the validity of the data was established using classical assumption tests. The results (Table 5) confirm that the data are statistically robust, and the Durbin-Watson statistics (1.96 for students, 1.95 for lecturers) indicate the absence of problematic autocorrelation. Furthermore, with all Variance Inflation Factor (VIF) values remaining well below the threshold of 10 (maximum 2.599) and minimum tolerance values sitting comfortably above 0.10 (0.385 for students, 0.419 for lecturers), there is no severe multicollinearity among the TPACK constructs. This ensures that the subsequent regression results are built on a solid foundation.

Table 5. Classical Assumption Test

Model	D-W	Min. Tolerance	Max. VIF
Students	1.96	0.385	2.599
Lecturer	1.95	0.419	2.387

Multiple linear regression (Table 6) confirmed that the predictive models were statistically significant and robust, explaining 60.6% of the variance in overall TPACK for students ($F = 98.363$, $p < .001$, $R^2 = .606$) and 50.6% of the variance for educators ($F = 31.075$, $p < .001$, $R^2 = .506$). Within these models, Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) emerged as the most critical predictors of effective integration for both groups. However, equally important is the finding that foundational Content Knowledge (CK) demonstrated a negative or negligible predictive value for both students ($\beta = -.02$) and lecturers ($\beta = -.01$). This is an important insight for higher education institutions, where an educator's mastery of their subject matter does not naturally translate to effective digital teaching. Without strong TPK and TCK to serve as a bridge, high-level subject expertise alone is not enough to drive student satisfaction or system utility in a LMS environment.

Table 6. Regression Analysis

	Stud. β	Lect. β	Stud. p	Lect. p
TK	0.114	0.095	0.013	0.171
PK	0.046	0.093	0.269	0.139
CK	-0.020	-0.013	0.695	0.865
PCK	-0.004	-0.066	0.937	0.396
TCK	0.316	0.264	0.000	0.001
TPK	0.419	0.428	0.000	0.000
R^2	0.606	0.506		

Based on these results, students generally tend to report a stronger correlation between content-related constructs, indicating that they perceive teaching effectiveness primarily through subject understanding and clarity of delivery. Meanwhile, educators show a stronger correlation among technology-related constructs, which suggests a greater emphasis on the interplay between digital tools and pedagogical strategies in facilitating learning. These results are consistent with findings on Jiménez Sierra et al., (2023) which mention that emphasize that educators' ability to blend technological and pedagogical dimensions determines the depth of ICT integration in learning. Overall, within the sampled institutions, the results reflect a relatively high level of perceived TPACK integration, where educators and students share similar perceptions of technology-enhanced learning effectiveness.

The lowest-rated constructs among students were TPK (M = 3.78) and PCK (M = 3.79), indicating ongoing challenges in combining technology and pedagogy effectively, whereas educators only rated slightly higher (TPK, M = 3.92; PCK, M = 3.88; see Table 3). These consistent patterns between both groups indicate that both groups acknowledge the challenges in effectively combining technology and pedagogy to create meaningful learning experiences. Although technology use is widespread, the pedagogical integration of ICT that transforms learning rather than merely supplements it remains limited. (Awang et al., 2025; Khoiriyah et al., 2024) Similarly, they found that many educators struggle to combine technology and design lessons that promote collaboration, inquiry, and reflection using digital tools. This is further supported by the moderate correlation between TPK and TPACK found in this study (r = 0.730 for students; r = 0.672 for lecturers; see Table 4), which shows that while

educators understand how technology can support teaching, full pedagogical synergy with technology is yet to be achieved. In the context of Batam, this suggests that while LMS platforms are generally reliable at serving their core functions, such as course management and assessment, their advanced capabilities for facilitating interactive and collaborative learning remain largely underutilized. Thus, to maximize the impact of LMS and synchronous tools, one may wish to focus on improving deeper system engagement, refining user experience, and integrating analytics and feedback mechanisms that directly inform teaching practices. By moving beyond basic competence, institutions can leverage their platforms not only for educational delivery but also to support ongoing enhancement of digital teaching practices.

The results suggest that LMS and synchronous ICT tools are perceived as effective and well-perceived among respondents in the sampled Batam institutions. Students and lecturers alike rated all TPACK constructs above 3.8 (see Table 3), demonstrating widespread adoption and a high level of confidence in utilizing technology for educational purposes. Educators consistently reported higher average scores than students in nearly all constructs, particularly in Technological Knowledge (M = 4.379 vs. 4.209), Content Knowledge (M = 4.220 vs. 4.038), Technological Content Knowledge (M = 3.984 vs. 3.891), and Technological Pedagogical Knowledge (M = 3.919 vs. 3.782; see Table 2). The independent samples t-test further corroborates these findings, revealing significant differences in TK ($p = 0.002$), PK ($p = 0.030$), CK ($p = 0.003$), and TPK ($p = 0.042$; see Table 4) between students and educators. These outcomes suggest that educators generally view themselves as more adept and confident in integrating technology and content into their teaching practices compared to students' perceptions. However, the extent of these differences is minor, indicating that while perception gaps exist, they are not substantial enough to suggest major disagreement, reflecting a relatively aligned understanding of ICT integration effectiveness between both groups. Overall, the consistently high average scores suggest that LMS and ICT integration in Batam's higher education context is perceived to function effectively, particularly in terms of technological readiness, course management, and instructional organization. Nonetheless, responses from both students and lecturers indicate that the depth of pedagogical transformation through ICT, using technology to actively reshape learning processes rather than merely supporting existing practice, remains an area for development.

These findings are consistent with Krassadaki et al., (2022), who argue that the post-pandemic era of digital education necessitates a shift from basic technology adoption towards technology-driven pedagogy, the strategic use of ICT to foster collaboration, critical thinking, and student agency. Similarly, Rahman et al., (2020) argue that the effectiveness of LMS integration depends less on its frequency of use but on how meaningfully it is embedded into pedagogical design. Therefore, while Batam's higher education institutions have established a robust digital infrastructure and a culture of technological confidence, future improvements should emphasize the design of interactive, data-informed instructional models. Enhancing these aspects will support a shift from routine use to innovative integration, ensuring that LMS and ICT tools not only facilitate learning but also redefine how learning occurs in digital environments.

CONCLUSION

This study examined the integration of Learning Management System (LMS) and synchronous ICT tools in higher education institutions in Batam through the TPACK. Both groups reported generally positive perceptions across all TPACK dimensions, with lecturers rating their own technological and pedagogical competencies slightly higher than students' perceptions, although these differences were small in practical terms.

Correlation and regression analysis showed that Technological Pedagogical Knowledge and Technological Content Knowledge are the strongest predictors of overall TPACK for both groups, indicating that respondents particularly value LMS and ICT when these tools support meaningful pedagogical activities and enrich subject delivery rather than simply digitizing existing practices. At the same time, relatively lower ratings on TPK and PCK highlight ongoing challenges in integrating technology and pedagogy to create interactive, student-centered learning experiences in the surveyed institutions. These findings suggest that universities may wish to prioritize professional development and system design that strengthen TPK and TCK, for example, by promoting collaborative tasks, timely feedback, and multimedia-rich resources within LMS and synchronous platforms.

However, this study also has several limitations. It relied on non-probability convenience sampling of respondents from six

LMS-using universities in Batam, which limits the generalizability of the findings to other institutions and regions. Future research should expand upon these findings by employing probabilistic sampling strategies and incorporating larger, more diverse samples across multiple regions to improve generalizability beyond Batam. Longitudinal studies could also be conducted to track how educators' and students' TPACK competencies evolve as technology use in higher education matures. Additionally, qualitative or mixed-methods approaches, such as interviews or classroom observations, could provide deeper insights into how LMS and ICT tools are applied in practice and how pedagogical innovation evolves over time. Further studies may also explore the impact of specific digital training programs or institutional policies on enhancing TPK and TCK, which were identified as key predictors of effective technology integration. By addressing these areas, future research can contribute to a more comprehensive understanding of digital pedagogy and its role in shaping the future of higher education.

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