

CURRICULUM ALIGNMENT AND ELECTRONIC SERVICE QUALITY AS PREDICTORS OF PRE-SERVICE TEACHERS' DIGITAL COMPETENCE

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ABSTRACT

The rapid digital transformation of education has heightened the need to develop digital competencies among pre-service teachers so they can teach effectively using technology. However, empirical evidence regarding how institutional conditions facilitate this competency development remains limited, particularly within the context of the Pre-service Teacher Professional Development Program (PPG Calon Guru) in Indonesia. This study examines the predictive relationships among curriculum coherence, e-service quality, and pre-service teachers' digital competence using the DigCompEdu framework. A cross-sectional quantitative survey was conducted with 267 students, selected via simple random sampling from a pool of 550 pre-service teachers in the Class of 2025 at Universitas Negeri Malang. Data were collected using a structured questionnaire, and analysis was performed using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS 4. The results indicate that curriculum coherence is the strongest predictor of digital competence ($\beta = 0.759$; $t = 26.276$; $p < 0.001$), while e-service quality also demonstrates a positive and significant predictive relationship ($\beta = 0.168$; $t = 5.324$; $p < 0.001$). Together, these two institutional factors explain 74.8% of the variance in digital competence ($R^2 = 0.748$), indicating high model explanatory power. These findings suggest that the implementation of a coherent curriculum and high-quality digital educational services is essential for enhancing pre-service teachers' digital competence. This study contributes to the literature by providing empirical evidence that curriculum coherence and digital service quality jointly determine digital competence, and it offers practical recommendations for improving curriculum management and Learning Management System (LMS) services in teacher education.

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INTRODUCTION

Digital transformation has become a strategic priority for education systems worldwide, fundamentally altering approaches to curriculum development, teaching methods, assessment systems, and the management of educational institutions. Digital technology is no longer viewed merely as a learning aid; it has become integral to enhancing educational quality, expanding learning opportunities, and preparing graduates for success in a rapidly changing social and technological landscape. Consequently, the success of digital transformation depends not only on the availability of adequate infrastructure but also on the ability of educators to integrate technology into the educational process effectively and meaningfully. As the roles of teachers become increasingly diverse, encompassing those of facilitator, educational material developer, partner, and innovator, digital competence has emerged as a crucial component of 21st-century teaching professionalism. (OECD, 2025a, 2025b).

Recent research increasingly highlights that the development of teachers' professional digital competence has become a strategic priority for education systems, particularly within the context of the digital transformation of educational environments. (Rasdiana et al., 2024). The rapid digital transformation has also encouraged educational institutions to adopt more integrated and evidence-based approaches to improving learning quality and institutional effectiveness, emphasizing that digital transformation should be supported by coherent organizational systems rather than isolated technological initiatives (Sumarsono et al., 2025). Previous studies also highlight that educational transformation requires institutional capacity to integrate digital technology into teaching and learning processes in order to enhance the quality of education and develop learners' competencies (Timan et al., 2022).

To conceptualize and assess educators' digital competence, the European Commission developed the Digital Competence Framework for Educators (DigCompEdu), which has become one of the most widely adopted international frameworks in teacher education (Redecker, 2017). Unlike typical digital literacy models, the DigCompEdu framework views digital competence as a teacher's ability to integrate digital technology into their professional practice. This ability is manifested through competencies related to the use of digital resources, the organization of teaching and learning processes, assessment, learner empowerment, and the development of the teachers' own digital competence. This approach emphasizes that digital competence is not limited to technical skills alone but encompasses the pedagogical and professional skills required to create high-quality educational experiences using technology. Consequently, developing digital competence has become a primary objective of teacher training programs focused on working in digitally transformed educational environments.

Despite its recognized importance, digital competence does not develop simply through access to digital technologies or participation in isolated technology training. Previous studies have demonstrated that pre-service teachers develop stronger digital competence when technology is systematically embedded within coherent learning experiences throughout teacher education programs (Tondeur, 2018). Similarly, the updated Synthesis of Qualitative Evidence (SQD) framework emphasizes that digital competence is fostered through continuous, authentic, collaborative, and reflective opportunities to integrate technology into teaching practice (Tondeur, 2018; Tondeur et al., 2025). These perspectives suggest that digital competence should be understood as an educational outcome emerging from supportive institutional learning conditions rather than from technology availability alone. Accordingly, understanding how institutional factors shape the development of digital competence has become an increasingly important research agenda in teacher education.

From an institutional perspective, The development of digital competence is influenced not only by individual abilities but also by the quality of the educational environment provided by teacher education institutions. Two institutional conditions appear particularly important. First, curriculum alignment provides coherent connections among intended learning outcomes, instructional activities, learning resources, and assessment. (Tyler, 1949) argued that educational objectives are more likely to be achieved when these curriculum components operate as an integrated system. Similarly, the principle of constructive alignment proposed by (Biggs, 1996) and further elaborated by (Biggs, J. & Tang, C., 2011) Meaningful learning is believed to occur when planned learning outcomes, learning activities, and assessment systems are aligned. In teacher training environments that utilize digital technology, this alignment enables the integration of technology as an integral component of the educational process, rather than merely as an isolated learning tool. Consequently, prospective teachers are

more likely to gain real-world learning experiences using technology, thereby fostering digital competence. Previous research also demonstrates that effective integration of ICT into educational processes depends on systematic institutional support rather than technology availability alone (Wiyono et al., 2022).

In addition to curriculum alignment, the quality of digital learning services represents another institutional condition that may support the development of digital competence. As Learning Management Systems (LMS) become the primary environment for communication, collaboration, assessment, and access to learning resources, students' learning experiences increasingly depend on the quality of electronic services provided. The electronic service quality (e-SERVQUAL) framework proposed by (Parasuraman et al., 2005) This quality is characterized by parameters such as efficiency, effectiveness, system availability, confidentiality, responsiveness, compensation, and connectivity. High-quality electronic services reduce technological barriers, enhance the accessibility and reliability of the digital learning environment, and enable students to engage more consistently in technology-based learning activities. Therefore, while curriculum alignment provides the pedagogical structure for developing digital competence, electronic service quality creates the technological environment that supports these learning processes. Overall, these complementary institutional conditions establish a strong theoretical foundation for anticipating higher levels of digital competence among teachers in the future. These findings align with existing evidence indicating that the effective use of ICT-supported educational environments enhances the learning process and improves the quality of teaching (Wiyono et al., 2022).

This institutional context is highly relevant to the teacher education system in Indonesia, where digital transformation has become a national strategic priority. The Pre-service Teacher Professional Education (PPG Calon Guru) Program has implemented a nationally standardized curriculum supported by the Ruang Guru dan Tenaga Kependidikan (Ruang GTK) Learning Management System as the official digital learning platform (Kemendikdasmen, 2023, 2025a, 2025b). Through this policy, curriculum implementation, learning resources, instructional activities, assessment, and academic interactions are delivered within a unified digital ecosystem intended to strengthen prospective teachers' professional and digital competencies. Ideally, the integration of a holistic curriculum and a robust digital learning environment should provide authentic learning experiences using technology that fosters digital competence in future educators.

However, empirical evidence indicates that the expected outcomes of this digital transformation have not yet been consistently achieved. Previous studies have noted varying levels of digital competence among prospective teachers in Indonesia, ranging from average to relatively high across different aspects of this competence (Adhani & Nursia, 2024; Hidayat et al., 2023; Rahim & Yustiana, 2023; Rizki et al., 2024; Yuvita et al., 2023). Likewise, although studies generally report positive perceptions of Learning Management System implementation within the PPG Program (Bashori et al., 2024; Imamuddin et al., 2024; Shalihah & Syafryadin, 2023), recurring issues related to system accessibility, network reliability, and technical support continue to affect students' digital learning experiences (Sari et al., 2025; Wahid et al., 2025). These findings indicate that the availability of digital infrastructure alone is insufficient to ensure the successful development of digital competence, highlighting the importance of examining broader institutional conditions that shape technology-enhanced learning.

Although research on digital competence and digital learning in teacher education is increasing, significant gaps remain. First, previous studies have largely focused on the level of digital competence among pre-service teachers but have not examined the institutional factors that facilitate its development (Adhani & Nursia, 2024; Hidayat et al., 2023; Rahim & Yustiana, 2023; Rizki et al., 2024; Yuvita et al., 2023). Second, research on Learning Management Systems has largely focused on user satisfaction, system quality, or learning effectiveness rather than examining how electronic service quality relates to digital competence (Bashori et al., 2024; Imamuddin et al., 2024; Shalihah & Syafryadin, 2023; Wahid et al., 2025). More importantly, limited empirical evidence has examined curriculum alignment and electronic service quality as complementary institutional predictors of digital competence within a single explanatory model, particularly in the context of Indonesia's recently implemented PPG Calon Guru curriculum and the Ruang GTK platform. Addressing these gaps, this study investigates whether curriculum alignment and electronic service quality significantly predict the digital competence of pre-service teachers based on the DigCompEdu framework. Specifically, the study examines the levels of curriculum alignment, electronic service quality, and digital competence and evaluates the individual and joint predictive relationships among these constructs. In this regard, the following hypotheses are proposed: 1) H1: Curriculum coherence is a significant

positive predictor of pre-service teachers' digital competence; 2) H2: Electronic service quality is a significant positive predictor of pre-service teachers' digital competence; and 3) H3: Curriculum coherence and electronic service quality jointly explain the level of pre-service teachers' digital competence.

In addition to addressing identified research gaps, this work contributes to the scholarly literature by proposing an institutional approach to developing the digital competencies of prospective teachers. Unlike previous studies that have primarily examined digital competence, curriculum implementation, or Learning Management Systems separately, this study integrates curriculum alignment and electronic service quality within a single PLS-SEM model grounded in the DigCompEdu framework. By examining these complementary institutional predictors in the context of Indonesia's recently implemented PPG Calon Guru curriculum and the Ruang GTK Learning Management System, This study provides empirical data that enriches the current understanding of digital transformation in teacher education and offers practical recommendations for improving curriculum management and developing digital learning services.

METHOD

Research Design

This study employs a quantitative approach with a cross-sectional survey design to examine the impact of curriculum alignment and e-service quality on the digital competence of prospective teachers. The cross-sectional survey method was selected because it enables the exploration of relationships between latent variables based on participants' subjective perceptions, recorded at a specific point in time within a real-world educational setting. The study was conducted at the Pre-service Teacher Professional Education (PPG Calon Guru) Program, Universitas Negeri Malang, Indonesia. The program is a nationally standardized teacher education program that integrates curriculum implementation with digital learning through the Ruang Guru dan Tenaga Kependidikan (Ruang GTK) Learning Management System.

Population and Sampling

The target population consisted of 550 education students (Class of 2025) enrolled in thirteen teacher education programs at the State University of Malang. Simple random sampling was employed to ensure that every student had an equal opportunity to participate in the study. The minimum sample size was calculated using Yamane's formula (1973), resulting in a required sample of 232 respondents. A total of 267 students participated in the survey, exceeding the minimum requirement and providing sufficient data for subsequent analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM).

Research Variables and Instruments

The study investigated three latent variables: curriculum alignment, electronic service quality, and digital competence. Digital competence served as the endogenous variable, whereas curriculum alignment and electronic service quality were treated as exogenous variables. All constructs were measured using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree").

Digital competence is assessed using the European Framework for the Digital Competence of Educators (DigCompEdu) developed by (Redecker, 2017). Taking into account the specific needs of future educators, this tool focuses on four pedagogical competence areas corresponding to the B1 proficiency level (Integrator): digital resources, teaching and learning, assessment, and learner empowerment. The initial version of the tool comprises 18 items. Examples of assessed indicators include the ability to select appropriate digital resources for the learning process, integrate digital technology into teaching activities, implement digital assessment strategies, and use technology to meet the diverse needs of learners.

Curriculum alignment was measured based on (Tyler, 1949) curriculum theory, encompassing four dimensions: learning objectives, learning materials, learning activities, and assessment. The initial instrument contained 16 items designed to evaluate the coherence among these curriculum components. Example indicators assessed the alignment between learning objectives and instructional materials, the consistency between learning activities and intended outcomes, and the suitability of assessment strategies for achieving instructional objectives.

Electronic service quality is assessed using the e-SERVQUAL model proposed by (Parasuraman et al., 2005), which encompasses seven dimensions: effectiveness, fulfillment, system availability, privacy, responsiveness, compensation, and

contactability. The initial instrument consists of 23 items evaluating students' perceptions of the digital educational services provided through the Ruang GTK learning management system. These indicators cover aspects such as platform accessibility, system reliability during learning activities, technical support responsiveness, and the protection of users' personal data.

Instrument Adaptation and Validation

All measurement instruments were adapted from established theoretical frameworks. The adaptation process involved translating the original English instruments into Indonesian, followed by contextual modification to ensure their relevance to the learning environment of the Pre-service Teacher Professional Education (PPG Calon Guru) Program. The translated instruments were subsequently evaluated by expert validators to examine their content relevance, conceptual appropriateness, and linguistic clarity.

Prior to the main survey, a pilot study was conducted with 50 prospective teachers to evaluate the psychometric properties of the instrument using SmartPLS 4. Items with outer loadings below the recommended threshold of 0.70 were excluded from further analysis. Consequently, six items related to curriculum coherence, five items related to e-service quality, and four items related to digital competence were removed from consideration. Therefore, the final research instrument comprised 10 items related to curriculum coherence, 18 items related to e-service quality, and 14 items related to digital competence.

Data Collection Procedure

Data were collected throughout June 2026 using an online questionnaire administered via Google Forms. The questionnaire link was distributed through the official WhatsApp groups comprising all students enrolled in the 2025 PPG Calon Guru cohort. In addition, broadcast messages were sent to ensure that all members of the population received the invitation and had an equal opportunity to participate in the study. To maximize the response rate, the questionnaire was also introduced during face-to-face learning sessions, while participation remained entirely voluntary.

Ethical Considerations

Before completing the questionnaire, participants were informed about the research objectives, the voluntary nature of their participation, and the use of the collected data solely for research purposes. Respondents were informed that they could identify themselves using either their full name or initials according to their preference. All responses were treated confidentially, and no personally identifiable information was disclosed during data analysis or publication.

Data Analysis

Data were analyzed using partial least squares structural equation modeling (PLS-SEM) in SmartPLS 4. PLS-SEM was selected due to its suitability for predictive studies involving multiple latent constructs measured by multiple indicators and its minimal requirements regarding data distribution. The analysis procedure comprised two stages. The first stage involved assessing the measurement model: examining indicator reliability (based on outer factor loadings), convergent validity (using average variance extracted – AVE), internal consistency reliability (using composite reliability – CR), and discriminant validity (using the Fornell-Larcker criterion and the heterotrait-monotrait ratio of correlations – HTMT). The second stage involved assessing the structural model using path coefficients, the coefficient of determination (R^2), effect size (f^2), and the standardized root mean square residual (SRMR). A bootstrapping method with 5,000 iterations was employed to test the significance of the proposed hypotheses. Statistical significance was determined at the 5% level ($p < 0.05$).

RESULT AND DISCUSSION

Result

Descriptive Statistics

The study involved 267 students enrolled in the 2025 cohort of the Pre-service Teacher Professional Education (PPG Calon Guru) Program at Universitas Negeri Malang. The respondents represented thirteen teacher education programs and had completed approximately six months of learning using the Ruang GTK Learning Management System.

Table 1. Descriptive Statistics of Research Variables

Variable	Mean	SD	Category
Curriculum Alignment	57.29	6.82	High
Electronic Service Quality	72.17	10.69	Moderately High
Digital Competence	62.88	6.83	Very High

Source: Processed Data Using SmartPLS (2026)

Table 1 presents the descriptive statistics of the three research variables. Digital competence exhibited the highest average score ($M = 62.88$, $SD = 6.83$), followed by curriculum alignment ($M = 57.29$, $SD = 6.82$) and electronic service quality ($M = 72.17$, $SD = 10.69$). Based on the predetermined class intervals, digital competence was categorized as very high, curriculum alignment as high, and electronic service quality as moderately high. These findings indicate that respondents generally perceived the curriculum to be well aligned with learning objectives and experienced satisfactory electronic services while demonstrating a relatively high level of digital competence.

Measurement Model Assessment

The measurement model was evaluated prior to the analysis of structural relationships. Convergent validity was assessed using outer factor loadings and the average variance extracted (AVE) metric. After removing indicators with insufficient loadings, all remaining indicator values exceeded the recommended threshold of 0.70, and the AVE values for each construct were above 0.50, indicating an acceptable level of convergent validity.

Reliability (internal consistency) was tested using the composite reliability (CR) metric. CR values for all constructs exceeded 0.90, indicating excellent reliability. Discriminant validity was assessed using the Fornell-Larcker criterion and the heterotrait-monotrait (HTMT) ratio. Each construct shared a higher proportion of variance with its own indicators than with other constructs, and all HTMT values remained below the recommended threshold of 0.85. Overall, these results confirm that the measurement model possesses sufficient validity and reliability to proceed with the subsequent structural analysis.

Table 2. Measurement Model Evaluation

Construct	Cronbach's alpha	Composite reliability (ρ_a)	Composite reliability (ρ_c)	Average variance extracted (AVE)
Curriculum Alignment	0.948	0.949	0.955	0.681
Electronic Service Quality	0.979	0.983	0.980	0.734
Digital Competence	0.965	0.965	0.969	0.689

Source: Processed Data Using SmartPLS (2026)

Structural Model Assessment

The structural model was evaluated using the coefficient of determination (R^2), effect size (f^2), standardized root mean square residual (SRMR), and bootstrapping hypothesis testing. The model explains 74.8% of the variance in digital competence ($R^2 = 0.748$), indicating high explanatory power. According to Hair et al. (2022), this value suggests that curriculum alignment and electronic service quality jointly accounted for a considerable proportion of the variation in pre-service teachers' digital competence. The model also demonstrated an acceptable level of overall fit, with the SRMR value remaining below the recommended threshold of 0.08. Furthermore, both independent variables exhibited meaningful effect sizes, indicating that each construct contributed to explaining digital competence.

Table 3. Structural Model Evaluation

Indicator	Value
R^2	0.748
SRMR	0.039
Model Interpretation	Good fit

Source: Processed Data Using SmartPLS (2026)

Hypothesis Testing

To test the hypotheses, a bootstrapping analysis was conducted using 5,000 samples. Table 4 presents the structural path coefficients. The results indicate that curriculum alignment has a positive and statistically significant influence on digital competence, supporting hypothesis H1. Similarly, the quality of electronic services demonstrates a positive and significant influence on digital competence, confirming hypothesis H2. Collectively, these two institutional factors explain nearly three-quarters of the variance in digital competence, supporting hypothesis H3: curriculum alignment and the quality of electronic services jointly determine digital competence.

Overall, the results indicate that both curriculum alignment and the quality of electronic services are significant institutional predictors of the digital competence of prospective teachers participating in the PPG (Teacher Professional Education) program. The relatively high coefficient of determination also suggests that enhancing curriculum alignment, combined with improving the quality of digital educational services, can significantly contribute to the development of digital competence within teacher preparation programs.

Table 4. Hypothesis Testing

Hypothesis	Path	β	t	p	Decision
H ₁	Curriculum Alignment → Digital Competence	0,759	26,276	0,000	Supported (Accepted)
H ₂	Electronic Service Quality → Digital Competence	0,168	5,324	0,000	Supported (Accepted)

Source: Processed Data Using SmartPLS (2026)

Discussion

Curriculum Alignment as a Predictor of Digital Competence

The present study identified curriculum alignment as the strongest institutional predictor of digital competence among pre-service teachers. Rather than merely indicating a statistically significant relationship, the relatively large standardized path coefficient ($\beta = 0.759$) suggests that curriculum alignment explains a considerable proportion of the variation in digital competence compared with other institutional factors included in the model. This finding implies that pre-service teachers who perceive stronger coherence among learning outcomes, instructional activities, learning resources, and assessment also tend to report higher levels of digital competence. From an institutional perspective, these results suggest that pedagogical coherence may represent a more influential predictor of digital competence than technological provisions alone.

One possible explanation for this result is that curriculum alignment serves as a pedagogical mechanism for the systematic development of digital competence. It is unlikely that digital competence can be developed solely through the frequent use of educational technology. Instead, it appears to develop when technology is embedded consistently within intended learning outcomes, instructional activities, assessment, and reflective practice. Under such conditions, digital tools are not treated as supplementary instructional resources but become integral components of learning experiences. Consequently, pre-service teachers repeatedly engage in authentic technology-supported tasks that encourage them to develop competencies related to digital resources, technology-enhanced teaching, digital assessment, and learner empowerment as conceptualized in the DigCompEdu framework. This interpretation helps explain why curriculum alignment demonstrated a substantially stronger predictive association than other institutional factors examined in this study.

This interpretation is closely aligned with (Tyler, 1949) curriculum theory, which argues that educational objectives are more likely to be achieved when learning objectives, instructional experiences, and assessment operate as an integrated system. Likewise, the principle of constructive alignment proposed by (Biggs, 1996) and further elaborated (Biggs, J. & Tang, C., 2011) emphasized that effective learning occurs when planned learning outcomes, learning activities, and assessment systems are aligned. The findings of this study extend these theoretical concepts by applying them to teacher training in a digital environment, demonstrating that coherence among curriculum components not only enhances learning effectiveness but also fosters the development of digital competencies. In other words, technology integration becomes pedagogically meaningful when implemented through thoughtful and holistic curriculum design, rather than as a fragmented technological innovation.

These findings are also consistent with previous empirical studies highlighting the importance of systematically integrating technology into teacher education curricula. (Tondeur et al., 2025) argued that pre-service teachers develop digital competence most effectively through authentic and repeated experiences of technology integration during teacher education. Similarly, the updated Synthesis of Qualitative Evidence (SQD) framework emphasizes continuous, collaborative, and reflective opportunities for technology-supported learning (Tondeur, 2018; Tondeur et al., 2025). (Howard et al., 2021) likewise demonstrated that technology-integrated instructional strategies embedded within teacher education curricula contribute positively to the development of pre-service teachers' digital competence. Collectively, these studies suggest that digital competence develops through sustained pedagogical experiences rather than isolated exposure to digital technologies. The present study reinforces this body of evidence by identifying curriculum alignment itself as an institutional predictor that may facilitate the systematic organization of such experiences within the Indonesian Pre-service Teacher Professional Education Program.

Beyond confirming previous findings, the present study also provides a nuanced interpretation of why curriculum alignment appears to exert a stronger predictive association than many technology-focused institutional factors reported in previous research. Several recent studies have emphasized curriculum mapping and competency-based curriculum development as essential mechanisms for preparing graduates for increasingly digital professional environments (Harden, 2001; Nurhalizah et al., 2025; Nyale et al., 2026; Wijngaards-de Meij & Merx, 2018). Rather than viewing curriculum alignment as an administrative process, these studies suggest that coherent curriculum structures enable students to encounter progressively connected learning experiences that reinforce targeted competencies. The present findings support this perspective by indicating that curriculum alignment may provide the organizational structure through which digital competence is continuously reinforced across multiple learning activities, thereby strengthening its association with students' perceived digital competence.

Nevertheless, previous research also indicates that curriculum alignment alone does not necessarily guarantee successful digital competence development. (Gerona & Yurango, 2025) reported that only a limited proportion of curriculum competencies explicitly addressed information, media, and technology skills, while (Nikolova et al., 2026) identified persistent discrepancies between intended, implemented, and experienced curricula. Likewise, (Sepadi & Mampane, 2025) argued that institutional resource disparities frequently hinder the consistent implementation of digitally oriented curricula. These findings suggest that the effectiveness of curriculum alignment depends not only on curriculum design but also on the institutional capacity to implement that design consistently. Compared with those contexts, the standardized national curriculum and centralized Ruang GTK Learning Management System implemented within the PPG Calon Guru program may have reduced implementation variability, thereby strengthening the observed association between curriculum alignment and digital competence.

An important contribution of the present study lies in its conceptual interpretation of curriculum alignment as a pedagogical mechanism rather than merely a curriculum management practice. Previous studies have generally examined technology integration, digital literacy, or learning management systems as direct determinants of digital competence. In contrast, the present findings suggest that digital competence is more appropriately understood as an outcome of coherent pedagogical experiences created through aligned curriculum structures. This perspective extends earlier work by (Kakeeto et al., 2020; Sillat et al., 2017), who emphasized the importance of embedding digital competence within curriculum design, by demonstrating empirically that curriculum coherence itself represents a significant institutional predictor of digital competence among pre-service teachers.

The findings should nevertheless be interpreted with appropriate methodological caution. Because the study employed a cross-sectional design, the observed relationship represents a significant predictive association rather than evidence of causality. Although curriculum alignment emerged as the strongest predictor in the structural model, digital competence is likely to be shaped by additional contextual factors, including instructor capability, institutional leadership, technological infrastructure, and learner characteristics. Therefore, curriculum alignment should be viewed as a foundational pedagogical condition that is associated with higher levels of digital competence when implemented consistently within supportive institutional environments. From a practical perspective, teacher education institutions may benefit from prioritizing curriculum coherence by ensuring that learning outcomes, instructional activities, digital resources, and

assessment remain systematically aligned throughout the teacher preparation program, thereby creating learning environments that consistently support the development of pre-service teachers' digital competence.

Electronic Service Quality as a Predictor of Digital Competence

This study demonstrates that e-service quality is a significant positive predictor of the digital competence of prospective teachers. However, compared with curriculum alignment, electronic service quality exhibited a considerably smaller standardized path coefficient ($\beta = 0.168$), indicating a more modest predictive association with digital competence. This finding suggests that although students who perceived higher-quality digital learning services also tended to report higher levels of digital competence, the quality of electronic services alone explained a relatively limited proportion of the variation in digital competence. Rather than diminishing the importance of digital services, this result indicates that technological support may function differently from pedagogical factors in shaping pre-service teachers' learning experiences.

Unlike curriculum alignment, which structures pedagogical experiences, electronic service quality appears to shape the technological context in which those experiences take place. Reliable systems, responsive technical support, secure platforms, and accessible digital resources reduce barriers that might otherwise interrupt learning activities. Nevertheless, the presence of high-quality digital services does not automatically translate into stronger digital competence unless students actively engage in pedagogically meaningful learning experiences. In this sense, electronic service quality appears to operate as an enabling institutional condition that facilitates technology use, whereas the actual development of digital competence depends on how those technologies are embedded within teaching and learning processes. This interpretation helps explain why its predictive association was substantially weaker than that of curriculum alignment despite remaining statistically significant.

This interpretation is consistent with the e-SERVQUAL framework proposed by (Parasuraman et al., 2005), where e-service quality is conceptualized through dimensions such as efficiency, order fulfillment, system availability, privacy, responsiveness, compensation, and ease of contact. Within digital learning environments, these dimensions primarily describe the quality of learners' interactions with electronic services rather than the quality of pedagogy itself. Consequently, when learning management systems operate reliably and provide timely user support, students are able to devote greater attention to learning activities instead of overcoming technical difficulties. The present findings therefore suggest that electronic service quality predicts digital competence indirectly by creating favourable learning conditions that support sustained engagement with digital technologies rather than by directly shaping pedagogical competence.

The findings are broadly consistent with previous studies reporting positive educational outcomes associated with high-quality learning management systems. (Bashori et al., 2024) found that pre-service teachers generally perceived LMS services positively, whereas (Imamuddin et al., 2024) demonstrated that LMS utilization was positively associated with learning outcomes. Likewise, (Shalihah & Syafryadin, 2023) reported favorable perceptions of LMS implementation within Indonesia's Teacher Professional Education Program. Together, these studies indicate that well-functioning digital platforms provide an important institutional foundation for online learning. This study adds to existing knowledge by demonstrating that students' perceptions of e-service quality are closely linked to their digital competence, indicating that service quality contributes not only to satisfaction with the learning process but also to the achievement of broader educational outcomes associated with technology use.

At the same time, the present findings refine previous literature by indicating that electronic service quality should not be interpreted as the primary mechanism through which digital competence develops. Recent studies have reported that system quality, information quality, and LMS utilization positively predict teachers' digital competence and technology integration (El Mustapha et al., 2025; Fitrah et al., 2025; Handayani et al., 2025; Suyitno & Dalhari, 2025). However, the comparatively smaller path coefficient observed in the present study suggests that technological infrastructure alone may be insufficient to explain substantial differences in digital competence. Instead, electronic service quality appears to create opportunities for technology-enhanced learning, while the extent to which those opportunities translate into competence depends on the pedagogical experiences provided within the curriculum. This interpretation complements previous research

by distinguishing between technological support and pedagogical processes rather than treating them as equivalent determinants of digital competence.

The findings should also be interpreted in light of previous studies documenting persistent challenges in digital learning environments. (Sari et al., 2025; Wahid et al., 2025) reported problems related to system accessibility, network stability, and technical support, while (Yusron et al., 2026) highlighted continuing disparities in digital infrastructure and technological readiness among educators. These challenges suggest that even well-designed digital services may not benefit all learners equally because institutional and technological constraints can limit effective participation in online learning. Compared with those contexts, the standardized implementation of the Ruang GTK Learning Management System within the PPG Calon Guru program may have reduced variability in students' access to digital services, allowing the positive association between service quality and digital competence to become more evident.

An important conceptual contribution of the present study is the distinction it offers between digital infrastructure and pedagogical design. Previous studies have frequently emphasized the importance of improving learning management systems or expanding access to educational technologies. The present findings suggest that these investments should be viewed as necessary enabling conditions rather than sufficient drivers of digital competence. High-quality electronic services make digital learning possible by providing stable, accessible, and responsive learning environments, but competence is more likely to develop when those services are integrated into coherent instructional designs. This perspective complements the findings reported in the curriculum alignment analysis, indicating that institutional support for digital competence involves both technological readiness and pedagogical coherence, although the latter appears to play a more prominent predictive role.

Finally, the results obtained must be interpreted with methodological caution. Since this study employs a cross-sectional design, the identified associations represent significant predictive relationships rather than evidence that improving e-service quality will directly lead to enhanced digital competence. Additional institutional and individual factors including curriculum implementation, instructors' digital pedagogical capability, students' prior technological experience, and organizational support may also contribute to the development of digital competence. From a practical perspective, teacher education institutions should continue investing in reliable and user-centered digital learning services while recognizing that improvements in electronic service quality are likely to yield greater educational value when accompanied by coherent curriculum implementation and meaningful technology-integrated learning experiences.

Curriculum Alignment and Electronic Service Quality Jointly Explain Digital Competence

The structural model demonstrated substantial explanatory power, with curriculum alignment and electronic service quality jointly explaining 74.8% of the variance in pre-service teachers' digital competence. Rather than indicating that these institutional factors determine digital competence, this finding suggests that students' perceptions of coherent curriculum implementation and high-quality digital learning services are jointly associated with higher levels of digital competence. The relatively high coefficient of determination indicates that institutional conditions constitute an important context for understanding differences in digital competence among participants in the Pre-service Teacher Professional Education Program.

Although both variables contributed to explaining digital competence, the findings indicate that they do not contribute equally. Curriculum alignment exhibited a substantially stronger standardized path coefficient than electronic service quality, suggesting that the two constructs perform complementary rather than equivalent functions within teacher education. Curriculum alignment appears to provide the pedagogical structure through which digital competence is developed, whereas electronic service quality creates the technological environment that enables those pedagogical processes to be implemented effectively. This distinction offers a more nuanced interpretation of the structural model by demonstrating that institutional support for digital competence extends beyond the provision of digital infrastructure alone.

Viewed together, these findings suggest that digital competence is better understood as the product of interactions between pedagogical design and institutional technological support. A well-aligned curriculum provides coherent learning objectives, instructional activities, and assessment that encourage meaningful engagement with digital technologies. At the same time, reliable electronic services ensure that these learning experiences can be accessed consistently through digital

platforms with minimal technical disruption. Consequently, digital competence is likely to emerge not from either condition independently, but from the combination of coherent pedagogy and supportive digital learning environments.

This interpretation extends previous literature, which has generally examined curriculum design and digital learning environments as separate lines of inquiry. Studies on curriculum have primarily emphasized the importance of integrating digital competence into learning outcomes and instructional design (Kakeeto et al., 2020; Tondeur et al., 2021), whereas studies on learning management systems have focused on system quality, usability, and technology adoption (Bashori et al., 2024; Imamuddin et al., 2024; Shalihah & Syafrudin, 2023). By integrating these two constructs into a single structural model, this study demonstrates that pedagogical and technological factors should not be viewed as competing explanations, but rather as complementary institutional conditions linked to digital competence.

The findings also contribute to current discussions on digital transformation in teacher education. Previous research has frequently highlighted the importance of curriculum reform or digital infrastructure independently. However, digital transformation within teacher education is unlikely to be achieved through improvements in only one of these domains. Investments in digital platforms may produce limited educational benefits if curriculum implementation does not intentionally integrate technology into meaningful learning experiences. Conversely, even well-designed curricula may not be fully realized when digital services are unreliable or difficult to access. The present findings therefore support a more systemic perspective in which pedagogical coherence and technological readiness operate as mutually reinforcing institutional conditions.

An important conceptual contribution of this study is the distinction between pedagogical mechanisms and supporting conditions within the institutional model of digital competence development. The findings suggest that curriculum alignment functions as the primary pedagogical mechanism because it organizes how technology is incorporated into teaching, learning, and assessment. Electronic service quality, by contrast, functions primarily as an enabling condition by providing reliable technological infrastructure that supports those pedagogical processes. This conceptual distinction helps explain why curriculum alignment demonstrated a substantially stronger predictive association than electronic service quality while both constructs remained significant within the same structural model. Rather than attributing digital competence primarily to technology availability, the findings emphasize the importance of aligning technological resources with coherent educational design.

From a practical perspective, the findings indicate that efforts to develop digital competence must be supported by a comprehensive institutional strategy. Teacher education institutions must simultaneously ensure curriculum coherence and the reliability of digital educational services, without prioritizing one over the other. Curriculum developers must continuously integrate digital competence into planned learning outcomes, learning activities, educational resources, and assessment systems, while learning management system administrators must ensure the stability, accessibility, security, and responsiveness of digital services. Such coordinated efforts are likely to create an institutional environment that is more effective in fostering digital competence among prospective teachers.

Finally, the results obtained must be interpreted within the framework of the research methodology. Since this study employs a cross-sectional design, the structural model reveals significant predictive relationships rather than causal ones. Although curriculum coherence and e-service quality collectively explain a substantial portion of the variance in digital competence, other contextual factors, such as lecturers' digital pedagogical competence, the role of institutional leadership, students' prior digital experience, and organizational culture, may also influence this indicator. These factors were not included in the model. Further longitudinal or mixed-methods studies could shed more light on the interplay of these institutional conditions over time and their impact on digital competence development in teacher education.

CONCLUSION

This study examines the roles of curriculum alignment and e-service quality in predicting the digital competence of prospective teachers enrolled in Indonesia's teacher professional development program (PPG Calon Guru). The results indicate that both curriculum alignment and e-service quality are significant positive predictors of digital competence, with curriculum alignment demonstrating a significantly stronger predictive relationship. The structural model explains 74.8% of

the variance in digital competence ($R^2 = 0.748$), highlighting the high explanatory power of these institutional factors within the proposed PLS-SEM model. These results should be viewed as indicative of predictive relationships rather than evidence of causality, given the study's cross-sectional design.

This study contributes to the growing literature on the digital transformation of teacher education by demonstrating that curriculum alignment and e-service quality play complementary roles. Curriculum coherence provides a pedagogical framework conducive to digital competence development, while digital service quality creates a supportive digital educational environment. From a practical perspective, the findings underscore the importance of combining consistent curriculum implementation with robust, user-friendly digital services to more effectively support the development of digital competence among prospective teachers.

Limitations of this study include its cross-sectional design and its restriction to a single educational institution, which may limit the generalizability of the findings. Future research is encouraged to employ longitudinal approaches or mixed-methods designs and to involve multiple educational institutions to further validate the proposed model and examine how these institutional factors influence digital competence development over time.

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