

Teacher Learning Communities and Digital Literacy as Predictors of Learning Innovation: Evidence from Primary School Teacher in Pekalongan, Indonesia

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Abstract: *The growing demand for adaptive and technology-supported learning requires teachers to develop innovative instructional practices through both professional collaboration and digital capacity. This study examined the predictive relationships between teacher learning communities, digital literacy, and learning innovation among primary school teachers in Tirta District, Pekalongan Regency, Indonesia. Employing a quantitative survey approach with an ex post facto design, this study involved 113 teachers from 19 primary schools using total sampling. Data were collected through Likert-scale questionnaires that were pilot-tested for item validity and internal consistency and analyzed using descriptive statistics, assumption tests, simple linear regression, and multiple linear regression. The findings indicated that teacher learning communities and digital literacy were positively associated with learning innovation. Simultaneously, both predictors explained 72.3% of the variance in learning innovation. Digital literacy demonstrated a larger standardized beta coefficient than teacher learning communities. This study contributes by integrating collective professional capacity through teacher learning communities and individual digital capacity through digital literacy as complementary predictors of learning innovation, encompassing value development, intellectual reasoning, scientific understanding, and internalization of learning values.*

Keywords: Digital Literacy; Learning Innovation; Primary Education; Teacher Learning Communities.

Abstract: *Tuntutan pembelajaran yang adaptif dan berbasis teknologi mendorong guru untuk mengembangkan praktik pembelajaran inovatif melalui kapasitas profesional kolektif dan kemampuan digital individual. Penelitian ini bertujuan menganalisis hubungan prediktif antara komunitas belajar guru, literasi digital, dan inovasi pembelajaran pada guru sekolah dasar di Kecamatan Tirta, Kabupaten Pekalongan, Indonesia. Penelitian ini menggunakan pendekatan kuantitatif dengan desain ex post facto yang melibatkan 113 guru dari 19 sekolah dasar melalui teknik total sampling. Data dikumpulkan menggunakan kuesioner skala Likert yang telah melalui uji coba untuk mengetahui validitas butir dan konsistensi internal, kemudian dianalisis menggunakan statistik deskriptif, uji prasyarat analisis, regresi linear sederhana, dan regresi linear berganda. Hasil penelitian menunjukkan bahwa komunitas belajar guru dan literasi digital memiliki hubungan positif dengan inovasi pembelajaran. Secara simultan, kedua variabel tersebut berperan sebagai prediktor inovasi pembelajaran. Penelitian ini memberikan kontribusi melalui integrasi kapasitas profesional kolektif melalui komunitas belajar guru dan kapasitas digital individual melalui literasi digital sebagai prediktor komplementer inovasi pembelajaran yang mencakup pengembangan nilai, pemahaman intelektual, penalaran ilmiah, dan internalisasi nilai pembelajaran.*

Kata kunci: Literasi Digital; Inovasi Pembelajaran; Pendidikan Dasar; Komunitas Belajar Guru.

Introduction

Digital transformation and changes in learner characteristics have fundamentally reshaped the provision of primary education. Schools can no longer focus solely on knowledge transmission; they are increasingly expected to create learning experiences that are adaptive, collaborative, student-centered, and responsive to diverse learning needs. These changes have positioned learning innovation as a strategic capacity for improving educational quality. Learning innovation is not merely characterized by the adoption of new technologies but also encompasses teachers' ability to renew instructional strategies, methods, media, learning resources, and patterns of interaction to create meaningful and inclusive learning experiences (Runge et al., 2023; Tzafilkou et al., 2023). In this study, learning innovation is further understood as teachers' capacity to develop learning processes that integrate cognitive development, value formation, and students' contextual understanding. Therefore, learning innovation is operationalized through three dimensions: student faith development, understanding, reasoning and scientific knowledge, and internalization, which represent teachers' efforts to develop students' values, critical thinking, and application of knowledge in real-life contexts.

Teachers occupy a central position in the innovation process because educational change is ultimately translated into pedagogical decisions and classroom practices. However, teachers' capacity to innovate is influenced not only by individual competencies but also by professional environments that support continuous learning and collaboration. Developing teachers' competencies requires professional learning opportunities integrated with daily practice (Admiraal et al., 2021), while teachers' ability to develop new practices is associated with professional beliefs, learning experiences, and supportive working environments (Yada et al., 2023).

One professional environment with strong potential to enhance innovation is the teacher learning community, commonly conceptualized as a professional learning community (PLC). Learning communities provide opportunities for teachers to share experiences, discuss instructional challenges, engage in reflection, develop professional knowledge, and collaboratively experiment with new pedagogical practices. PLCs function as professional learning environments where individual knowledge can be transformed into collective school capacity (Huijboom et al., 2021). Previous studies have demonstrated that PLCs contribute to teacher innovation through creative self-efficacy (Liu et al., 2022), professional development, student achievement (Çopur & Demirel, 2022), reflective practice, and collective learning (Nehez, 2024; Denee, 2024). In primary education contexts, PLCs have also been associated with teacher professional development and performance (Balasi & Iordanidis, 2024; Mydin et al., 2024).

Nevertheless, collaborative capacity alone is insufficient to address the demands of digital-era education. Teachers also require digital literacy to access, evaluate, and pedagogically utilize digital resources. This study distinguishes digital literacy from digital competence. Digital literacy refers to teachers' ability to access, understand, evaluate, analyze, and critically use digital information and resources for learning purposes. Meanwhile, digital competence represents a broader professional capacity involving technology integration, digital communication, digital content development, assessment, and pedagogical application of technology. Thus, digital literacy can be viewed as an essential foundation supporting the development of teachers' digital competence. Teacher digital competence extends beyond technical skills and includes the ability to select appropriate technologies, develop learning resources, communicate effectively, conduct assessments, and empower learners through digital technologies (Lucas et al., 2021;

Heine et al., 2023). The DigCompEdu framework also emphasizes digital competence as an important component of teachers' professional capacity for effective technology integration (Cabero-Almenara et al., 2021; Suzer & Koc, 2024).

The relationship between digital literacy and learning innovation becomes evident when technology is transformed into meaningful pedagogical practices. Teachers' digital competence influences technology-enhanced instruction, learner empowerment, and instructional quality (Runge et al., 2023). Digital literacy also becomes educationally meaningful when technological knowledge is translated into appropriate pedagogical decisions (De León et al., 2023).

Although previous studies have examined teacher learning communities and digital competence separately, the theoretical connection between these two capacities and learning innovation remains insufficiently explained. Learning innovation requires both collective professional capacity and individual digital capacity. Teacher learning communities provide the social mechanism through which teachers exchange ideas, reflect on practices, and collaboratively develop innovative solutions. Meanwhile, digital literacy provides the individual capacity required to transform these ideas into technology-supported instructional practices. Therefore, these two variables should not be viewed as independent factors but as complementary capacities that jointly support sustainable learning innovation.

The importance of these factors is particularly evident in primary schools in Tirto District, Pekalongan Regency, Indonesia. Preliminary data indicated that learning innovation had not developed optimally. A preliminary survey involving ten teachers was conducted using the learning innovation questionnaire developed for this study. The instrument measured three dimensions: student faith development, understanding, reasoning and scientific knowledge, and internalization. The average achievement score was 55.0%, which was categorized as low based on the percentage classification criteria applied in this study. The results showed that student faith development reached 54.0%, understanding, reasoning and scientific knowledge reached 56.0%, and internalization reached 55.0%. These findings indicate that some teachers still rely on conventional instructional approaches, while technology utilization and professional collaboration through learning communities remain limited.

Previous research has provided valuable evidence regarding PLCs and digital competence; however, these research areas have largely developed separately. PLC studies have mainly focused on self-efficacy, commitment, professional development, teacher identity, resilience, and instructional practices (Zheng et al., 2021; Zhang et al., 2023; Zhang et al., 2024; Mydin et al., 2024; Vu et al., 2025). Meanwhile, digital competence studies have emphasized technological proficiency, digital pedagogy, and technology integration (De León et al., 2023; Gümüş & Kukul, 2023; Tzafilkou et al., 2023; Aydin et al., 2024). The novelty of this study lies not merely in combining two variables but in proposing an integrated framework explaining how collective professional capacity and individual digital capacity interact to strengthen learning innovation in primary schools.

Accordingly, this study aims to analyze the effects of teacher learning communities and teacher digital literacy on learning innovation, both partially and simultaneously, among primary school teachers in Tirto District, Pekalongan Regency. Based on this conceptual framework, the hypotheses are formulated as follows: (H1) Teacher learning communities have a positive and significant effect on learning innovation; (H2) Teacher digital literacy has a positive and significant effect on learning innovation; and (H3) Teacher learning communities and teacher digital literacy simultaneously have a positive and significant effect on learning innovation.

Method

This study employed a quantitative approach using a survey method and an ex post facto design. Because an ex post facto design examines naturally occurring conditions without experimental manipulation, this study does not establish causal relationships. Therefore, the findings are interpreted as statistical associations and predictive relationships among teacher learning communities, teachers' digital literacy, and learning innovation rather than causal effects. The research model consisted of two predictor variables, namely teacher learning communities (X1) and teachers' digital literacy (X2), and one criterion variable, namely learning innovation (Y).

The study was conducted in primary schools in Tirto District, Pekalongan Regency, Central Java, Indonesia. Data collection was conducted in 2025, while data processing and statistical analysis were completed in 2026. The population consisted of all teachers from the 19 primary schools operating in Tirto District, totaling 113 teachers. These 19 schools represented the entire population of primary schools in the research area, not a selected sample based on specific criteria. Due to the limited population size and accessibility of all members, total sampling (census sampling) was applied, involving all 113 teachers as respondents.

Respondent characteristics, including gender, age, educational qualification, teaching experience, grade level taught, employment status, and school characteristics, were collected to provide contextual information regarding the research participants and support interpretation of the findings. Data were collected using a structured questionnaire consisting of closed-ended statements measured on a five-point Likert scale. The instruments were developed based on theoretical frameworks and previous empirical studies related to each construct. The development process involved identifying theoretical dimensions, developing indicators, constructing questionnaire items, and conducting expert review before empirical testing.

Teacher learning communities (X1) were measured using 30 items covering five dimensions: shared values and vision, collective responsibility, reflective dialogue, collaboration, and shared personal practice. These dimensions were based on the professional learning community framework, which emphasizes collective learning, shared responsibility, reflection, and collaboration as key elements of teacher professional development. Teachers' digital literacy (X2) was measured using 45 items covering five dimensions: access, selection, understanding, evaluation, and analysis. The dimensions were developed from digital literacy and digital competence perspectives, emphasizing teachers' ability to access, understand, critically evaluate, and appropriately utilize digital resources for educational purposes.

Learning innovation (Y) was measured using 27 items covering three dimensions: students' faith development; understanding, reasoning (intellectual development), and scientific knowledge; and internalization. These dimensions represent learning innovation as a transformation of learning processes that integrates value development, cognitive growth, and contextual application of knowledge.

Before the main survey, instrument validation was conducted through expert judgment and pilot testing. Experts in educational management and learning evaluation reviewed the relevance, clarity, and alignment of items with the theoretical dimensions of each construct. Subsequently, a pilot study involving 30 teachers outside the research sample was conducted to examine item validity and reliability. Item validity was assessed using item-total correlation analysis, with the criterion that the correlation coefficient exceeded the critical value of 0.361 at the 5% significance level. All items met the validity criteria and were retained. Reliability testing using Cronbach's alpha produced coefficients of 0.978 for learning innovation, 0.982 for teacher learning communities, and 0.988 for teachers' digital literacy. Although these values indicate

very high internal consistency, they were interpreted cautiously because extremely high alpha coefficients may indicate item redundancy. Therefore, reliability results were considered together with theoretical consistency and expert validation.

Data collection was conducted by distributing questionnaires directly to teachers in participating schools. Participants were informed about the research objectives, voluntary participation, confidentiality of responses, and the academic use of collected data. No personally identifiable information was recorded. Since all variables were measured through self-report questionnaires from the same respondents, potential common method bias was considered. To minimize this risk, the study applied theoretically grounded indicators, ensured respondent anonymity, and used consistent measurement procedures across variables.

Data analysis was conducted using IBM SPSS Statistics version 25. Descriptive statistics were used to describe variable distributions, followed by regression assumption tests, including normality, linearity, multicollinearity, and heteroscedasticity tests. Hypothesis testing employed simple and multiple linear regression analyses to examine predictive relationships among variables. The regression coefficients were interpreted as predictive contributions and statistical associations rather than evidence of causality. The multiple regression model was expressed as: $Y = a + b_1X_1 + b_2X_2 + e$, where Y represents learning innovation, X_1 represents teacher learning communities, X_2 represents teachers' digital literacy, a represents the constant, b_1 and b_2 represent regression coefficients, and e represents residual error. Statistical significance was determined at $\alpha = 0.05$.

Result and Discussion

Descriptive analysis was conducted to describe the characteristics of teacher learning communities, teachers' digital literacy, and learning innovation among 113 primary school teachers in Tirto District, Pekalongan Regency. The descriptive statistics are presented in Table 1.

Table 1. Descriptive Statistics of the Research Variables

Variable	N	Mean	SD	Minimum	Maximum
Learning Innovation (Y)	113	97.75	19.838	53	136
Teacher Learning Communities (X1)	113	101.27	19.832	44	140
Teachers' Digital Literacy (X2)	113	149.94	29.342	66	206

Source: Research data processed, 2026.

To interpret the level of each variable, the total scores were categorized using percentage-based classification intervals. The categories were determined by calculating the percentage of obtained scores compared with the maximum possible score, which was then classified into five levels: very low, low, moderate, moderately high, and high.

The distribution of variable categories is presented in Table 2.

Tabel 2. The distribution of variable categories

Variable	Category	Frequency	Percentage
Learning Innovation	Moderately High	34	30.10%
	High	31	27.40%
Teacher Learning Communities	High	41	36.28%
	Moderately High	39	34.51%
Digital Literacy	Moderately High	38	33.63%
	High	38	33.63%

Overall, the three variables were predominantly distributed within the moderately high and high categories, indicating that teachers generally demonstrated relatively positive conditions regarding professional collaboration, digital literacy, and learning innovation. Regression Assumption Tests Before conducting regression analysis, assumption tests were performed, including normality, linearity, multicollinearity, and heteroscedasticity tests. The results are summarized in Table 3.

Table 3. Summary of Regression Assumption Tests

Test	Indicator	Result	Criterion	Conclusion
Normality	Kolmogorov–Smirnov Sig.	0.200	> 0.05	Normally distributed
Linearity X1 → Y	Deviation from Linearity	0.384	> 0.05	Linear
Linearity X2 → Y	Deviation from Linearity	0.147	> 0.05	Linear
Multicollinearity X1	Tolerance / VIF	0.769 / 1.301	> 0.10/< 10	No multicollinearity
Multicollinearity X2	Tolerance / VIF	0.769 / 1.301	> 0.10/< 10	No multicollinearity
Heteroscedasticity X1	Glejser Sig.	0.661	> 0.05	No heteroscedasticity
Heteroscedasticity X2	Glejser Sig.	0.267	> 0.05	No heteroscedasticity

Source: Research data processed, 2026.

The results indicate that all regression assumptions were satisfied. Therefore, regression analysis was considered appropriate for examining the predictive relationships among teacher learning communities, digital literacy, and learning innovation. Simple linear regression was conducted to examine the predictive relationship between each independent variable and learning innovation.

The analysis showed that teacher learning communities were positively associated with learning innovation. The model produced an R^2 value of 0.511, indicating that teacher learning communities statistically explained 51.1% of the variance in learning innovation. The regression coefficient was significant ($t = 10.760$, $p < 0.001$), indicating support for H1.

Similarly, teachers' digital literacy demonstrated a positive association with learning innovation. The analysis produced an R^2 value of 0.560, indicating that digital literacy statistically explained 56.0% of the variance in learning innovation. The regression coefficient was significant ($t = 11.880$, $p < 0.001$), supporting H2. Multiple regression analysis was then conducted to examine the predictive relationship of teacher learning communities and digital literacy simultaneously. The results are presented in Table 4.

Table 4. Multiple Regression Analysis Results

Predictor	B	Std. Error	β	t	p
Constant	2.352	5.987	–	0.393	0.695
Teacher Learning Communities (X1)	0.462	0.057	0.461	8.070	< 0.001
Teachers' Digital Literacy (X2)	0.356	0.039	0.526	9.204	< 0.001

Model: $R = 0.851$; $R^2 = 0.723$; Adjusted $R^2 = 0.718$; $F = 143.907$; $p < 0.001$.

Source: Research data processed, 2026.

The multiple regression model was statistically significant ($F = 143.907$, $p < 0.001$) and explained 72.3% of the variance in learning innovation. Both teacher learning communities and digital literacy were significant predictors of learning innovation, supporting H3. Comparison of standardized beta coefficients showed that digital literacy had a larger standardized beta coefficient ($\beta = 0.526$) than teacher learning communities ($\beta = 0.461$). This finding indicates that digital literacy demonstrated a relatively larger predictive coefficient within the regression model;

however, it should not be interpreted as statistically stronger contribution because the difference between the two coefficients was not tested statistically. The summary of hypothesis testing is presented in Table 5.

Table 4. Summary of Hypothesis Testing Results

Hypothesis	Relationship	Main Statistics	R ²	p	Decision
H1	Teacher Learning Communities → Learning Innovation	$r = 0.715$; $t = 10.760$	0.511	< 0.001	Supported
H2	Teachers' Digital Literacy → Learning Innovation	$r = 0.748$; $t = 11.880$	0.560	< 0.001	Supported
H3	Teacher Learning Communities and Teachers' Digital Literacy → Learning Innovation	$R = 0.851$; $F = 143.907$	0.723	< 0.001	Supported

Source: Research data processed, 2026.

DISCUSSION

The findings indicate that teacher learning communities are positively associated with learning innovation among primary school teachers in Tirta District, Pekalongan Regency. This relationship suggests that teachers who experience stronger professional collaboration environments tend to demonstrate greater capacity to develop innovative instructional practices. However, because this study employed a cross-sectional ex post facto design, the findings should be interpreted as predictive relationships rather than evidence of direct causal effects. The relationship between teacher learning communities and learning innovation can be explained through the role of professional collaboration in developing collective knowledge. Teacher learning communities provide opportunities for teachers to discuss instructional challenges, exchange experiences, reflect on teaching practices, and collaboratively develop alternative approaches to learning. Through these processes, individual knowledge can be transformed into collective professional capacity that supports instructional improvement. Huijboom et al. (2021) demonstrated that professional learning communities function as professional learning environments where teachers develop knowledge through interaction and experience sharing. Similarly, Liu et al. (2022) found that professional learning communities are positively associated with teacher innovation through enhanced creative self-efficacy. These findings suggest that collaborative professional environments may encourage teachers to experiment with new instructional strategies because teachers receive feedback, support, and diverse perspectives from colleagues. This study extends previous research by emphasizing that teacher learning communities are not only related to teacher competence, self-efficacy, and professional development but are also associated with teachers' capacity to develop learning innovation. Previous studies have shown that PLCs contribute to professional learning, teacher self-efficacy, commitment, and performance (Zheng et al., 2021; Yada et al., 2023; Çopur & Demirel, 2022; Mydin et al., 2024). Therefore, collaborative professional capacity represents an important contextual condition that may support teachers in creating and sustaining innovative learning practices. The role of reflective dialogue, shared responsibility, and collaboration within teacher learning communities is consistent with previous findings. Zheng et al. (2021) identified reflective dialogue, shared purpose, and collective focus on student learning as important characteristics of effective PLCs. Yada et al. (2023) also demonstrated the relationship between PLC participation, experiential learning, and teacher self-efficacy. However, the present study does not provide sufficient evidence to determine which specific dimension of teacher learning communities has the strongest predictive influence because dimensional extraction analysis was not included as part of the validated analytical procedure. Therefore, individual dimensions

should be interpreted as characteristics of teacher learning communities rather than as confirmed determinants of learning innovation. Teacher learning communities may also have implications for developing instructional practices that are more responsive to diverse student needs. Alhanachi et al. (2021) demonstrated that PLCs can support culturally responsive teaching, while Mo et al. (2021) found that professional communities are related to teachers' capacity to address diversity in classroom contexts. Nevertheless, inclusive learning was not directly measured as a separate construct in this study. Therefore, the relationship between teacher learning communities and inclusive learning should be understood as a potential educational implication rather than a direct empirical finding. Future studies should investigate inclusive learning as an independent variable to provide stronger evidence regarding this relationship.

The findings also indicate that teachers' digital literacy is positively associated with learning innovation. This suggests that teachers with stronger digital literacy capacities tend to demonstrate greater readiness to develop technology-supported and adaptive instructional practices. However, this relationship should be interpreted as a predictive association rather than a causal effect. Digital literacy in educational contexts involves more than technical ability to operate digital devices. It includes teachers' capacity to access, select, understand, evaluate, and analyze digital information and resources according to pedagogical objectives. Lucas et al. (2021) conceptualized teacher digital competence as a multidimensional capacity influenced by personal and contextual factors. Similarly, Tzafilkou et al. (2023) emphasized that effective digital competence involves the integration of technological knowledge, pedagogy, and professional practice. The relationship between digital literacy and learning innovation may occur because digital literacy expands teachers' pedagogical possibilities. Teachers who are able to critically select and evaluate digital resources may have greater opportunities to develop diverse learning materials, utilize interactive platforms, and adapt instructional strategies according to learning objectives. Runge et al. (2023) found that teachers' digital competence-related beliefs are associated with technology-enhanced instructional quality, including learner empowerment, differentiation, and cognitive activation. Heine et al. (2023) further emphasized that selecting and evaluating digital resources represents an important component of teachers' professional digital competence. Howard et al. (2021) also highlighted that digital competence development requires integration between technological knowledge and pedagogical understanding. Although digital literacy demonstrated a relatively larger standardized beta coefficient than teacher learning communities in the regression model, this difference should not be interpreted as statistically stronger influence because the difference between coefficients was not tested. Instead, the finding indicates that digital literacy showed a relatively stronger predictive coefficient within the current model.

The main conceptual contribution of this study lies in examining teacher learning communities and digital literacy simultaneously as predictors of learning innovation. The findings suggest that learning innovation may be better understood through the interaction between collective professional capacity and individual digital capacity. Teacher learning communities provide the social environment for generating ideas, reflecting on practices, and sharing professional knowledge. Meanwhile, digital literacy enables teachers to translate these ideas into technology-supported instructional activities. Thus, collaborative professional learning and digital capacity represent complementary resources rather than separate factors. Previous studies have generally examined these areas independently. Research on PLCs has focused on self-efficacy, professional development, teacher identity, resilience, performance, and instructional practices (Zhang et al., 2023; Zhang et al., 2024; Mydin et al., 2024; Vu et al., 2025). Meanwhile, digital competence research has emphasized technology integration, digital

pedagogy, and technology-enhanced instruction (De León et al., 2023; Tzafilkou et al., 2023; Suzer & Koc, 2024). By integrating these perspectives, this study provides empirical evidence that sustainable learning innovation requires both a supportive professional ecosystem and teachers' individual digital capacity. The findings suggest that schools should develop learning innovation strategies by strengthening both teacher collaboration and digital literacy development. Professional development programs should not focus only on improving teachers' technical skills but should also create collaborative spaces where teachers can discuss, evaluate, and apply technology-supported instructional strategies. The implications regarding adaptive and inclusive-oriented learning should be interpreted carefully. Although stronger professional collaboration and digital literacy may provide opportunities for teachers to respond to diverse student needs, inclusive learning was not directly measured in this study. Several limitations should also be acknowledged. First, the cross-sectional ex post facto design limits the ability to establish causal relationships among variables. Second, the study relied on self-report questionnaires, which may introduce response bias because teachers' perceptions may not fully represent their actual classroom practices. Third, because all variables were measured using the same respondents and instruments, potential common method bias cannot be completely excluded. Finally, the study was conducted only in primary schools in Tirta District, Pekalongan Regency, which limits the generalizability of findings to other educational contexts. Future studies should consider longitudinal designs, broader geographical samples, and additional variables such as school leadership, innovation culture, pedagogical competence, technological support, and teacher self-efficacy to develop a more comprehensive understanding of learning innovation.

Conclusion

This study concludes that teacher learning communities and teachers' digital literacy are positively associated with learning innovation among primary school teachers in Tirta District, Pekalongan Regency. The findings indicate that collective professional capacity developed through collaboration, reflection, shared responsibility, and professional interaction, together with individual digital capacity in accessing, evaluating, and utilizing digital resources, represents complementary dimensions related to teachers' ability to develop innovative learning practices. The simultaneous relationship between these two capacities highlights that learning innovation is not only related to individual technological capability but also to the professional environment that supports knowledge sharing and collaborative improvement. Therefore, the findings provide empirical support for understanding learning innovation as a process supported by both collective and individual professional resources within primary education contexts.

Several practical implications can be derived from these findings. Schools and educational stakeholders should consider strengthening sustainable teacher learning communities while simultaneously developing teachers' digital literacy through relevant professional development programs, mentoring, and collaborative learning activities. However, these implications should be interpreted as potential strategies for supporting learning innovation rather than guaranteed outcomes, because adaptive, contextual, and inclusive-oriented learning practices were not directly measured as separate constructs in this study. This study also has several limitations. First, the cross-sectional ex post facto design limits the ability to establish causal relationships among variables; therefore, the findings should be interpreted as associations and predictive relationships within the research context. Second, the study relied on self-report questionnaires, which may introduce perception bias and may not fully represent teachers' actual instructional practices. Third, because all variables were measured using the same respondents and

questionnaire method, potential common method bias cannot be completely excluded. Fourth, the study was conducted only among primary school teachers in Tirto District, Pekalongan Regency, which limits the generalizability of findings to other educational contexts. In addition, teachers were clustered within schools, meaning that school-level characteristics may have influenced individual responses. Future research is recommended to employ longitudinal or multilevel approaches, include broader geographical samples, and incorporate additional variables such as school leadership, innovation culture, pedagogical competence, technological support, and teacher self-efficacy to develop a more comprehensive explanation of learning innovation.

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