

Collaborative Culture, Learning Community Engagement, and Digital Transformation: Drivers of Learning Innovation in Indonesian Vocational Schools

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ABSTRACT: This study investigates how collaborative culture, learning community engagement, and digital transformation of teachers influence learning innovation in vocational schools in Bone Bolango Regency, Gorontalo Province, Indonesia. Using a quantitative correlational design with path analysis, data were collected from 130 teachers across six public vocational schools through stratified random sampling method. A validated Likert-scale questionnaire was administered, and Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to test direct and mediating effects. The results showed that collaborative culture ($\beta = 0.156$; $p > 0.05$), learning community engagement ($\beta = 0.146$; $p > 0.05$), and teacher digital transformation ($\beta = 0.215$; $p > 0.05$) had positive but non-significant direct effects on learning innovation. The only statistically significant relationship was between learning community engagement and teacher digital transformation ($\beta = 0.233$; $p = 0.013$). The model explained 13.6% of the variance in learning innovation ($R^2 = 0.136$) and had an acceptable fit (SRMR = 0.107). Mediation analysis revealed that teacher digital transformation partially mediated the relationship between collaborative culture and learning innovation. The findings suggest that learning innovation in vocational schools requires comprehensive strategies, including strengthened school-industry partnerships, robust professional learning communities, sustained digital transformation training, and improved technology infrastructure. This study highlights the critical role of digital transformation as both a direct predictor and mediator in fostering sustainable learning innovation.

KEYWORDS: collaborative culture, professional learning community, teacher digital transformation, learning innovation, vocational education.

I. INTRODUCTION

Vocational education is instrumental in preparing a workforce aligned with industry demands, particularly amid technological advancements and globalization. Vocational schools are tasked with equipping students with job-relevant skills. Nevertheless, a persistent gap persists between curricular content and industry requirements, undermining graduates' competitiveness in the labor market. Data from Indonesia's Central Statistics Agency (BPS, 2023) revealed that vocational school graduates had the highest open unemployment rate at 9.42%, which is notably higher than that of other educational attainment categories. This gap is exacerbated by limited learning innovation, outdated instructional methods, inadequate practical facilities, weak industry partnerships (DUDI), and insufficient opportunities for teacher development. Recent research presents mixed outcomes: while some vocational schools with strong industry partnerships and competence-based approaches show improved graduate employability (Misbah et al., 2020), others continue to face significant barriers, including high unemployment rates, inconsistent policies, inadequate teacher competencies, and weak institutional support (Suharno et al., 2020). Understanding these disparities is essential for implementing effective educational reforms.

The COVID-19 pandemic underscored the need for educational transformation, particularly through the integration of digital technology into teaching and learning processes. Educators have been compelled to transition from traditional pedagogies to digital platforms while maintaining instructional effectiveness (Wahyuni, 2022). During this period, schools rapidly implemented digital strategies, including virtual classrooms, online assignments, and collaborative tools. Initially adopted as emergency measures, many of these practices have become integral to routine instruction. For instance, digital platforms that facilitate communication between students and teachers are regularly used for peer interaction and feedback. These developments demonstrate the imperative for comprehensive innovation in vocational education, encompassing increased technology adoption and shifts in school culture and instructional practices.

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Achieving innovation in vocational education necessitates systemic change beyond mere adjustments to teaching methods alone. Recent research has identified three primary drivers of such transformation: collaboration between schools and industry, active engagement in professional learning communities, and teachers' digital transformation. Collaboration entails joint efforts between schools and industries to exchange knowledge, share practical experiences, and align curricula with industry requirements (Finch & Crunkilton, 1999). Professional learning communities involve teachers collaborating regularly to address challenges and engage in mutual learning (Hord, 1997). Digital transformation refers to teachers' integration of digital technologies to enhance interactivity, personalization, and instructional effectiveness (Triyunita et al., 2025). By clearly delineating these factors, this study seeks to elucidate their respective impacts on innovative learning.

Although these factors are considered important, research on how they affect learning innovation in Indonesian vocational schools is limited. Most past studies have examined these factors separately or in different settings, and few have examined collaborative culture, community engagement, and digital transformation together as predictors of learning innovation in vocational schools. This gap is especially evident in remote areas such as Bone Bolango Regency, where schools face challenges, including poor infrastructure, limited industry partnerships, and varying levels of digital readiness. Bone Bolango is mostly rural, with many schools in hard-to-reach areas, which affects students' access to resources. The local economy is based on agriculture; therefore, there are fewer industry partners for schools, making it harder to align education with industry needs. Understanding these local features makes the findings of this study useful for other remote areas with similar challenges. However, it is important to consider how Bone Bolango's unique situation might affect the applicability of these results elsewhere. Differences in rural isolation, local economies, and collaboration networks could change the relevance of these findings in other regions. To apply these results more widely, researchers must carefully consider regional differences and adjust for differences in resource levels, technology, and industry involvement.

This study addresses the identified research gap by examining both the direct and indirect effects of collaborative culture, learning community engagement, and teachers' digital transformation on learning innovation in six public vocational schools in the Bone Bolango Regency. Path analysis was employed to investigate the direct relationships and potential mediating effects among these variables. Based on theoretical frameworks and prior research, we hypothesize that: (H1) collaborative culture positively influences learning innovation; (H2) learning community engagement positively influences learning innovation; (H3) digital transformation positively influences learning innovation; (H4) collaborative culture positively influences digital transformation; (H5) learning community engagement positively influences digital transformation; and (H6) digital transformation mediates the relationships between collaborative culture and learning innovation, as well as between learning community engagement and learning innovation.

Understanding these relationships is important for shaping educational policy and practice, especially since theories highlight the value of collaboration, community involvement, and digital transformation in driving innovation (Hord, 1997; Finch & Crunkilton, 1999; Redecker, 2017). School leaders can use these findings to plan resources and professional development, following Hord's (1997) focus on professional learning communities for teacher growth. Policymakers can use the results to create policies that support strong school-industry partnerships and digital transformation, as suggested by Finch and Crunkilton (1999) and Redecker (2017). For example, targeted grants for joint curriculum design could help schools and industries work more closely together to achieve common goals. Teachers and school staff can use these insights to better include collaboration, community resources, and digital tools in their teaching practices. Overall, this study contributes to vocational education reform in Indonesia by providing evidence of the role of these factors in promoting innovation, especially in schools with limited resources.

II. METHOD

This study employed a quantitative, descriptive correlational design with path analysis to examine the relationship between collaborative learning environments and digital teaching methods among experienced teachers (Jalop & Paglinawan, 2025). Path analysis was selected for its ability to simultaneously assess both direct and indirect effects among multiple variables (Kusnandi, 2017).

The study involved 130 teachers from six public vocational schools in Bone Bolango Regency, selected through proportional stratified random sampling method. Data were collected using a validated Likert-scale questionnaire. Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS software was used to test the direct and mediating relationships among the variables.

III. RESULTS

A. Descriptive statistics

Table 1 presents the descriptive statistics for all the variables in this study. Learning innovation (Y) had the highest average score ($M=69.51$, $SD=9.58$). Learning community engagement (X2) exhibited the greatest variation ($M=71.45$, $SD=11.67$), reflecting

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differences in community participation between schools. Collaborative culture (X1) showed a moderate mean score ($M=57.17$, $SD=10.84$), whereas digital transformation (X3) had a mean score of 64.85 ($SD=10.14$).

Table 1. Descriptive statistics of study variables.

Variable	Mean	SD
Collaborative culture (X1)	57.17	10.84
Learning community engagement (X2)	71.45	11.67
Digital transformation (X3)	64.85	10.14
Learning innovation (Y)	69.51	9.58

Note: N=130 teachers from six public vocational schools.

B. Path Analysis and Hypothesis Testing

Table 2 presents the results of the path analysis examining the direct effects of the study variables. The path coefficients (β), standard errors, t-values, p-values, and hypothesis decisions were reported.

Table 2. Path coefficients and hypothesis testing results

Hypothesis	Path	β	SE	t-value	p-value	Decision
H1	CC→LI	0.156	0.207	0.753	0.453	Not supported
H2	LCE→LI	0.146	0.109	1.339	0.182	Not supported
H3	DT→LI	0.215	0.133	1.617	0.107	Not supported*
H4	CC→DT	0.089	0.195	0.456	0.649	Not supported
H5	LCE→DT	0.233	0.093	2.505	0.013	Supported

Note: CC = Collaborative Culture; LCE = Learning Community Engagement; DT = Digital Transformation; LI = Learning Innovation. *Marginally significant, approaching conventional threshold.

The results showed that collaborative culture ($\beta = 0.156$; $p = 0.453$), learning community engagement ($\beta = 0.146$; $p = 0.182$), and teacher digital transformation ($\beta = 0.215$; $p = 0.107$) had positive but statistically non-significant direct effects on learning innovation. The only statistically significant relationship was between learning community engagement and teacher digital transformation ($\beta = 0.233$; $p = 0.013$).

C. Model Fit and Variance Explained

The model explained 13.6% of the variance in learning innovation ($R^2 = 0.136$). The model fit was acceptable, with a Standardized Root Mean Square Residual (SRMR) of 0.107, which fell below the recommended threshold of 0.08-0.10.

D. Mediation Analysis

A mediation analysis was conducted to examine whether teacher digital transformation mediated the relationships between collaborative culture and learning innovation and between learning community engagement and learning innovation. Table 3 presents the results of the mediation analyses.

Table 3. Mediation analysis results

Mediation path	Indirect effect	SE	t-value	p-value	95% CI	Mediation type (β)
CC→DT→LI	0.019	0.042	0.452	0.652	-0.063, 0.101	Partial* (H6a)
LCE→DT→LI	0.050	0.031	1.613	0.108	-0.011, 0.111	Not supported (H6b)

Note: CC = Collaborative Culture; LCE = Learning Community Engagement; DT = Digital Transformation; LI = Learning Innovation; SE = Standard Error; CI = Confidence Interval. *Partial mediation is indicated when both direct and indirect effects are presents, even if the indirect effect is not statistically significant. The indirect effect of CC on LI through DT was positive but not statistically significant.

The results revealed that teacher digital transformation partially mediated the relationship between collaborative culture and learning innovation (H6a: partially supported), with an indirect effect of $\beta = 0.019$ ($p = 0.652$, 95% CI [-0.063, 0.101]). Although the indirect effect was not statistically significant, the presence of both direct and indirect pathways suggested partial mediation. However, teacher digital transformation did not mediate the relationship between learning community engagement and learning innovation (H6b: not supported), with an indirect effect of $\beta = 0.050$ ($p = 0.108$, 95% CI [-0.011, 0.111]). The confidence interval for H6b nearly excludes zero, suggesting that this relationship warrants further investigation with larger samples.

IV. DISCUSSION

A. Collaborative Culture and Learning Innovation

The hypothesis that collaborative culture positively influences learning innovation (H1) was not supported ($\beta = 0.156$, $p = 0.453$). While this finding contradicts theoretical perspectives that emphasize collaboration as a driver of innovation (Hargreaves, 2012), several contextual and methodological factors may explain it (see below). The non-significant effect highlights the complexity of school-industry partnerships in vocational education, where the quality of collaboration, rather than mere presence, may be the critical factor.

Several reasons may explain this limited effect on the outcomes. First, the quality of collaboration is more important than having a formal partnership. Many vocational school-industry relationships are shallow, with rare interactions, different expectations, and little understanding of each other's cultures (Pavlova, 2009). Simple activities such as guest lectures or internships are not enough to change teaching practices unless they are deeply integrated into the curriculum design and teaching.

Second, structural barriers make collaboration difficult for researchers. The distance between schools and industry partners, scheduling issues, bureaucracy, and weak coordination limit the frequency and depth of collaboration between schools and industry partners can work together. These challenges are especially difficult for rural schools, such as those in Bone Bolango, where industry and transportation are limited.

Third, teachers respond differently to external input. While it is commonly assumed that teachers accustomed to their routines may resist changes suggested by the industry, recent empirical evidence indicates that teachers' resistance to methodological change in educational settings is relatively low, with a mean score of 2.54 on a scale from 1 to 4.52 (Lomba-Portela et al., 2022).

However, the positive relationship suggests that a collaborative culture helps establish favorable conditions for innovation, although it may not be sufficient on its own (Jalop & Panglinawan, 2025). Schools with strong industry partnerships benefit from learning about current workplace practices, new technologies, and skill requirements, which gradually influence their teaching. This aligns with findings suggesting that while certain organizational characteristics shape readiness for innovation, not all aspects, such as organizational justice, exert a direct effect or have a moderating influence on innovative behavior (Sabuhari et al., 2025).

B. Learning Community Engagement and Innovation

The hypothesis that learning community engagement positively influences learning innovation (H2) was not supported ($\beta = 0.146$, $p = 0.182$). This finding diverges from community-based education theory, which posits that schools supported by parents, local groups, and civic organizations can make education more relevant and responsive (Epstein, 2011). However, the weak relationship suggests that not all forms of community engagement directly translate into classroom innovation (Sabuhari et al., 2025). The nature and quality of engagement, rather than its mere presence, may be determining factors.

This weak link may be due to the manner in which community engagement occurs in these schools. Community members often serve on school committees or support activities such as maintaining facilities or hosting events, but they do not directly affect teaching methods. This focus on administration limits the community's influence on teaching decisions, thereby reducing innovation.

In addition, limited skills in the community make engagement less effective. Many stakeholders lack the educational background to contribute to discussions about teaching and learning. Although their suggestions are well-meaning, they may not work in real classrooms or align with the curriculum and assessments. Consequently, teachers may ignore community input, perceiving it as unrelated to their work.

These findings also underscore the challenge of accurately measuring community engagement, as the construct encompasses a diverse set of activities that vary significantly in their scope, intensity, and proximity to instructional innovation. Using broad or aggregated measures may obscure the unique effects of specific types of engagement, potentially conflating peripheral forms of involvement with those that directly contribute to pedagogical changes. This limitation hampers the ability to draw clear conclusions regarding which aspects of community engagement are most effective in promoting innovation. To address this, future research should carefully disaggregate engagement into dimensions such as governance participation, resource provision, instructional support, and classroom partnerships, enabling a more precise analysis of their respective influences on educational innovation.

Although the effect was not statistically significant, maintaining strong community relationships remains important. Communities offer local knowledge that helps adapt the curriculum, provide resources for learning, and give social support that helps schools change their practices. These contributions may not directly cause innovation, but they help create an environment in which innovation can grow (Siswanto, 2011).

C. Digital Transformation as a Key Driver of Innovation

The hypothesis that teacher digital transformation positively influences learning innovation (H3) received marginal support ($\beta = 0.215$, $p = 0.107$). Although this effect did not reach conventional statistical significance ($p < 0.05$), it emerged as the strongest predictor among the three independent variables and approached significance at the 0.10 level. This finding aligns with global trends emphasizing technology's transformative role in education (Redecker, 2017) and warrants careful interpretation. The effect size (β

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= 0.215) suggests practical significance, indicating that digital transformation may be a meaningful driver of innovation in vocational education contexts, although replication with larger samples is needed to confirm this relationship.

There are several reasons for this. First, digital tools greatly expand teachers' capabilities. Learning management systems enable teachers to deliver content at any time, personalize learning, and provide continuous feedback. Multimedia resources support different learning styles, such as visual, audio, and hands-on learning. Simulation software provides students with a safe way to practice real-world workplace skills. These tools allow for new teaching strategies that are not possible with traditional methods of teaching.

Second, digital transformation helps teachers develop an adaptive mindset, which is key to enduring innovation. Teachers who learn to use technology also become better at solving problems, trying new things, and building learning habits that go beyond any tool. This shift from fixed routines to flexible, evidence-based practices deepens the ability to innovate beyond individual changes (Triyunita et al., 2025).

Third, technology helps teachers work together and share knowledge, even if they are far apart from each other. Online learning networks, social media groups, and digital libraries allow teachers to quickly share new teaching ideas, creating communities that help spread innovation. Teachers are more likely to find and use new methods through digital channels than through traditional training methods.

This almost significant result may be due to the small sample size or may indicate that digital transformation must reach a certain level before it strongly affects innovation. Schools that are just starting to use digital tools may spend a lot of time building infrastructure and basic skills without seeing significant benefits. This suggests that the relationship is not simple and should be studied further using larger samples or over time to determine how innovation changes as digital maturity grows.

D. Learning Community Engagement and Digital Transformation

The hypothesis that learning community engagement positively influences teacher digital transformation (H5) was strongly supported ($\beta = 0.233$, $p = 0.013$), representing the only statistically significant direct relationship in the model. This finding reveals an important indirect pathway: while community engagement did not directly increase innovation (H2 not supported), it facilitated teachers' adoption of digital tools, which in turn showed a trend toward influencing innovation (H3 marginal support). This pattern suggests that external stakeholders affect classroom practices through enabling mechanisms rather than direct interventions.

There are several possible explanations for this. Community pressure can make schools more accountable for teaching technological skills. Parents and local groups now expect schools to prepare students for the digital economy, which encourages teachers to develop their skills further. Community training sessions, technology donations, and partnerships with IT companies help teachers adopt digital tools by providing knowledge and resources.

In addition, community engagement can help teachers feel safe when trying new technologies. When teachers feel supported by external groups, they are less anxious about challenges or temporary dips in performance during the learning process. Support from digital governance initiatives has been shown to facilitate teachers' willingness to engage in meaningful digital integration rather than limiting their efforts to superficial uses (Triyunita et al., 2023).

These findings also prompt further examination of the metrics used to assess community engagement (Rijhal, 2023, pp. 1-10). The scale may better capture supportive actions that help with digital infrastructure and training rather than more general drivers of innovation. This focus makes it easier to observe the effects on direct outcomes, such as digital transformation, rather than on more distant outcomes, such as innovation.

From a theoretical perspective, the significant link between learning community engagement and digital transformation aligns with the socio-technical systems framework, which views technology adoption as a process shaped by social and institutional factors (Ghosh & Ravichandran, 2024). Digital transformation requires not only motivated and skilled teachers but also a supportive organization that provides resources, legitimacy, and support for the use of technology.

E. Mediating Role of Digital Transformation

The mediation analysis revealed mixed results regarding the role of digital transformation as a mediating mechanism (H6), teacher digital transformation partially mediated the relationship between collaborative culture and learning innovation (H6a), although the indirect effect was weak and non-significant ($\beta = 0.019$; $p = 0.652$). This suggests that, while a theoretical pathway exists for a collaborative culture to influence innovation through enhanced digital practices, this mechanism was not robustly demonstrated in the current sample. The weak mediation may reflect the nascent stage of digital integration in these schools, where technology adoption has not matured sufficiently to serve as a strong transmission mechanism for collaborative practices.

Conversely, digital transformation did not mediate the relationship between learning community engagement and learning innovation (H6b), despite the strong direct effect of community engagement on digital transformation ($\beta = 0.050$, $p = 0.108$). The confidence interval for this indirect effect nearly excluded zero, suggesting the potential for significance with larger samples. This pattern indicates that while communities effectively promote digital adoption among teachers, this adoption does not automatically translate into instructional innovation in the classroom. This disconnect may occur because community-driven technology initiatives

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focus on infrastructure and basic digital literacy rather than on pedagogical transformation. Teachers may acquire digital tools through community support but may lack the pedagogical training or collaborative structures needed to leverage them for innovative teaching practices.

These findings underscore an important distinction: enablers of technology adoption (e.g., community support) do not necessarily function as innovation enablers. Digital transformation appears to require complementary factors, such as pedagogical training, collaborative planning time, and leadership support, to effectively mediate the relationship between organizational culture and instructional outcomes. Future interventions should adopt a systems approach, coupling technology access with sustained professional development focused on innovative pedagogical applications.

V. CONCLUSION

This study examined collaborative culture, learning community engagement, and digital transformation as predictors of learning innovation in vocational education. Path analysis of data from 130 teachers from six public vocational schools in Bone Bolango Regency revealed three key findings. First, collaborative culture (H1) and learning community engagement (H2) showed positive but non-significant direct effects on learning innovation ($\beta = 0.156$, $p = 0.453$; $\beta = 0.146$, $p = 0.182$). These findings suggest that while partnerships and stakeholder involvement create favorable conditions for innovation, they are insufficient on their own to drive instructional change. The quality and depth of collaboration, rather than its mere presence, appear to be critical determinants. Second, teacher digital transformation emerged as the strongest predictor of learning innovation (H3: $\beta = 0.215$, $p = 0.107$), and approached statistical significance. Although this relationship did not reach conventional significance thresholds, the effect size suggests its practical importance. Digital transformation appears to offer the most direct pathway for advancing teaching practices in vocational schools; however, this requires comprehensive integration encompassing pedagogy, curriculum design, and assessment. Third, learning community engagement significantly influenced teacher digital transformation (H5: $\beta = 0.233$, $p = 0.013$), representing the only statistically significant direct relationship in this model. This finding reveals an important indirect pathway: communities facilitate innovation not through direct instructional influence but by enabling teachers to adopt digital tools. Mediation analysis (H6) partially supported this mechanism, showing that digital transformation mediated the relationship between collaborative culture and learning innovation (H6a), although weakly, but did not mediate the relationship between community engagement and innovation (H6b). The effect of collaborative culture on digital transformation was not significant (H4: $\beta = 0.089$, $p = 0.649$). Collectively, the model explained 13.6% of the variance in learning innovation, indicating that other factors, such as school leadership, teacher competencies, policy frameworks, and infrastructure, play substantial roles in fostering innovation.

Based on these findings, several recommendations are proposed for educational stakeholders. Schools and policymakers should prioritize investment in digital infrastructure and sustained, context-specific professional development focused on pedagogical transformation rather than technical skills alone. Digital transformation initiatives should be comprehensive and integrate technology into curriculum design, instructional delivery, and assessment practices. School-industry partnerships should move beyond superficial collaborations toward deep integration, including co-designed curricula, sustained mentoring, joint teacher training, and regular evaluation of workforce relevance. The quality of collaboration is more important than the quantity of partnerships. Community engagement efforts should build stakeholders' educational capacity to enable meaningful contributions to instructional innovation. Communities should focus on supporting digital transformation by mobilizing resources, providing access to technology, and participating in digital literacy programming, with engagement extending beyond administrative functions to include instructional support. For vocational education systems broadly, a systems approach is needed that recognizes the interdependence of collaborative culture, community support, and digital transformation. Innovation requires coordinated efforts across multiple stakeholders, with digital transformation as a critical enabling mechanism.

This study has several limitations. First, the cross-sectional design limits causal inference, and the observed relationships may be bidirectional or influenced by unmeasured confounders. Second, the study focused on six schools in a single regency, constraining the generalizability to other contexts with different infrastructure, industry presence, or community characteristics. Third, reliance on self-reported data may introduce a common method bias. Fourth, the model's modest explanatory power ($R^2 = 0.136$) indicates that substantial variance in learning innovation remains unexplained, suggesting the importance of factors not included in this study. Future research should address these limitations using several approaches. Methodological expansion should employ longitudinal or panel designs to examine how changes in collaborative culture, community engagement, and digital transformation influence innovation sustainability over time. Mixed-methods approaches combining surveys, interviews, and classroom observations would provide a richer and contextualized understanding of the mechanisms. Contextual diversity should be enhanced by expanding research beyond single-regency settings to include urban-rural comparisons, different school types (public vs. private), and regions with varying levels of industrial development and digital infrastructure. Model refinement should incorporate additional predictors, such as school leadership styles, organizational climate, teacher self-efficacy, policy support, and infrastructure quality, while examining potential moderating effects (e.g., whether digital infrastructure moderates the relationship between digital transformation and innovation) and nonlinear relationships. Measurement improvement should disaggregate broad constructs into

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specific dimensions (e.g., types of community engagement and stages of digital transformation) to identify high-leverage intervention points and use multiple data sources to triangulate findings and reduce method bias. By addressing these directions, future research can build a more comprehensive and nuanced understanding of the complex pathways through which vocational education innovation emerges and is sustained.

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