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Digital Leadership Impact on Teacher Innovation in Higher Vocational Colleges: The Intermediary Role of the Organizational Innovation Climate

Guo Wei*, Bity Salwana Alias and Aida Hani Binti Mohd Kalok
Faculty of Education,
Universiti Kebangsaan Malaysia (UKM), Malaysia

Abstract. Teachers' innovative serves as a continuous driving force in educational reform and acts as a crucial institutional safeguard for promoting educational modernization. 450 teachers from higher vocational colleges in China answered a questionnaire, aiming to systematically explore the relationship between digital leadership and teachers' innovative behavior, while also examining the mediating effects of the organizational innovation climate. Through structural equation modeling analysis, three primary findings emerged: (1) Digital leadership has a statistically significant positive predictive effect on teachers' innovative behavior; (2) The organizational innovation climate partially mediates this relationship; (3) The moderated mediation model accounts for the total variance in innovative behavioral outcomes. These findings elucidate the mechanisms through which digital leadership influences teachers' innovative behavior and provide an empirical foundation for developing targeted intervention strategies. This study contributes to the educational management literature by expanding the theoretical understanding of these dynamics.

Keywords: Digital Leadership; Teacher Innovative; Organizational Innovation Climate; Higher Vocational College

1. Introduction

The widespread adoption of digital transformation in education has created a new learning ecosystem that has fundamentally changed teaching paradigms and redefined the modes of interaction between leaders and teachers (Arifah et al., 2024). This technological paradigm shift has catalyzed the emergence of digital leadership as a crucial governance framework in academia. Digital infrastructure now acts as a pivotal driver for quality enhancement in higher vocational colleges, prompting systemic transformations in administrative structures while

*Corresponding author: Guo Wei; *P127599@siswa.ukm.edu.m*

concurrently facilitating pedagogical modernization through an innovative organizational climate (Lukmantoro et al., 2024).

Social cognitive theory is widely applied in the field of education, particularly providing a crucial theoretical framework for understanding the interaction between individual behavior and the environment. Social cognitive theory emphasizes the impact of an individual's self-efficacy and environmental factors on behavior, which is especially important in innovative teaching practices by educators. Research shows that teachers' innovative behaviors are influenced not only by their personal self-efficacy but also by the school environment and social support（Li et al., 2024). In terms of digital leadership, social cognitive theory provides a framework for understanding that helps educational leaders better support teachers' professional development during the digital transformation process. Research indicates that teachers' learning in a digital environment not only relies on cognitive processes but is also influenced by social and emotional factors, which aligns with the perspective of social cognitive theory (Sascha et al., 2022).

Digital leadership is crucial in fostering educational innovation. According to social cognitive theory, the behavior of leaders within organizations serves as a model, influencing and guiding the cognition and behavior of organizational members. Through innovative teaching methods and technological tools, digital leadership can enhance teachers' digital technology skills and work engagement, ultimately contributing to improved life satisfaction (Yuan & Wang, 2025). Furthermore, digital leadership positively influences organizational exploratory innovation by mediating digital entrepreneurial orientation and digital organizational culture (Wang, T. et al., 2022). Additionally, digital leadership significantly impacts the promotion of organizational sustainability. Research indicates that digital leadership enhances organizational sustainability through the mediating effects of digital organizational culture and digital capabilities (Cheng et al., 2025). Digital leadership facilitates the innovative behavior of teachers by augmenting their self-efficacy and by fostering transformational leadership practices among school leaders, as noted by Zainal and Mohd Matore (2021). This, in turn, supports higher vocational colleges in achieving sustainable long-term development amid digital transformation. Nonetheless, the pathways and specific mechanisms through which digital leadership influences teachers' innovative behavior in higher vocational colleges remain insufficiently explored.

The organizational climate for innovation is crucial in the educational sector, particularly in fostering innovative behavior among teachers. Social cognitive theory posits that environmental factors significantly influence the formation of individual behavior. A supportive school environment profoundly affects teachers' professional identity and innovative practices. Research indicates that teacher support can bolster students' professional identity, while a school's innovative climate and appreciation for aesthetics facilitate the development of students' innovative behaviors (Lin & Chang, 2022). Such an environment provides teachers with a conducive atmosphere for innovation, encouraging them to adopt novel teaching methods and technologies. Additionally, the perception

of environmental corporate social responsibility (CSR) and its influence on employees' innovative behavior warrants attention. Evidence suggests that perceptions of environmental CSR can enhance employees' innovative behavior by strengthening their organizational identity (Wu, W. et al., 2021). This sense of identity aligns teachers with organizational objectives throughout the innovation process, thereby enhancing their active participation in innovative activities. Nonetheless, existing research has yet to adequately address the mediating role of the organizational innovation climate in the relationship between digital leadership and teachers' innovative behavior within higher vocational colleges.

Grounded in social cognitive theory, this study seeks to thoroughly investigate the interconnections among digital leadership, organizational innovation climate, and the innovative behavior of teachers in higher vocational educational institutions. This study aims to address several critical research questions: firstly, what is the direct impact of digital leadership on the innovative behavior of educators within higher vocational institutions? Secondly, does the organizational innovation climate serve as a mediating factor between digital leadership and educators' innovative behavior? Thirdly, what strategies can be employed to enhance the implementation of the Continuing Vocational Education and Training (CVET) system by optimizing digital leadership and the organizational innovation climate, thereby fostering the innovative behavior of educators in higher vocational colleges? By addressing these questions, the study seeks to offer theoretical insights and practical guidance for the educational management of higher vocational institutions, ultimately advancing the innovative progression of vocational education.

2.Theoretical Synthesis and Research Positioning

2.1 The Relationship between Digital Leadership and Teacher Innovative Behavior

Digital leadership, conceptualized as leaders' strategic orchestration of digital assets to modulate organizational members' cognitive-affective states and behavioral patterns, emerges as a pivotal architect of institutional metamorphosis (Zhang & Zheng, 2023). Digital leadership guides teachers to transform from passive executors to active innovators. It serves as a strategic lever that simultaneously drives industrial paradigm shifts through data-centric governance frameworks, optimizes organizational innovation efficacy through digital platform integration, and cultivates individual creative capacities via cognitive enhancement strategies (Yunita & Isnaini, 2024).

Research on corporate digital leadership indicates that it can have a direct positive impact on employee creativity, as well as an indirect effect through job reshaping (Shafariah et al., 2024). One significant aspect of digital leadership is its ability to directly predict and enhance teachers' life satisfaction by improving their digital technology skills and work engagement. This is evident in a study conducted in Shandong and Jiangsu Provinces, which highlighted the sequential mediating roles of digital technology skills and work engagement in the relationship between digital leadership and teachers' life satisfaction (Yuan & Wang, 2025).

The establishment of a digital resource-sharing platform has broken the time and space limitations of traditional teaching. The China Smart Education Platform has significantly improved the efficiency of dissemination and the breadth of application of teachers' innovative practices by gathering high-quality resources and building an interdisciplinary collaborative network. Furthermore, digital leadership influences the digital transformation processes within educational institutions and can enhance organizational innovation performance through the development of digital platforms (Indrio et al., 2024).

The development, management, guidance, and application of technical knowledge by leaders can significantly enhance the performance of educational institutions. Digital leadership enhances teachers' digital engagement and task performance (Yuan & Khan, 2024). It also provides emotional and resource support, thereby fostering increased work engagement and job satisfaction among teachers (Wibowo et al., 2024). According to resource conservation theory, individuals are inclined to protect, maintain, and acquire resources they deem valuable to manage current or future stressors (Agustina et al., 2020). The impact of leadership on innovative work behavior highlights the mediating roles of proactive personality and employee engagement, suggesting that leaders who are genuine and transparent can significantly influence their employees' willingness to innovate (Bai Yina et al., 2022).

The constructive leadership behaviors exhibited by digital leadership can inspire individuals to safeguard and acquire their resources, thereby demonstrating transformative behaviors that enhance their resources and align with organizational objectives. Consequently, this study posited the following hypothesis:
H1: Digital leadership is positively associated with teachers' innovative behavior in higher vocational colleges.

2.2 The Relationship between Organizational Innovation Climate and Teacher Innovative Behavior

In an organization with a positive innovation climate, there is a culture of open-mindedness that significantly contributes to fostering creativity and innovation among employees. This openness is not merely a passive acceptance of new ideas but an active encouragement of diverse perspectives and a willingness to explore novel solutions. During the COVID-19 pandemic, the provision of digital support by schools was found to influence teachers' well-being, highlighting the importance of digital strategies in maintaining a positive work environment (Diaz et al., 2023). The presence of an organizational innovation climate that promotes open-mindedness can mediate the relationship between job stressors and employees' sustained innovation behavior, enhancing creative self-efficacy and ultimately leading to more innovative outcomes (He et al., 2019).

An innovative climate is intrinsically associated with heightened creativity among university faculty, and this relationship is partially mediated by feedback-seeking behavior, which further enhances creative teaching and research capabilities (Du & Chang, 2023). This construct promotes the diffusion of innovation through three primary mechanisms: (1) reinforcing the environmental valence of innovation, (2)

augmenting psychological capital, which includes self-efficacy, resilience, and future orientation, and (3) facilitating the structural development of collaborative knowledge networks (Liang et al., 2022; Zhen et al., 2022). Furthermore, establishing an organizational innovation climate must consider various factors, such as leadership style, organizational structure, and social responsibility, which collectively create an environment conducive to innovation (Wu, J. et al., 2022). Within such a climate, educators are more inclined to implement innovative teaching practices and apply their findings to actual teaching scenarios, thereby fostering the innovative development of the entire organization (Palazzeschi et al., 2018).

Simultaneously, the organizational innovation climate is intricately linked to teachers' job satisfaction and organizational identity. A positive innovation climate can bolster teachers' sense of identification with the organization. This, in turn, increases their willingness to contribute to its development (Álvarez-García et al., 2021). Furthermore, this enhanced sense of identification not only improves teachers' job satisfaction but also mitigates job burnout and reduces the intention to leave. As a result, it stabilizes the teaching workforce and fosters continuous innovation within the organization (Parrello et al., 2019).

By fostering a supportive digital environment, educational leaders can significantly contribute to the development of teachers' digital competencies and the overall effectiveness of educational institutions. The establishment of an organizational innovation climate must emphasize communication and collaboration among teachers. Through effective communication, teachers can exchange innovative ideas and experiences, forming a mutually supportive innovation network that is essential for enhancing the overall innovation capabilities of the organization (Walumbwa et al., 2010). Building on this foundation, the present study proposed the following hypothesis:
H2: Organizational innovation climate is positively associated with teachers' innovative behavior in higher vocational colleges.

2.3 The Relationship between Digital Leadership and Organizational Innovation Climate

Digital leadership combined with a strong digital entrepreneurial orientation and a supportive digital organizational culture, can significantly enhance exploratory innovation (Wang T. et al., 2022). The role of strategic orientation toward digitalization in shaping innovative organizational performance. Employee resistance to innovation as a potential barrier, suggesting that organizations need to address this challenge to fully realize the benefits of digital transformation (Wang Y., 2022). By providing resources and opportunities for digital competence sharing, creating methods and practices for digital competence management, and promoting a collaborative culture, leaders can enhance mutual learning and digital competence among professionals. This approach not only supports the development of digital skills but also fosters a friendly and safe digital organizational atmosphere (Hammarén et al., 2023).

Leadership, human resources, and organizational climate are critical components of successful digital transformation (Trenerry et al., 2021). Digital leadership can

enhance an organization's innovative climate and overall performance by effectively integrating these elements. Empirical studies have demonstrated that entrepreneurial practices, entrepreneurship courses, and the fusion of entrepreneurial and professional education significantly enhance the outcomes of entrepreneurial education (Huang et al., 2021).

By enhancing service innovation capacities and facilitating the adaptive management of technology-driven disruptions (Brunner et al., 2023). Within the context of higher vocational education, the adoption of innovative educational practices significantly enhances students' entrepreneurial teamwork and strategic innovation capabilities. Survey research has demonstrated a significant positive correlation between innovative education and teamwork, with teamwork further exhibiting a significant positive correlation with strategic innovation (Zhao et al., 2020). In this regard, digital leadership can further stimulate teachers' innovative behavior by promoting an internal organizational innovation climate. Based on this, the study proposed the following hypothesis:
H3: Digital leadership is positively associated with the organizational innovation climate of higher vocational colleges.

Building upon the preceding discussion, a conceptual framework has been formulated and is illustrated in Figure 1. Within this framework, digital leadership is identified as the independent variable, teacher innovative behavior as the dependent variable, and organizational innovation climate operates as the mediating variable.

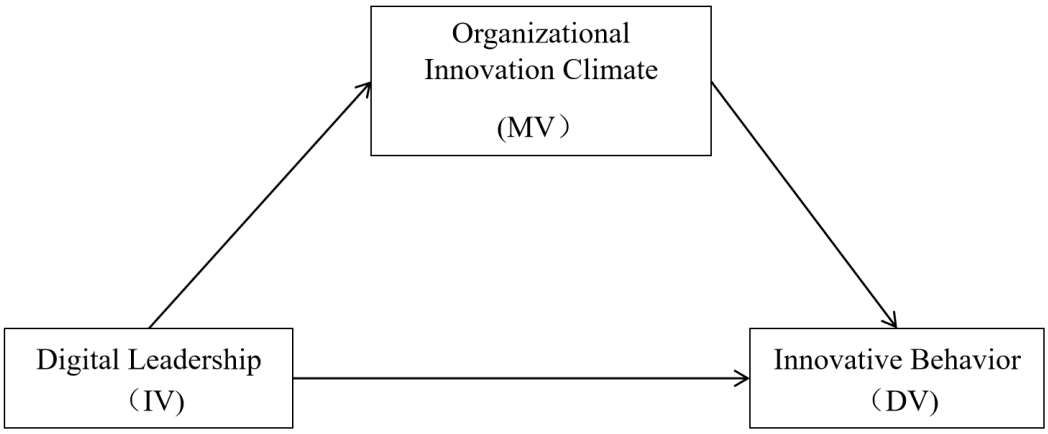

Figure 1: The conceptual framework

While existing research has delineated the synergistic interaction between digital leadership constructs and innovative behavioral patterns, a notable gap persists in the literature, especially concerning higher vocational education. The majority of these studies have predominantly focused on corporate employees, thereby largely neglecting teachers in higher vocational colleges. The relationship between digital leadership, organizational innovation climate, and teacher innovation behavior in higher vocational colleges has not been extensively studied. Examining this relationship and evaluating the mediating role of organizational innovation climate could provide significant insights for future

research on teaching innovation among teachers in higher vocational education. Addressing this research gap will enhance understanding of how to foster teacher innovation in vocational colleges, thereby contributing to the sector's high-quality development.

3. Methodology

3.1 Population and Sampling

The study population comprised 33,046 teachers from 82 higher vocational colleges in Sichuan Province. Following Krejcie and Morgan's (1970) sample size determination formula for finite populations, a minimum sample of 377 participants was required for a population of N = 20,000 at a 95% confidence level with a 5% margin of error. Given larger target population (N = 33,046), the sample size was proportionally increased to 450 to improve statistical power and external validity.

This study employed a combination of convenience sampling and stratified random sampling methodologies. Given the extensive and geographically dispersed population of 33,046 teachers from 82 higher vocational colleges in Sichuan Province, conducting a comprehensive survey posed significant challenges. Convenience sampling was utilized to efficiently acquire a preliminary set of samples, ensuring the feasibility of the research. Concurrently, to enhance the representativeness of the sample, stratified random sampling was implemented. This involved the number of higher vocational colleges in different cities in Sichuan Province, followed by random sampling within each stratum. This approach ensured that an appropriate proportion of teachers from each stratum was included in the sample, thereby improving the representativeness and reliability of the research findings.

3.2 Research Instrument

3.2.1 Digital Leadership Scale

The Digital Leadership Scale utilized in this study was directly adopted from the version developed by Zhang and Zheng (2023), due to its superior reliability and validity. This scale effectively measures the variables pertinent to the research and aligns well with the study's context and objectives. Comprising 18 items across four dimensions—digital thinking, digital resource construction, digital ethical empathy, and digital cognitive practice, the scale employs a 5-point Likert format. Following a rigorous confirmatory factor analysis (CFA), the scale demonstrated excellent fit indices, including $\chi^2/df = 2.546$ ($p < 0.001$), CFI = 0.975, TLI = 0.970, RMSEA = 0.07, and a Cronbach's alpha coefficient of 0.983. These results indicate that the scale is highly accurate and stable in assessing the construct of digital leadership. It effectively captures the leadership traits and behavioral performance of leaders in higher vocational colleges within the digital domain, thereby providing reliable data support for the study.

3.2.2 Organizational Innovation Climate Scale

This study directly adopted the Organizational Innovation Climate Scale, as developed by Zheng (2006), which comprises 40 items distributed across seven dimensions, including leadership effectiveness, organizational philosophy, team operation, learning support, environmental climate, working conditions, and

policies, utilizes a 5-point Likert scale. The scale's validation is supported by a factor analysis fit index of $\chi^2/df = 2.91$, CFI = 0.934, TLI = 0.905, RMSEA = 0.077, and a Cronbach's alpha coefficient of 0.923, indicating robust reliability and validity. Consequently, this scale provides a comprehensive and precise measure of the organizational innovation climate within higher vocational colleges, serving as a valid tool for investigating its mediating role in the relationship between digital leadership and teachers' innovative behaviors.

3.2.3 Innovation Behavior Scale

The Innovation Behavior Scale (IBS), adapted from Hong et al. (2009), operationalized 25 innovation-related behavioral indicators through reverse-scored Likert items (1 = completely inconsistent to 5 = completely consistent). Higher composite scores corresponded to elevated frequencies of innovation implementation. Confirmatory factor analysis (CFA) validated the measurement model, demonstrating exceptional fit indices: $\chi^2/df = 1.421$ ($p<0.001$), CFI = 0.928, TLI = 0.933, RMSEA = 0.027. The scale exhibited strong psychometric properties, with high internal consistency (Cronbach's $\alpha = 0.919$), confirming its reliability for capturing innovation dynamics in vocational education settings.

3.3 Data Analysis Procedure

Data management and analytical procedures were conducted using SPSS 26.0 for descriptive and correlational analyses, alongside Amos 24.0 for structural equation modeling (SEM). The SEM framework was employed to evaluate the hypothesized mediation model, testing both direct and indirect pathways between digital leadership, organizational innovation climate, and teacher innovation behavior.

Measurement models were first validated through confirmatory factor analysis (CFA) to ensure construct validity, followed by structural model testing to assess hypothesized relationships. To mitigate common method bias, a Harman single-factor test was performed, confirming that no single factor accounted for greater than 50% of the total variance (Podsakoff et al., 2003). Analytical protocols aligned with established SEM guidelines (Kline, 2015), emphasizing model parsimony, discriminant validity, and goodness-of-fit criteria.

4. Results

A total of 450 valid questionnaires were obtained from 82 higher vocational colleges in Sichuan Province, China. The final sample comprised 19.4% male (n=87) and 80.6% female (n=363) participants, with teaching experience distributed as follows: 41.4% (n=186) with $\leq$5 years, 21.3% (n=96) with 6-10 years, and 37.3% (n=168) with $\geq$11 years of service.

4.1 Descriptive Statistics

Table 1 summarizes the descriptive statistics and intercorrelations among the study variables. Mean scores for digital leadership (M = 3.68, SD = 0.97), organizational innovation climate (M = 3.23, SD = 0.50), and teacher innovation behavior (M = 3.44, SD = 0.81) indicated moderate to high levels of the constructs.

The bivariate correlation analysis reveals key insights: Digital leadership is a strong predictor of teacher innovation behavior ($r=0.41$, $p<0.001$), and a supportive organizational innovation climate significantly boosts teacher creativity ($r=0.51$, $p<0.001$). A minor but significant gender difference exists in perceptions of the innovation climate ($r=0.12$, $p<0.05$), while income shows no correlation with innovation variables ($p>0.05$), indicating financial incentives alone may not drive innovation. Including these factors as covariates in multivariate analyses enhances the validity of the findings by controlling for potential confounding effects.

Table 1. Descriptive Statistics

	M	SD	Gender	Teaching Years	Monthly Income	TIB	OIC	DL
Gender	—	—	1					
Teaching Years	—	—	0.01	1				
Monthly Income	—	—	0.003	0.34**	1			
Teacher Innovation Behavior (TIB)	3.44	0.81	-0.04	0.07	-0.06	1		
Organization Innovation Climate (OIC)	3.23	0.50	0.12*	0.07	0.05**	0.31	1	
Digital Leadership (DL)	3.68	0.97	0.09	0.09	0.46	0.41**	0.66**	1

Significance levels: *p<0.05; **p<0.01; ***p<0.001.

4.2 Analytical Framework

To examine the hypothesized mediation model, variables were standardized, and path analysis was conducted using Hayes' PROCESS Macro (Version 4.1, Model 6). The model specified digital leadership as the independent variable, teacher innovation behavior as the dependent variable, and organizational innovation climate as the mediator, while controlling for gender, teaching experience, and monthly income. The regression results (Table 2) revealed the following findings:

Hypothesis H1: Digital leadership significantly predicted teacher innovation behavior (β =0.19, t=6.50, p<0.001).

Hypothesis H2: Organizational innovation climate exhibited a significant positive effect on teacher innovation behavior (β =0.31, t=5.40, p<0.001).

Hypothesis H3: Digital leadership positively predicted organizational innovation climate (β =0.34, t=15.61, p<0.001).

Table 2. Regression analysis of the model

Regression Equation	Fitting index				
		R2	**F**	**β**	**t**
Organizational Innovation Climate		0.45	64.33**		
	Gender			0.10	1.83
	Teaching Years			0.00	-0.05
	Monthly Income			0.02	0.36
	Digital Leadership			0.34	15.61**
Teachers' Innovative Behavior		0.57	70.05***		
	Gender			0.05	0.92
	Teaching Years			0.00	-0.1
	Monthly Income			0.07	2.03*
	Digital Leadership			0.19	6.50***
	Organizational Innovation Climate			0.31	5.4***

To rigorously evaluate the hypothesized mediation pathways, a bias-corrected bootstrap analysis (5,000 resamples, 95% confidence interval) was performed. The total effect of digital leadership on teacher innovation behavior was significant (β = 0.376, 95% CI [0.328, 0.424]), with the indirect effect accounting for 48.4% of the total variance (β = 0.182, 95% CI [0.139, 0.229]). All confidence intervals excluded zero, confirming the statistical significance of the mediation effects. These results substantiate the organizational innovation climate as a critical mechanism through which digital leadership fosters innovative pedagogical practices.

Table 3. Analysis of the indirect effects of Variables

Item	Effect Size	Standard Error	95% Confidence Interval		Effect Ratio
			LLCI	ULCI	
Total effect	0.376	0.025	0.328	0.425	100%
Direct effect	0.194	0.030	0.135	0.253	51.596%
Total indirect effect	0.182	0.028	0.129	0.238	48.404%
DL--OIC	0.103	0.022	0.064	0.146	27.394%
OIC--TIB	0.061	0.017	0.030	0.096	16.223%
DL--OIC--TIB	0.018	0.007	0.005	0.032	4.787%

The analysis substantiated that organizational innovation climate acted as a statistically significant moderator in the relationship between digital leadership and teaching innovation among teachers in higher vocational colleges. Specifically, elevated levels of organizational innovation climate amplify the positive influence of digital leadership on teachers' innovation behaviors, with adequate resource allocation and institutional support mechanisms serving as critical enablers of this synergistic interaction.

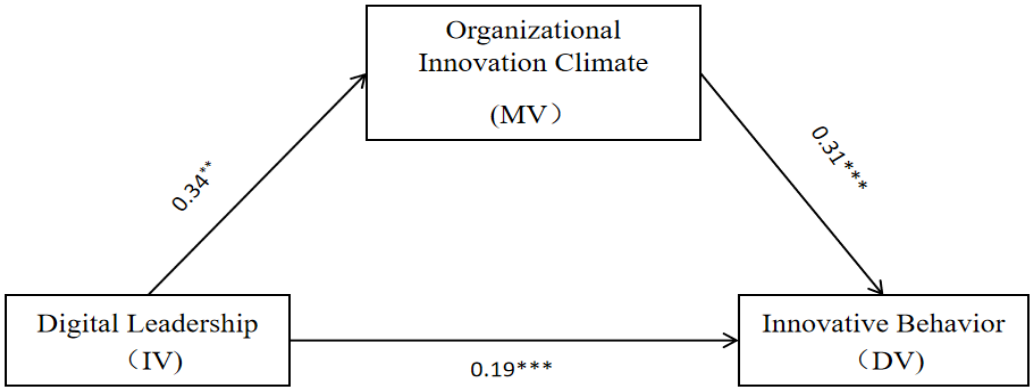

Figure 2. Analytical framework

5.Discussion

5.1 The Interplay between Digital Leadership and Teacher Innovation in Higher Vocational Education

This study empirically substantiates that digital leadership exerts significant causal effects on teachers' innovation behavior in higher vocational colleges. The digital transformation process amplifies pedagogical innovation through two interdependent mechanisms:(a) Teachers' digital literacy − encompassing information and communication technology (ICT) proficiency and data-driven decision-making competencies, serves as a foundational enabler for adopting advanced technologies (e.g., AI-assisted tools, adaptive learning platforms). Enhanced self-efficacy mediates this relationship (Zainal & Mohd Matore, 2021), as evidenced by increased experimentation with blended learning models and micro-credentialing frameworks. (b) Digital leadership serves as an organizational enabler that fosters teacher innovation in higher vocational colleges. According to Li and Tang (2022), team perceptions of leadership can positively influence individual innovative performance through the cross-level mediation of psychological safety, underscoring the interconnectedness of leadership dynamics and innovation outcomes. Furthermore, institutional support mechanisms, such as just-in-time professional development and decentralized innovation hubs, enhance the effective translation of digital competencies into classroom practice (Lin et al., 2023).

Notably, the moderating role of the organizational innovation climate underscored the necessity of aligning leadership strategies with institutional contextual factors. Future research should employ longitudinal designs to disentangle temporal dynamics and conduct cross-cultural comparisons to assess contextual boundary conditions.

5.2 Organizational Innovation Climate: A Multifaceted Catalyst for Teaching Innovation at Different Levels

The study confirmed that organizational innovation climate significantly predicts teachers' innovation behavior in higher vocational colleges, operating through multilevel mechanisms aligned with social cognitive theory (Bandura, 1986).

Creative Self-Efficacy Mediation, perceived organizational support for innovation, enhances teachers' creative self-efficacy (Wang, H. et al., 2021), fostering risk-taking in pedagogical redesign. When teachers perceive that the organization values and supports innovation, their work engagement is heightened, leading to more active participation in innovative activities (Zhang & Su, 2020). By fostering a campus learning environment that encourages innovation, teachers are more effectively equipped to develop and implement innovative teaching methodologies (Iqbal et al., 2022). These mechanisms collectively elevate educational quality, as evidenced by meta-analytic findings linking innovation climates to improved student problem-solving skills. Future studies should investigate the threshold effects of climate maturity and the role of digital infrastructure integration in sustaining these dynamics.

5.3 Digital Leadership: A Driving Force behind the Formation of Organizational Innovation Climates

This study established that digital leadership exerts a transformative influence on organizational innovation climates in higher vocational institutions, operating through sociotechnical systems that integrate human capital, digital infrastructure, and institutional governance. Digital leadership fosters innovative climates within organizations by institutionalizing cross-functional knowledge-sharing platforms (Sukmawati et al., 2024) and implementing real-time feedback loops. These systems reduce information asymmetry compared to traditional hierarchies (Dilmac et al., 2012), enabling agile responses to pedagogical disruptions. In vocational education, digital transformation indicates that teachers increased sense of confidence. This confidence leads to a greater adoption of innovative practices (Kim, 2024). This aligns with the innovation diffusion paradox, where perceived safety mediates the adoption of non-incremental innovations (Rogers, 2003). Data-driven professional development pipeline, including the micro-credentialing in AI-aided instructional design, amplify teacher self-efficacy (Ying & Hui, 2022).

The moderating role of institutional digital maturity further underscores the necessity of aligning leadership strategies with infrastructure readiness. Digital leadership enhances the innovative potential of organizational members by cultivating an open, inclusive, and supportive climate. Institutions that adopt digital leadership strategies − such as open-access knowledge repositories, interactive digital town halls, and virtual brainstorming sessions−report increased levels of psychological safety among faculty, thereby promoting risk-taking and innovative thinking (Sukmawati et al., 2024). Future research should investigate nonlinear threshold effects and cross-cultural variations in Digital Leadership archetypes.

6. Conclusion

This study presents robust empirical evidence supporting the digital transformation of higher vocational education. It demonstrates that the promotion of digital leadership and the cultivation of a positive organizational innovation climate can significantly enhance teacher innovation. These findings have practical implications for educational institutions, indicating the necessity to

prioritize the development of digital leadership competencies among administrators, foster an innovation-conducive environment, and enhance institutional preparedness for digital transformation. Such initiatives are instrumental in optimizing teacher innovation incentive mechanisms and advancing the modernization of vocational education, thereby improving educational quality and equipping students more effectively for the demands of the digital era.

In future research directions, longitudinal studies tracking the lifecycle effects of digital leadership and cross-cultural comparisons of innovation climate thresholds are warranted. Additionally, exploring AI ethics frameworks and blockchain-based credentialing systems could further bridge the digital-human nexus in higher vocational education.

7. Limitation

While this study advances our understanding of digital leadership dynamics in vocational education, three limitations warrant acknowledgment to contextualize its contributions.

(1) Geographical and Institutional Specificity: The sample was confined to teachers within geographically bounded higher vocational colleges in Sichuan Province, China. Despite proportional sampling enhancements, regional disparities in economic development indices and localized policy frameworks may constrain ecological validity. Future studies should adopt multiregional sampling to test cross-contextual robustness.

(2) Unexamined Moderating Constructs: The theoretical model omits critical moderators such as psychological capital and team-level absorptive capacity. Incorporating these variables through hierarchical linear modeling (HLM) would elucidate the boundary conditions for climate-mediated effects.

(3) Common Method Variance (CMV) Risks: Sole reliance on self-reported metrics introduces CMV biases, particularly for socially desirable constructs like innovation behavior. Triangulation via multisource data and experience sampling methods could mitigate this limitation while capturing real-time behavioral dynamics.

These constraints delineate critical pathways for advancing vocational education research. This is particularly important for refining digital leadership's role within Industry 4.0-aligned pedagogical ecosystems.

8. References

Agustina, R., Kamdi, W., Hadi, S., & Nurhadi, D. (2020). Influence of the principal's digital leadership on the reflective practices of vocational teachers mediated by trust, self-efficacy, and work engagement. *International Journal of Learning, Teaching and Educational Research, 19*(11), 24–40. https://doi.org/10.26803/ijlter.19.11.2

Álvarez-García, J., del Río-Rama, M. D. L. C., Oliveira, C., & Durán-Sánchez, A. (2021). Structure of relationships between the university organizational image and

student loyalty. *Frontiers in Psychology, 12*, 727961. https://doi.org/10.3389/fpsyg.2021.727961

Arifah, N., Bafadal, I., & Sumarsono, R. B. (2024). Change leadership in the development of digital learning ecosystem: A case study in an excellent school. *The Southeast Asian Conference on Education 2024: Official Conference Proceedings* (pp. 489–501). https://doi.org/10.22492/issn.2435-5240.2024.44

Bai, Y., Wang, Z., Alam, M., Gul, F., & Wang, Y. (2022). The impact of authentic leadership on innovative work behavior: Mediating roles of proactive personality and employee engagement. *Frontiers in Psychology, 13*, 879176. https://doi.org/10.3389/fpsyg.2022.879176

Brunner, T. J. J., Schuster, T., & Lehmann, C. (2023). Leadership's long arm: The positive influence of digital leadership on managing technology-driven change over a strengthened service innovation capacity. *Frontiers in Psychology, 14*, 988808. https://doi.org/10.3389/fpsyg.2023.988808

Cheng, Z., Jin, X., & Kwak, W. J. (2025). Using the new positive aspect of digital leadership to improve organizational sustainability: Testing moderated mediation model. *Acta Psychologica*, 255, 104963. https://doi.org/10.1016/j.actpsy.2025.104963

Diaz, M. L., Rossi, L., & Soncin, M. (2023). Teaching away from school: Do school digital support influence teachers' well-being during Covid-19 emergency? *Large-scale Assessments in Education, 11*(1), 10. https://doi.org/10.1186/s40536-023-00159-7

Du, T., & Chang, Y. C. (2023). Influence of organizational innovation climate on creativity and the mediating role of feedback-seeking behavior—a case study of university teachers in Hebei, China. *International Journal of Learning, Teaching and Educational Research, 22*(4), 87–103. https://doi.org/10.26803/ijlter.22.4.6

Hammarén, M., Pölkki, T., & Kanste, O. (2024). The management of digital competence sharing in health care: A qualitative study of managers' and professionals' views. *Journal of Advanced Nursing, 80*(5), 2051–2064. https://doi.org/10.1111/jan.15963

He, P. X., Wu, T. J., Zhao, H. D., & Yang, Y. (2019). How to motivate employees for sustained innovation behavior in job stressors? A cross-level analysis of organizational innovation climate. *International Journal of Environmental Research and Public Health, 16*(23), 4608. https://doi.org/10.3390/ijerph16234608

Hong, W. Z., Jing, W. K., Qun, Y. X., & Xing, D. H. (2010). The influence of teacher effectiveness, work motivation and mood on teaching innovation. *Psychological Science, 5*, 1254–1257. https://link.oversea.cnki.net/doi/10.16719/j.cnki.1671-6981.2010.05.057

Huang, Y., Zhang, Y., Long, Z., Xu, D., & Zhu, R. (2021). How to improve entrepreneurship education in "double high-level plan" higher vocational colleges in China. *Frontiers in Psychology, 12,* 743997. https://doi.org/10.3389/fpsyg.2021.743997

Iqbal, J., Asghar, M. Z., Asghar, A., & Waqar, Y. (2022). Impact of entrepreneurial curriculum on entrepreneurial competencies among students: The mediating role of the campus learning environment in higher education. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.950440

Liang, K., Lin, S., Liu, J., & Zhu, Y. (2022). Unlock the innovation potential of meaning of work: An empirical study of scientific and technological workers in China. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.870318

Li, K., Wijaya, T. T., Chen, X., & Harahap, M. S. (2024). Exploring the factors affecting elementary mathematics teachers' innovative behavior: An integration of social

cognitive theory. *Scientific Reports, 14*(1), 2108. https://doi.org/10.1038/s41598-024-52604-4

Li, T., & Tang, N. (2022). Inclusive leadership and innovative performance: A multi-level mediation model of psychological safety. *Frontiers in Psychology, 13*, 934831. https://doi.org/10.3389/fpsyg.2022.934831

Lin, R., Yang, J., Jiang, F., & Li, J. (2023). Does teacher's data literacy and digital teaching competence influence empowering students in the classroom? Evidence from China. *Educational Information Technology (Dordrecht), 28*(3), 2845–2867. https://doi.org/10.1007/s10639-022-11274-3

Lin, W., & Chang, Y. C. (2022). School climate's effect on hospitality department students' aesthetic experience, professional identity and innovative behavior. *Frontiers in Psychology, 13*, 1059572. https://doi.org/10.3389/fpsyg.2022.1059572

Lukmantoro, D., Hariyati, N., Riyanto, Y., & Setyowati, S. (2024). Strategic leadership of school principals in enhancing character education in the digital literacy era. *International Journal of Recent Educational Research*, *5*(4). https://doi.org/10.46245/ijorer.v5i4.622

Palazzeschi, L., Bucci, O., & Di Fabio, A. (2018). Re-thinking innovation in organizations in the Industry 4.0 scenario: New challenges in a primary prevention perspective. *Frontiers in Psychology, 9*, 30. https://doi.org/10.3389/fpsyg.2018.00030

Parrello, S., Ambrosetti, A., Iorio, I., & Castelli, L. (2019). School burnout, relational, and organizational factors. *Frontiers in Psychology, 10*, 1695. https://doi.org/10.3389/fpsyg.2019.01695

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Shafariah, H., Asril, A., & Agoestyowati, R. (2024). Leadership transformation in the digital age: implications for employee performance and engagement in modern organizations. *International Journal of Management Science and Information Technology, 4*(2), 482–491. https://doi.org/10.35870/ijmsit.v4i2.3372

Sukmawati, M., Giatman, M., & Maksum, H. (2024). E-leadership: Concept and influence of digital leadership. *Jurnal Teknologi Informasi Dan Pendidikan, 17*(1), 87–97. https://doi.org/10.24036/jtip.v17i1.811

Trenerry, B., Chng, S., Wang, Y., Suhaila, Z. S., Lim, S. S., Lu, H. Y., & Oh, P. H. (2021). Preparing workplaces for digital transformation: An integrative review and framework of multi-level factors. *Frontiers in Psychology*, 12, 620766. https://doi.org/10.3389/fpsyg.2021.620766

Wang, H., Chen, M., & Li, X. (2021). Moderating multiple mediation model of the impact of inclusive leadership on employee innovative behavior. *Frontiers in Psychology*, *12*, 666477. https://doi.org/10.3389/fpsyg.2021.666477

Wang, T., Lin, X., & Sheng, F. (2022). Digital leadership and exploratory innovation: From the dual perspectives of strategic orientation and organizational culture. *Frontiers in Psychology*, *13,* 902693. https://doi.org/10.3389/fpsyg.2022.902693

Wang, Y. (2022). Analyzing the mechanism of strategic orientation towards digitization and organizational performance settings enduring employee resistance to innovation and performance capabilities. *Frontiers in Psychology*, *13*, 1006310. https://doi.org/10.3389/fpsyg.2022.1006310

Walumbwa, F. O., Hartnell, C. A., & Oke, A. (2010). Servant leadership, procedural justice climate, service climate, employee attitudes, and organizational citizenship behavior: A cross-level investigation. *Journal of Applied Psychology, 95*(3), 517–529. https://doi.org/10.1037/a0018867

Wibowo, S., Bendriyanti, R. P., & Maja, I. (2024). Leadership strategies in digital education: enhancing teacher development and student outcomes through technology integration. *International Journal of Social and Human, 1*(3), 271–277. https://doi.org/10.59613/3t4hxw62

Wu, J., Gong, X., & Liu, Y. (2022). Research on the influence mechanism of employees' innovation behavior in the context of digital transformation. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.1090961

Wu, W., Yu, L., Li, H., & Zhang, T. (2022). Perceived environmental corporate social responsibility and employees' innovative behavior: A stimulus-organism-response perspective. *Frontiers in Psychology, 12*, 777657. https://doi.org/10.3389/fpsyg.2021.777657

Zhang, Z., & Zheng, X. (2023). Digital leadership: structural dimensions and scale development. *Economic Management, 11*, 152-168 https://doi.org/10.19616/j.cnki.bmj.2023.11.008

Yunita, F. E., & Isnaini, S. (2024). Analisis peran kepemimpinan digital dan budaya organisasi dalam meningkatkan kinerja karyawan: Tinjauan literatur sistematis [analysis of the role of diital leadership and organizational culture in improving employee performance: A systematic literature review]. *Religion, Education, and Social Laa Roiba Journal, 6*(11). https://doi.org/10.47467/reslaj.v6i11.5295

Yuan, F., & Khan, M. S. (2024). Investigating the impact of digital leadership on innovation performance of public universities in Yunnan, China. *Journal of Infrastructure, Policy and Development.* https://doi.org/10.24294/jipd.v8i9.7663

Yuan, F., & Wang, J. (2025). How does digital leadership affect teachers' life satisfaction in primary and secondary schools: The sequential mediating role of digital technology skills and work engagement. *Medicine (Baltimore), 104*(8), e41546. https://doi.org/10.1097/MD.0000000000041546

Zainal, M. A., & Mohd Matore, M. E. E. (2021). The influence of teachers' self-efficacy and school leaders' transformational leadership practices on teachers' innovative behaviour. *International Journal of Environmental Research and Public Health, 18*(12), 6423. https://doi.org/10.3390/ijerph18126423

Zhao, D., Zhong, H., Wu, Y., & Zhou, Q. (2020). A study of the impact of internet-based instruction integrated innovation education on university student entrepreneurial team collaboration and strategic innovation. *Frontiers in Psychology, 11*, 1264. https://doi.org/10.3389/fpsyg.2020.01264

Zhang, J., & Su, W. (2020). Linking leader humor to employee innovative behavior: The roles of work engagement and supervisor's organizational embodiment. *Frontiers in Psychology, 11*. https://doi.org/10.3389/fpsyg.2020.592999

Zhao, X., Yi, C., & Chen, C. (2022). How to stimulate employees' innovative behavior: Internal social capital, workplace friendship and innovative identity. *Frontiers in Psychology*, *13*, 1000332. https://doi.org/10.3389/fpsyg.2022.1000332

Appendix 1
Questionnaire

Dear Respondent,

Your participation in this questionnaire is crucial to the success of our research. The data collected will only be used for academic research purposes and will be treated with strict confidentiality. All responses will be anonymized, ensuring that your identity will not be revealed in any way.

We sincerely appreciate your time and support in completing this questionnaire. Your insights will contribute to a better understanding of this important topic in the field of vocational education. Thank you!

1.Basic Information

(1) Gender:

Male

Female

(2) Years of Teaching Experience

Less than 5 years

5 - 10 years

11 - 15 years

16 - 20 years

More than 20 years

(3) Monthly Income

Less than 5000 yuan

5001 - 8000 yuan

8001 - 12000 yuan

12001 - 15000 yuan

More than 15000 yuan

2.Digital Leadership (from:1: strongly disagree to 5 strongly agree)

Number	Dimension	Item Entry	1	2	3	4	5
DL1	Digital Thinking Change	My president is digitally transformational					
DL2		My president is aware of the current digital transformation state of the college					
DL3		My president is willing to embrace digital technologies					
DL4		My president is able to use data to accurately analyses the real needs of lecturers					
DL5		My president is aligned with the digital transformation direction in terms of strategic positioning					
DL6	Digital Resource Building	My president has the ability to manage digital resources such as data from different departments					
DL7		My president is able to ensure that digital resources are openly shared					
DL8		My president has a good ability to allocate digital resources in an integrated manner					
DL9	Digital Ethics Empathy	My president has a strong ability to help us to understand digital transformation					
DL10		My president doesn't just give orders through the digital system, they put themselves communicate offline at the right time					
DL11		My president encourages us to ease our resistance to using digital technology					
DL12		My president uses data to evaluate our work while paying attention to our true emotions					
DL13	Digital Cognitive Practice	My president is willing to learn the practicalities of various digital information systems					
DL14		My president develops their digital competence through digital-related books, lectures and courses					

DL15		My president has a good understanding of the digital technologies that are most relevant to their colleges					
DL16		My president is able to identify the real difficulties in digital transformation					
DL17		My president has the ability to expand new digital environment					
DL18		My president is able to use digital to improve the efficiency of governance processes					

3. Organizational Innovation Climate Scale (from 1 never true to 5 always true)

Number	**Dimension**	**Item Entry**	1	2	3	4	5
OIC1	Leadership Effectiveness	Presidents can respect different opinions					
OIC2		Presidents can trust lecturers					
OIC3		Presidents have good communication skills					
OIC4		Presidents set a good example					
OIC5		Presidents support my creativity in teaching					
OIC6	Organizational Philosophy	College has smooth exchange of opinions					
OIC7		College advocates innovation					
OIC8		College encourages the spirit of error					
OIC9		College encourages innovation thinking					
OIC10		College can provide incentives to encourage innovation ideas					
OIC11		College lacks creativity					
OIC12	Team Operation	Colleagues can support each other					
OIC13		Colleagues can exchange ideas					
OIC14		Colleagues have a good consensus					
OIC15		Colleagues can resolve problems through communication					
OIC16		Colleagues have the same goal					
OIC17	Learning Support	Encourages to observe other teachers' achievements					
OIC18		Cultivation of staff is an important task of our college					
OIC19		Attaches importance to exchange of new knowledge					
OIC20		Lecturers who are keen on learning can be supported					
OIC21		Provides sufficient opportunities for study					
OIC22		College attaches importance to social feedback					
OIC23	Environmental Climate	Have a free workspace					
OIC24		I can freely decorate my work environment					
OIC25		The atmosphere of my workspace is harmonious					
OIC26		My work environment can give me more creative inspiration					
OIC27		In my work environment, I can often get support from others					
OIC28	Working Conditions	I can get effective assistance from professionals					
OIC29		I can get sufficient data					
OIC30		I have enough equipment to carry out my work					

OIC31		I often get relevant teaching resources to effectively promote my work					
OIC32		I can freely set my work progress					
OIC33		My work content has space to express myself freely					
OIC34		I can work independently without interference					
OIC35		My work is very challenging					
OIC36	Policies	Changes in education policies give more room for innovation					
OIC37		Retain space for free creative thinking.					
OIC38		we are driven to be more innovative in our teaching.					
OIC39		My work is disrupted by changes in education policies					
OIC40		College can flexibly respond to changes in the external social environment.					

4. Innovation Behavior Scale (1=completely inconsistent to 5=completely consistent).

Number	**Dimension**	**Item Entry**	1	2	3	4	5
TI1	Innovate in Thinking	Often reflect on the teaching process to meet the needs of students					
TI2		Give students appropriate expectations and encourage them to make progress					
TI3		Communicate with students with an attitude of acceptance and respect					
TI4		Review my teaching with an open attitude					
TI5		Accept students' positive suggestions on teaching content					
TI6	Innovate in Teaching Content	Integrate related fields to innovate curriculum					
TI7		Provide students with deeper teaching content					
TI8		Integrate social current affairs to combine students' learning					
TI9		Learn about new developments in the subjects to enrich my teaching content					
TI10		Try to explain some teaching content from a new perspective					
TI11	Innovate in Teaching Methods	Redesign teaching content according to students' needs					
TI12		Flexibly use teaching methods such as cooperative learning					
TI13		Change teaching methods according to individual differences of students to improve students' learning effects					
TI14		Understand the applicable time of various teaching methods					
TI15		Adjust teaching strategies according to the cultural characteristics of the area where the school is located					
TI16	Innovate in Teaching Resources	Use creative activities in the classroom to make students happy to learn					
TI17		Use various methods to encourage enterprises to participate					
TI18		Use information technology such as the Internet for teaching					
TI19		Use e-mail, WeChat, QQ, etc. to maintain good communication with students					
TI20		Use a variety of teaching aids to enhance students' learning effects					
TI21	Innovate in Learning Evaluation	Choose appropriate evaluation methods based on teaching objectives					
TI22		Design different evaluation indicators based on differences of students					
TI23		Respect students' innovative performance in various aspects during evaluation					
TI24		Provide students with opportunities for self-evaluation					
TI25		Provide students with opportunities for mutual evaluation					