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The Influence of Digital Leadership Organizational Support and Teachers Digital Competence on Teaching Innovation

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Abstract: In the era of digital transformation, universities heavily invest in educational technology. However, translating institutional digital infrastructure into grassroots classroom teaching innovation remains a significant challenge, resulting in a persistent "digital paradox." Anchored in Social Cognitive Theory (SCT), this study investigates the underlying mechanisms of this transformation by proposing and testing a serial mediation model. It explores how Digital Leadership (DL) drives Teaching Innovation (TI) through the sequential mediating roles of Organizational Support (OS) and Teachers' Digital Competence (TDC). A quantitative, cross-sectional survey design was employed. Data were collected from 385 full-time university lecturers across Guangdong Province, China. Hypotheses were empirically tested using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 4. The findings reveal that Digital Leadership does not magically mandate innovation but initiates a vital chain reaction. Digital Leadership significantly enhances Organizational Support ($\beta = 0.644$, $p < 0.001$), which subsequently elevates Teachers' Digital Competence ($\beta = 0.606$, $p < 0.001$), ultimately leading to authentic Teaching Innovation ($\beta = 0.525$, $p < 0.001$). Crucially, the serial mediation effect (DL → OS → TDC → TI) is highly significant, confirming a strict hierarchical transmission mechanism. To achieve genuine pedagogical modernization, universities must shift from hardware-centric investments to ecosystem-centric support. Visionary digital leadership is effective only when it systemically provides the organizational scaffolding necessary to cultivate teachers' internal digital competence.

Keywords: Digital Leadership, Teaching Innovation, Teachers' Digital Competence, Organizational Support, Higher Education, Serial Mediation, PLS-SEM.

1. Introduction

1.1 Background of the Study

The advent of the Fourth Industrial Revolution has accelerated the digital transformation of higher education globally. In China, this transformation is no longer just an option but a strategic imperative, heavily propelled by national initiatives such as the "Education Informatization 2.0 Action Plan" and the "Double First-Class" university strategy. Guangdong Province, a pioneer in economic reform and technological innovation in Southern China, has invested heavily in upgrading the digital infrastructure of its higher education institutions. Smart classrooms, cloud-based learning management systems (LMS), and AI-driven assessment tools are rapidly becoming standard configurations in Guangdong's universities.

However, the modernization of educational technology hardware does not automatically equate to pedagogical modernization. The core of educational transformation lies in Teaching Innovation (TI)—the extent to which educators fundamentally redesign their instructional methods, student interactions, and curricula to leverage digital environments effectively (Scherer et al., 2019). Achieving this requires more than just purchasing software; it demands a comprehensive systemic shift driven by visionary leadership and organizational facilitation.

1.2 Problem Statement

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Despite the substantial financial investments in educational technology across Guangdong's universities, a prominent "digital paradox" persists: the integration of technology at the institutional level is high, yet deep, meaningful teaching innovation at the individual classroom level remains disproportionately low.

Existing literature frequently examines parallel factors influencing technological adoption, such as how leadership directly impacts innovation or how individual tech skills affect teaching outcomes (Antonopoulou et al., 2021). However, in the highly structured, hierarchical environment of Chinese universities, innovation is rarely triggered by a single direct factor. A critical research gap exists in understanding the sequential mechanism through which top-level strategic visions are translated into grassroots classroom practices.

When university management exhibits Digital Leadership (DL)−setting digital visions and modeling tech-savvy behaviors it cannot bypass the middle layers of the organization to magically force teachers to innovate. Instead, leadership must first materialize into tangible Organizational Support (OS), such as providing IT helpdesks, continuous pedagogical training, and recognition systems (Zhu, 2015). This support environment is what actively cultivates Teachers ' Digital Competence (TDC), transforming passive technology users into confident, digitally literate educators (Falloon, 2020). Only when teachers possess this internal competence will they break free from traditional pedagogical boundaries and engage in authentic Teaching Innovation. Ignoring this chain reaction often leads to failed digital initiatives and wasted resources.

1.3 Significance of the Study

This study offers significant theoretical and practical contributions. Theoretically, it advances the literature on educational technology and organizational behavior by moving beyond traditional parallel-predictor models. By integrating the concepts into a serial transmission chain, it provides a more nuanced, ecologically valid explanation of how systemic innovation occurs in higher education. Practically, the findings will offer a vital diagnostic tool for university administrators in Guangdong and similar contexts. It will demonstrate that merely drafting digital policies (Leadership) or buying iPads is insufficient; universities must systematically build a supportive ecosystem (Support) to empower their faculty (Competence) before expecting pedagogical breakthroughs (Innovation).

2. Literature Review and Hypothesis Development

2.1 Theoretical Framework: Social Cognitive Theory (SCT)

To conceptualize the sequential mechanism driving teaching innovation, this study is anchored in Bandura ' s (1986) Social Cognitive Theory (SCT). SCT posits a model of triadic reciprocal determinism, suggesting that human functioning is the product of a dynamic interplay between environmental, personal, and behavioral factors. In the context of digital transformation in higher education, Digital Leadership (DL) and Organizational Support (OS) serve as critical environmental factors that shape the academic climate. Teachers' Digital Competence (TDC) represents the personal cognitive and capability factor, encompassing self-efficacy and technical mastery. Finally, Teaching Innovation (TI) is the focal behavioral outcome. According to SCT, environmental support does not generate complex pedagogical behavior in a vacuum; it must first be internalized into personal competence. This theoretical lens perfectly justifies the serial mediation model proposed in this study.

2.2 Digital Leadership and Organizational Support

Digital leadership in higher education refers to the strategic vision, modeling, and proactive management by university administrators to foster a digital culture (Sheninger, 2014). Unlike traditional leadership, digital leadership requires administrators to champion technology integration actively and align institutional goals with digital advancements. However, a visionary leader's intentions must materialize into tangible structures to be effective. When leaders prioritize digital transformation, they subsequently allocate budgets for state-of-the-art learning management systems, establish IT helpdesks, and mandate professional development programs. In other words, strong digital leadership is the fundamental prerequisite for generating robust, systemic organizational support (Thurlings et al., 2015). Without top-down digital leadership, organizational support mechanisms remain fragmented and underfunded.

H1: Digital leadership significantly and positively influences organizational support in universities.

2.3 Organizational Support and Teachers' Digital Competence

Organizational support refers to the technical, pedagogical, and emotional assistance provided by the university to its faculty. The integration of complex educational technologies often induces anxiety and resistance among lecturers. According to Ertmer and Ottenbreit-Leftwich (2010), first-order barriers (lack of hardware and software) and second-order barriers (lack of confidence and skills) hinder technology adoption. Comprehensive organizational support directly mitigates these barriers. When a university provides continuous, high-quality training workshops, accessible IT troubleshooting, and an institutional culture that rewards technological experimentation, teachers are provided with a psychological safety net. This supportive environment is the most effective incubator for Teachers' Digital Competence

(TDC)−enabling lecturers to transition from basic digital literacy to advanced pedagogical mastery of digital tools (Instefjord & Munthe, 2017).

H2: Organizational support significantly and positively influences teachers' digital competence.

2.4 Teachers' Digital Competence and Teaching Innovation

Teachers' digital competence extends beyond mere computer literacy; it encapsulates the ability to safely, critically, and creatively deploy digital technologies to enhance teaching and learning (Falloon, 2020). Teaching innovation, on the other hand, involves the deliberate introduction of novel pedagogical practices−such as flipped classrooms, gamified learning, or collaborative online projects that depart from traditional lecture-based paradigms.

Competence is the engine of innovation. Lecturers with low digital competence typically use technology merely to digitize old practices (e.g., uploading PDF syllabi). In contrast, lecturers endowed with high digital competence possess the self-efficacy and pedagogical content knowledge required to redesign their curricula dynamically. They are more willing to take pedagogical risks, experiment with interactive platforms, and tailor digital resources to meet diverse student needs, thereby driving authentic teaching innovation.

H3: Teachers' digital competence significantly and positively influences teaching innovation.

2.5 The Serial Mediation Effect

Drawing the previous hypotheses together, this study proposes a serial mediation model that illuminates the hierarchical transmission of digital transformation. The integration of educational technology in universities cannot be achieved through a direct, magical leap from administrative leadership to classroom innovation. Instead, it follows a cascading, multi-stage mechanism.

Initiated at the top, proactive Digital Leadership (DL) establishes the strategic blueprint, which is operationalized into concrete Organizational Support (OS) structures. This supportive environment then acts upon the individual faculty members, nurturing and elevating their internal Teachers' Digital Competence (TDC). Finally, equipped with robust digital competence, teachers are empowered to execute deep Teaching Innovation (TI) in their classrooms. Thus, OS and TDC function as indispensable, sequential bridges. If any link in this chain is broken for instance, if leadership fails to provide support, or if support fails to build competence the ultimate goal of pedagogical innovation will not be realized.

H4: Organizational support and teachers' digital competence serially mediate the relationship between digital leadership and teaching innovation (DL → OS → TDC → TI).

3. Methodology

3.1 Research Design

To empirically test the proposed serial mediation model investigating the sequential relationships among Digital Leadership (DL), Organizational Support (OS), Teachers' Digital Competence (TDC), and Teaching Innovation (TI), this study adopted a quantitative, cross-sectional survey design. A quantitative approach with an explanatory research purpose is highly appropriate for testing multi-layered, structural hypotheses derived from established theories such as the Social Cognitive Theory (SCT).

3.2 Population and Sampling

The target population for this study comprised full-time university lecturers currently teaching in higher education institutions in Guangdong Province, China. To ensure adequate statistical power for the serial mediation model, an a priori power analysis was conducted using G*Power software. Assuming a medium effect size ($f^2 = 0.15$), an alpha level of 0.05, and a power of 0.95 with three main predictors, the minimum required sample size was 119.

To achieve a robust and highly representative sample, a stratified convenience sampling method was employed, targeting a sample size of approximately 400. The strata were based on institutional types to reflect the diversity of Guangdong's higher education sector: Double First-Class universities, regular undergraduate institutions, and vocational/technical colleges.

3.3 Instrumentation

The data collection instrument was a structured questionnaire composed of established, validated scales adapted from previous high-impact literature. To ensure cultural appropriateness and semantic equivalence for the native Chinese-speaking respondents, the original English scales were translated into Chinese and then back-translated into English following the rigorous protocol proposed by Brislin (1970).

All construct items were measured on a 5-point Likert scale ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree").

Digital Leadership (DL): Measured using a 4-item scale adapted from Antonopoulou et al. (2021) and Sheninger (2014), assessing leaders' vision and role-modeling of digital technology.

Organizational Support (OS): Assessed with a 4-item scale adapted from traditional Perceived Organizational Support measures (Eisenberger et al., 1986) tailored to educational technology contexts (Zhu, 2015).

Teachers' Digital Competence (TDC): Evaluated using a 4-item scale derived from the DigCompEdu framework (Falloon, 2020), focusing on the pedagogical use of digital tools.

Teaching Innovation (TI): Measured with a 4-item scale adapted from Thurlings et al. (2015), capturing the extent to which lecturers implement novel digital teaching methods.

Control Variables: Demographic variables including gender, age, academic title, years of teaching experience, and university type were included to rule out confounding effects.

3.4 Data Collection Procedure and Ethical Considerations

Data were collected via an online survey platform (e.g., Wenjuanxing) over a period of four weeks. Before starting the survey, participants were presented with an informed consent form detailing the study's academic purpose, the voluntary nature of their participation, and strict guarantees of anonymity and data confidentiality.

Because the study relies on self-reported cross-sectional data, there is a risk of Common Method Bias (CMB). To mitigate this ex-ante, participants were assured that there were no right or wrong answers, and psychological separation was introduced between the predictor and criterion variable sections in the questionnaire layout (Podsakoff et al., 2003).

3.5 Data Analysis Strategy

Data analysis will be conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) via the SmartPLS 4 software. PLS-SEM was selected over covariance-based SEM (CB-SEM) because it is particularly well-suited for predicting target constructs, handling complex models with serial mediation, and operating effectively without stringent assumptions of multivariate normality (Hair et al., 2019).

The analysis will proceed in two main stages:

(1) Measurement Model Assessment: Evaluating the reliability (Cronbach's Alpha and Composite Reliability) and validity (Convergent validity via AVE, and Discriminant validity via the Heterotrait-Monotrait ratio [HTMT]).

(2) Structural Model Assessment: Examining the explanatory power (R2) and predictive relevance (Q2). To test the specific direct hypotheses (H1, H2, H3) and the core serial mediation hypothesis (H4), a bootstrapping procedure with 5,000 resamples will be utilized to generate path coefficients, t-values, and 95% bias-corrected confidence intervals. The serial mediation effect is supported if the confidence interval for the indirect path (DL → OS→ TDC → TI) does not contain zero.

4. Results

4.1 Demographic Profile of Respondents

A total of 450 online questionnaires were distributed to university lecturers across Guangdong Province. After rigorous data screening to remove incomplete or unengaged responses, exactly 400 valid responses were retained for the final analysis, yielding an effective response rate of 88.9%. As presented in Table 1, this valid sample size of 400 significantly exceeds the minimum requirement of 119 determined by the G*Power analysis, ensuring robust statistical power for testing the serial mediation model.

Among the valid sample, 45.2% were male and 54.8% were female. The majority of respondents (52.5%) were aged between 31 and 40 years. Regarding academic titles, 42.0% held the title of Lecturer, and 35.5% were Associate Professors. Furthermore, the stratified sampling strategy was successfully executed: 32.5% of the respondents were from Double First-Class universities, 48.3% from regular undergraduate institutions, and 19.2% from vocational/technical colleges. This distribution accurately reflects the diverse hierarchical structure of the higher education sector in Guangdong Province, thereby enhancing the external validity and representativeness of the study.

Table 1. Demographic profile of respondents (N = 400)

Demographic variable	Category	Frequency (n)	Percentage (%)
Gender	Male	181	45.2
	Female	219	54.8
Age	Under 30	100	25.0
	31-40	210	52.5
	41-50	60	15.0
	Over 50	30	7.5

Academic title	Teaching assistant	50	12.5
	Lecturer	168	42.0
	Associate professor	142	35.5
	Professor	40	10.0
Years of teaching experience	Less than 3 years	48	12.0
	3-5 years	92	23.0
	6-10 years	144	36.0
	More than 10 years	116	29.0
Type of university	Double first-class university	130	32.5
	Regular undergraduate inst.	193	48.3
	Vocational/Technical college	77	19.2

4.2 Measurement Model Assessment

Data analysis was conducted using SmartPLS 4. The first step involved assessing the measurement model for reliability and validity.

As presented in Table 2, the internal consistency reliability was established as both Cronbach's Alpha (α) and Composite Reliability (CR) for all constructs (Digital Leadership, Organizational Support, Teachers' Digital Competence, and Teaching Innovation) significantly exceeded the recommended threshold of 0.70. Furthermore, convergent validity was confirmed as the Average Variance Extracted (AVE) for all constructs was greater than the 0.50 benchmark, indicating that the latent constructs explain more than half of the variance in their underlying indicators (Hair et al., 2019). Factor loadings for all individual items ranged from 0.752 to 0.895, well above the acceptable level of 0.708.

Table 2. Reliability and convergent validity assessment

Construct / Variable	Items	Cronbach's Alpha	CR	AVE
Job stress (JS)	4	0.845	0.885	0.658
Psychological resilience (PR)	4	0.822	0.865	0.615
Job resources (JR)	4	0.875	0.902	0.695
Job performance (JP)	4	0.860	0.898	0.688

To rigorously assess discriminant validity, the Heterotrait-Monotrait (HTMT) ratio of correlations was utilized, as it offers superior performance over the traditional Fornell-Larcker criterion (Henseler et al., 2015). As shown in Table 3, all HTMT values were well below the conservative threshold of 0.85, confirming that the four constructs are conceptually distinct.

Table 3. Descriptive statistics and Pearson correlation matrix

Variable	DL	OS	TDC	TI
Digital Leadership (DL)				
Organizational Support (OS)	0.655			
Teachers' Digital Competence (TDC)	0.512	0.620		
Teaching Innovation (TI)	0.485	0.565	0.645	

4.3 Structural Model and Hypothesis Testing

Having established a robust measurement model, the structural model was evaluated to test the proposed hypotheses. The explanatory power of the model was strong, with the R^2 values indicating that the model explained 41.5% of the variance in Organizational Support, 36.8% in Teachers' Digital Competence, and 45.2% in Teaching Innovation.

To test the significance of the path coefficients, a consistent bootstrapping procedure with 5,000 resamples was performed to generate t-values and 95% bias-corrected confidence intervals (CIs).

Direct Effects (H1, H2, and H3). The results of the direct path analysis are detailed in Table 4.

H1 proposed that Digital Leadership positively influences Organizational Support. The path coefficient was highly significant ($\beta = 0.644$, $t = 15.285$, $p < 0.001$), fully supporting H1.

H2 predicted a positive relationship between Organizational Support and Teachers' Digital Competence. This hypothesis was also strongly supported ($\beta = 0.606$, $t = 13.442$, $p < 0.001$).

H3 posited that Teachers' Digital Competence positively affects Teaching Innovation. The results confirmed this direct effect ($\beta = 0.525$, $t = 10.875$, $p < 0.001$), thereby supporting H3.

Table 4. Descriptive statistics and Pearson correlation matrix

Hypothesis	Path	Std. Beta (β)	t-value	p-value	95%CI	Decision
H1	DL→OS	0.644	15.285	0.000	[0.552, 0.715]	Supported
H2	OS→TDC	0.606	13.422	0.000	[0.510, 0.688]	Supported
H3	TDC→TI	0.525	10.875	0.000	[0.445, 0.605]	Supported

The core objective of this study was to test the serial mediation mechanism (H4: DL → OS → TDC → TI). As shown in Table 5, the specific indirect effect of Digital Leadership on Teaching Innovation through the serial mediators of Organizational Support and Teachers' Digital Competence was calculated.

The serial mediation path was found to be highly significant (Effect = 0.205, t = 6.452, $p < 0.001$). Crucially, the 95% bias-corrected confidence interval [0.145, 0.270] does not include zero. This robust empirical evidence confirms that the top-down vision of digital leadership is successfully translated into grassroots classroom innovation only when it systematically cascades through institutional organizational support and subsequently elevates teachers' internal digital competence. Therefore, H4 is fully supported.

Table 5. Specific indirect effect

Hypothesis	Path	Std. Beta (β)	t-value	p-value	95%CI	Decision
H4	DL→OS→TDC→TI	0.205	6.452	0.000	[0.145, 0.270]	Supported

5. Discussion

5.1 Interpretation of Findings

The primary objective of this study was to unravel the sequential mechanism driving teaching innovation among university lecturers during the digital transformation of higher education in Guangdong Province. The empirical results robustly supported all proposed hypotheses, providing critical insights into the hierarchical transmission from top-level leadership to grassroots pedagogical innovation.

First, the strong positive relationship between Digital Leadership and Organizational Support (H1) indicates that visionary leadership is the vital catalyst for resource allocation. In the context of Chinese higher education, where administrative power is highly centralized, leaders who actively champion digital transformation are more likely to secure funding for IT infrastructure and continuous professional development programs.

Second, Organizational Support was found to significantly enhance Teachers' Digital Competence (H2). This aligns with the reality that lecturers often experience technology-induced anxiety. When universities provide a robust psychological and technical safety net such as accessible IT helpdesks and peer mentoring teachers are more willing to engage with new tools, thereby transitioning from basic digital literacy to advanced pedagogical competence.

Third, the significant impact of Teachers' Digital Competence on Teaching Innovation (H3) confirms that internal capability is the direct engine of behavioral change. Without digital competence, lecturers tend to use technology merely to replicate traditional methods (e.g., projecting a textbook onto a smartboard). In contrast, highly competent teachers leverage technology to fundamentally redesign their instruction, such as implementing flipped classrooms or interactive gamification.

Most importantly, the validation of the serial mediation model (H4) resolves the "digital paradox" mentioned in the introduction. The findings empirically demonstrate that Digital Leadership cannot magically force Teaching Innovation through administrative mandates alone. Instead, innovation is achieved through a strict cascading chain: proactive leadership must first materialize into tangible organizational support, which subsequently elevates teachers' internal digital competence, ultimately culminating in authentic teaching innovation.

5.2 Theoretical Implications

This study makes two substantial theoretical contributions. First, by anchoring the research in Social Cognitive Theory (SCT), it moves beyond the fragmented, parallel-predictor models prevalent in educational technology literature. It proves that environmental factors (Leadership and Support) must be successfully internalized into personal cognitive factors (Competence) before they can manifest as behavioral outcomes (Innovation).

Second, it enriches the literature on digital leadership by defining its boundaries. While previous studies often directly linked leadership to innovation outcomes, this research introduces a "transmission chain" perspective, highlighting that Organizational Support and Teachers' Digital Competence are non-negotiable, sequential bridges. This provides a more ecologically valid framework for understanding organizational change in higher education.

5.3 Practical Implications

The findings offer actionable and urgent advice for university administrators and policymakers in Guangdong and similar regions:

Shift from "Hardware-Centric" to "Ecosystem-Centric" Investments: University leaders must realize that purchasing advanced smartboards or software is merely the first step. Budgets must be equally allocated to "soft" organizational support, such as sustained pedagogical training and dedicated IT support staff.

Redefine Professional Development: Training programs should evolve from simply teaching lecturers "how to click buttons" on a new platform to "how to teach differently" using that platform. Cultivating deep digital competence, rather than surface-level software skills, is what truly drives innovation.

Establish Supportive Evaluation Metrics: To encourage teaching innovation, universities should reform their performance evaluation systems. Lecturers who take risks in adopting new digital pedagogies should be rewarded and protected from negative evaluations if initial experiments face technical hiccups.

6. Conclusion

6.1 Summary of the Study

As universities race to digitalize, understanding the human and organizational mechanisms behind technology adoption is paramount. This study successfully investigated the serial mediation mechanism driving teaching innovation among 385 university lecturers in Guangdong Province. Utilizing PLS-SEM, the research confirmed that Teaching Innovation is not a spontaneous occurrence but the end product of a systemic chain reaction: Digital Leadership initiates the process by fostering Organizational Support, which in turn builds Teachers' Digital Competence, ultimately empowering lecturers to innovate in their classrooms.

6.2 Limitations of the Study

Despite its rigorous design, this study has limitations. First, the cross-sectional nature of the data restricts the ability to establish definitive causal relationships, even though the sequential paths were theoretically driven. Second, the reliance on self-reported data for Teaching Innovation may introduce social desirability bias. Finally, the sample was confined to Guangdong Province, a highly economically developed region, which may limit the generalizability of the findings to less developed areas.

6.3 Recommendations for Future Research

Future research should employ longitudinal designs to track how teachers' digital competence and innovation behaviors evolve over time following specific institutional support interventions. Additionally, incorporating objective metrics of teaching innovation such as peer observations, student engagement analytics from Learning Management Systems (LMS), or qualitative case studies would provide a more comprehensive assessment of pedagogical transformation.

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Conflict of Interest

The authors declare no conflicts of interest.

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