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Research Article

Digital leadership and teachers' ICT competency: The moderating role of teaching experience

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ABSTRACT

Digital transformation in higher education is widely assumed to benefit from stronger institutional digital leadership, yet it remains unclear whether that benefit holds equally for all teachers. This study examined how university teachers' perceptions of digital leadership are associated with their information and communication technology (ICT) competency, and whether teaching experience moderated this association. Drawing on the technology-organization-environment framework and social cognitive theory as complementary lenses, this study collected survey data from 397 university teachers in China. Data were analyzed using structural equation modelling and moderated regression. Digital leadership was positively associated with teachers' ICT competency. Its five dimensions were also positively and comparably associated with ICT competency, with no statistically significant differences in path strength. Teaching experience moderated the overall association, which was stronger among less-experienced teachers and weaker among more-experienced teachers. These findings reframe digital leadership as an organizational condition whose value is bounded by career stage and point to career-stage-sensitive rather than uniform support for teachers. By specifying an organization-to-individual account of digital transformation and identifying teaching experience as a boundary condition, this study extends digital leadership research in higher education.

Keywords: digital leadership, ICT competency, teaching experience, technology-organization-environment framework, higher education

INTRODUCTION

The digital transformation of higher education is reshaping instructional practices, governance structures, and leadership models (Hanelt et al., 2021; Pettersson, 2021). Within this transformation, digital leadership, defined as the capacity of university leaders to articulate a digital vision, align organizational structures and resources, and cultivate conditions for technology-supported teaching, has been regarded as an organizational condition associated with teachers' information and communication technology (ICT) competency (Ghamrawi & Tamim, 2023; Jameson et al., 2022). However, substantial institutional investment in digital infrastructure and digital transformation initiatives does not necessarily lead to teaching that moves

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beyond instrumental or low-level uses of technology. This suggests that institutional digital strategies may not translate uniformly into individual teachers' ICT competency (Xiao, 2019, 2023).

Much research on leadership and technology integration has treated digital leadership as a generally positive condition for teachers' use of technology (Eberl & Drews, 2021; Tondeur et al., 2018). While this work has established an important empirical foundation, prior research has rarely examined whether leadership operates similarly across teachers at different career stages and has instead tended to treat teachers as a relatively homogeneous group. Moreover, prior evidence has largely been drawn from K-12 settings, principal-level leadership, and aggregate leadership models, leaving institution-level digital leadership in higher education comparatively underexamined (Chen & Kouhsari, 2025; Jameson et al., 2022). Whether the value of institutional digital leadership is uniform or conditional, therefore, remains an open question precisely where it matters most: at the institutional level in higher education.

Teaching experience is a strong candidate for such a condition because it may shape teachers' technology adoption, confidence, and professional learning needs related to technology use (Dele-Ajayi et al., 2021; Kruskopf et al., 2024). This gap matters because universities need to know not only whether digital leadership is associated with teachers' ICT competency, but also for whom that association is strongest. This motivates treating teaching experience as a potential boundary condition rather than as one covariate among many.

This question is particularly salient in Chinese higher education. National policy has rapidly expanded digital infrastructure and promoted digital transformation across universities, yet many institutions continue to face difficulties in moving beyond basic technology provision towards meaningful pedagogical integration (Xiao, 2019, 2023). National policy agendas and institutional implementation mechanisms strongly shape digital transformation in Chinese higher education. This policy-oriented context makes it important to examine whether findings from Western higher education or school-based research apply to Chinese universities (Jameson et al., 2022; Tømte, 2024). The present study, therefore, uses Chinese higher education as a relevant empirical setting for examining how digital leadership is associated with teachers' ICT competency in a policy-oriented digital transformation context.

To examine these gaps, the present study draws on two complementary perspectives. The technology-organization-environment (TOE) framework (Tornatzky & Fleischer, 1990) is used to locate digital leadership as an organizational condition that shapes the institutional environment for technology use, while social cognitive theory (SCT) explains why this organizational condition may be filtered through individual characteristics (Bandura, 1986), specifically teaching experience (Schunk & DiBenedetto, 2020; Uçar & Sungur, 2017). The study draws selectively on the TOE framework's organizational lens and integrates it with SCT to model an organization-to-individual pathway. Accordingly, the study addresses three research questions:

1. To what extent is digital leadership associated with university teachers' ICT competency?
2. To what extent is each of the five dimensions of digital leadership associated with teachers' ICT competency, and do these associations differ in strength?
3. Does teaching experience moderate the association between overall digital leadership and teachers' ICT competency?

This study makes three contributions. First, it advances a career-stage perspective on digital leadership by examining whether its association with teachers' ICT competency varies by teaching experience. Second, it differentiates overall and dimension-specific associations between digital leadership and ICT competency. This allows digital leadership to be examined as a set of distinct leadership functions rather than as a single aggregate construct. Third, it provides evidence from Chinese higher education, where digital transformation has been strongly promoted through national and institutional initiatives. The findings can inform more differentiated support for teachers at different career stages.

LITERATURE REVIEW

Digital Leadership

Digital leadership refers to leadership practices through which universities articulate a digital vision, align organizational structures and resources, and cultivate conditions for technology-supported teaching and

professional learning. In educational settings, digital leadership has been conceptualised as a strategic and organizational capacity that connects digital transformation agendas with teaching, learning, professional development, and institutional change (Eberl & Drews, 2021; Jameson et al., 2022; Zhang et al., 2025). The present study applies this idea to higher education, focusing on leadership practices that support teachers' ICT-related professional work.

From a leadership perspective, the central issue is not the provision of technology itself, but whether institutional leaders provide direction, coordination, capacity-building, and professional learning conditions that support pedagogically meaningful technology use. In many higher education settings, this task is complicated by differences in teaching practices across universities. Digital leadership in higher education, therefore, concerns strategic coordination and teacher-facing support for technology-supported teaching.

The International Society for Technology in Education (2024) provides a useful framework for conceptualizing digital leadership as a multidimensional construct. Following the International Society for Technology in Education (ISTE) framework, this study conceptualizes digital leadership through five dimensions: equity and citizenship advocate (EC), visionary planner (VP), empowering leader (EL), systems designer (SD), and connected learner (CL). These dimensions capture distinct leadership functions rather than interchangeable indicators of a single managerial behavior. For example, VP concerns the alignment of institutional goals and digital strategies, whereas EL concerns support for teachers' experimentation, professional learning, and technology-supported teaching. This multidimensional conceptualization provides the basis for examining digital leadership both as an overall construct and through its specific measured dimensions.

Teachers' ICT Competency

Teachers' ICT competency refers to their capacity to use digital technologies effectively, critically, and pedagogically across instructional design, classroom interaction, course management, and continuing professional learning (Claro et al., 2018; Farjon et al., 2019; Tondeur et al., 2018; UNESCO, 2018). As a multidimensional construct, it reflects not only teachers' technical skills but also their capacity to use digital tools pedagogically to enhance teaching and learning (Blau & Shamir-Inbal, 2017).

Recent research has increasingly treated teachers' ICT competency as multidimensional capacities shaped by both individual and institutional conditions. Individual factors such as confidence, prior experience, self-efficacy, and professional learning orientation may influence how teachers engage with digital technologies (Scherer et al., 2023; Tondeur et al., 2025). Organizational conditions, including access to training, digital resources, leadership support, and institutional expectations, may also affect whether teachers can translate digital tools into their teaching practice (Backfisch et al., 2021; Lucas et al., 2021). These conditions are treated as part of the context in which ICT competency develops, rather than as ICT competency itself.

The present study adopts the ICT competency instrument developed by Li et al. (2023), which comprises five dimensions: frequency of ICT tool usage (FITU), innovative teaching practices with ICT (ITP), institutional support, resources and ICT training (ISR), online engagement and course management (OECM), and perceived importance and adoption of ICT (PIA). FITU captures the regularity with which teachers use ICT tools in teaching-related work. ITP reflects the use of ICT to support innovative pedagogical practices. ISR refers to teachers' perceived institutional facilitation of ICT-supported teaching, including ICT-related training, technical support, hardware conditions, and access to teaching resources. OECM concerns teachers' use of digital platforms for interaction, organization, feedback, assessment, and course delivery. PIA captures teachers' perceived value of ICT and their willingness to adopt it in teaching. Together, these dimensions operationalize ICT competency as a broad professional capacity involving ICT use, pedagogical application, institutional facilitation, online course management, and perceived adoption.

Relationship Between Digital Leadership and Teachers' ICT Competency

A growing body of research has examined how leadership relates to teachers' use of digital technologies. Much of this work links leadership practices, such as articulating a digital vision, modelling technology use, fostering collaboration, and providing sustained professional learning, to stronger technology integration among teachers (Daniëls et al., 2019; Fernández-Batanero et al., 2022; Leithwood et al., 2020). School-based studies of principals' technology or digital leadership have also reported positive associations with teachers'

ICT use and technology integration (Hamzah et al., 2021; Raman et al., 2019). However, much of it is derived from K-12 settings or cross-sectional perception-based designs. Comparable evidence at the institutional level in higher education remains limited (Jameson et al., 2022). Existing higher education studies more often address technology-supported teaching and learning broadly than the specific association between digital leadership and teachers' ICT competency (Narayan & Naidu, 2024; Sailer et al., 2021).

The strength of the leadership-technology association varies across studies. Some studies report substantial positive associations between supportive or technology-oriented leadership and teachers' digital practice, whereas others find weaker or context-dependent associations (Hamzah et al., 2021; Ninković et al., 2023). Rather than reflecting inconsistency alone, this variation suggests that leadership does not operate on a homogeneous body of teachers. The strength of leadership-technology associations may depend on both institutional context and teacher characteristics. Among these, teaching experience is particularly relevant because teachers at different career stages are likely to differ in how they interpret and respond to institutional leadership.

Teaching experience has been associated with teachers' confidence, concerns about technology integration, and ICT-related self-efficacy (Dele-Ajayi et al., 2021; Farjon et al., 2019; Kruskopf et al., 2024). These factors may affect how teachers interpret institutional leadership and use available support for technology-supported teaching (Scherer et al., 2023). In this sense, teaching experience provides a plausible boundary condition in the relationship between digital leadership and ICT competency.

Furthermore, many studies have examined digital leadership or leadership support at the aggregate level. Consequently, prior studies often overlook potential variations in how distinct leadership dimensions link to teachers' technology-related practice. This is a meaningful gap because leadership functions vary in their proximity to teachers' instructional work and may therefore relate to ICT competency in different ways. Examining digital leadership at the dimensional and overall levels, therefore, offers a more differentiated account.

In Chinese higher education, national policies have promoted digital transformation and the development of ICT infrastructure, while universities continue to face challenges in moving from technology provision to pedagogical integration (Xiao, 2019, 2023). This context makes it important to examine whether digital leadership is associated with teachers' ICT competency in Chinese universities, and whether this association differs by teaching experience.

Theoretical Framework and Hypothesis Development

This study draws on two complementary theoretical perspectives, the TOE framework (Tornatzky & Fleischer, 1990) and SCT (Bandura, 1986) to specify an organization-to-individual pathway. TOE is used to position digital leadership as an organizational condition for teachers' ICT competency. SCT is used to explain why teachers may respond differently to this organizational condition according to their teaching experience.

The TOE framework explains technology-related change through technological, organizational, and environmental conditions (Tornatzky & Fleischer, 1990). This study focuses on the organizational dimension. Digital leadership is considered a relevant organizational condition because it involves vision-setting, resource coordination, system design, professional learning, and support for technology-supported teaching. These leadership practices define the institutional environment in which teachers develop and enact ICT competency. The technological and environmental dimensions of TOE are not modelled because the research question focuses on leadership as the organizational condition under examination.

The TOE perspective supports the expected association between digital leadership and teachers' ICT competency. It positions digital leadership as an organizational condition that is theoretically associated with teachers' ICT competency. When universities provide coherent digital direction, supportive systems, and professional learning conditions, teachers are more likely to report higher levels of ICT-related professional capacity.

H1. Digital leadership is positively associated with university teachers' ICT competency.

Digital leadership is not a single undifferentiated condition. Its dimensions represent different organizational functions; each dimension may provide a distinct form of organizational support for technology-supported teaching. Therefore, each dimension is expected to be positively associated with teachers' ICT competency.

H2. Each of the five dimensions of digital leadership is positively associated with teachers' ICT competency.

Whether these dimensions differ in the relative strength of their associations is less clear, as prior evidence offers no basis for ranking them. This is therefore examined as an open question (RQ2) rather than through a directional hypothesis.

SCT extends the model by explaining why the same organizational condition may not be associated with ICT competency in the same way for all teachers. SCT views behavior and capability development as shaped by the interaction between environmental conditions and personal factors (Bandura, 1986; Schunk & DiBenedetto, 2020). In this study, perceived digital leadership represents the environmental condition. Teaching experience represents the personal factor. ICT competency represents the teacher-level professional capacity.

Teaching experience is relevant because it may shape teachers' self-efficacy, professional routines, and interpretation of institutional support. SCT therefore supports the expectation that teaching experience conditions the association between digital leadership and ICT competency.

H3. Teaching experience moderates the association between overall digital leadership and teachers' ICT competency, such that the association is stronger for less-experienced teachers.

RESEARCH METHODOLOGY

Research Procedure and Sample

This study employed a quantitative, cross-sectional survey design to examine the associations between digital leadership and university teachers' ICT competency, as well as the moderating role of teaching experience. Structural equation modelling (SEM) was used to test the hypothesized associations among the latent constructs.

A two-stage sampling procedure was employed. In the first stage, twelve universities in north-eastern China (Jilin, Heilongjiang, and Liaoning) were purposively selected. The regional focus was adopted for two reasons. First, the region includes universities of different institutional types and tiers, such as comprehensive, science and technology, normal, "Project 985/211", and non-211 institutions. Second, universities in this region provide a relevant setting for examining digital transformation under both national policy priorities and uneven institutional resource conditions.

The sample included teachers from different disciplines, institutional types, and career stages. Although the sample is not nationally representative, the diversity across provinces, institution types, and teacher profiles provides a reasonable basis for examining patterns of digital leadership and ICT competency in comparable Chinese higher education contexts.

In the second stage, human resources offices at each selected university generated rosters of eligible participants based on predefined inclusion and exclusion criteria. The inclusion criteria required that participants be full-time university teachers currently engaged in teaching and not hold administrative positions. Part-time teachers and administrative staff were excluded. From the eligible rosters, a simple random sample was drawn using a random number generator. To protect teachers' confidentiality, the research team did not have access to complete personnel lists. The human resources offices carried out all individual-level sampling.

Data were collected using an anonymous online questionnaire administered through the Wenjuanxing platform. The survey remained open for approximately two weeks, and one reminder was sent after the first week. Before completing the questionnaire, participants were informed about the purpose of the study, the confidentiality of their responses, and their right to withdraw at any time. Electronic informed consent was obtained from all participants. No personally identifiable information was collected. The survey achieved an overall response rate of 66.17%. After screening the returned questionnaires for eligibility and data

completeness, 397 valid responses were retained for analysis, representing 91.1% of all returned questionnaires.

Research Instruments and Data Analysis

All constructs were measured using self-report scales adapted from established instruments. The original items were developed in English and translated into Chinese using a translation-back-translation procedure (Brislin, 1970). Minor wording adjustments were made to improve clarity and contextual relevance for Chinese higher education while preserving the original items' meaning. All items were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Digital leadership was measured using Zhang et al.'s (2025) adaptation of the ISTE standards for education leaders. The scale consists of 22 items across five dimensions: equity and citizenship advocate (EC, 4 items), visionary planner (VP, 5 items), empowering leader (EL, 5 items), systems designer (SD, 4 items), and connected learner (CL, 4 items).

Teachers' ICT competency was measured using the instrument developed by Li et al. (2023). The scale consists of 33 items across five dimensions: frequency of ICT tool usage (FITU, 7 items), innovative teaching practices with ICT (ITP, 6 items), institutional support, resources and ICT training (ISR, 6 items), online engagement and course management (OECM, 9 items), and perceived importance and adoption of ICT (PIA, 5 items).

Reliability was assessed using Cronbach's alpha and composite reliability (CR). Convergent validity was evaluated using standardized factor loadings and average variance extracted (AVE). Discriminant validity was assessed using the Fornell-Larcker criterion and the heterotrait-monotrait (HTMT) ratio of correlations.

Common method bias was addressed procedurally and statistically. Procedurally, the survey was anonymous and voluntary, and respondents were assured that there were no right or wrong answers. Statistically, common method bias was assessed using a full collinearity test (Kock, 2015) and an unmeasured latent method construct, which loaded on all indicators and was constrained to be orthogonal to the substantive constructs.

Data analyses were conducted using IBM SPSS Statistics 30.0, IBM SPSS Amos 30.0, and R. SPSS was used for descriptive statistics and correlations. Amos was used for confirmatory factor analysis, second-order measurement models, SEM, and model comparisons. R was used to calculate HTMT values and to conduct the moderated regression. Composite scores were formed in two steps: item scores were averaged within each dimension, and the five dimension scores were then averaged to form the digital leadership and ICT competency composites, thereby assigning equal weight to each dimension. Maximum likelihood estimation was used in Amos. Model fit was evaluated using χ^2/df, CFI, TLI, RMSEA, and SRMR, following commonly used SEM criteria (Whittaker & Schumacker, 2022). Robustness analyses were conducted after removing ISR from the ICT competency construct.

RESEARCH RESULTS

Preliminary Analysis Results

Among the 397 participants, 57.4% were female, and 42.6% were male. Teaching experience ranged from 1-5 years (12%), 6-10 years (33%), 11-15 years (37%), to 16 years or more (18%). On average, teachers reported moderate to high levels of perceived digital leadership (mean [M] = 3.64, standard deviation [SD] = 0.84) and ICT competency (M = 3.51, SD = 0.88).

Table 1 presents the Pearson correlations. Digital leadership was positively correlated with ICT competency ($r = 0.613$, $p < .001$). All five leadership dimensions were also positively correlated with ICT competency ($r = 0.444$-0.496, $p < .001$).

Measurement Model Analysis

All constructs demonstrated satisfactory internal consistency. The first-order Cronbach's alpha values ranged from 0.866 to 0.975, exceeding the 0.70 criterion (DeVellis, 2017). The digital leadership scale had a Cronbach's alpha of 0.940, and the ICT competency scale had a Cronbach's alpha of 0.965.

Table 1. Pearson correlations among key variables

	EC	VP	EL	SD	CL	DL	ICT
EC	1						
VP	0.472***	1					
EL	0.418***	0.443***	1				
SD	0.430***	0.488***	0.498***	1			
CL	0.559***	0.563***	0.433***	0.444***	1		
DL	0.732***	0.787***	0.745***	0.733***	0.804***	1	
ICT	0.444***	0.467***	0.496***	0.453***	0.472***	0.613***	1

***p < .001

Table 2. HTMT ratios among first-order dimensions

	EC	VP	EL	SD	CL	FITU	ITP	ISR	OECM	PIA
EC										
VP	.534									
EL	.464	.483								
SD	.495	.549	.551							
CL	.619	.610	.461	.488						
FITU	.423	.388	.395	.407	.403					
ITP	.356	.389	.365	.335	.372	.619				
ISR	.344	.295	.379	.369	.312	.434	.425			
OECM	.403	.456	.456	.435	.446	.630	.596	.432		
PIA	.373	.395	.439	.350	.363	.594	.512	.443	.542	

CR values ranged from 0.866 to 0.944. AVE values ranged from 0.617 to 0.809. All values exceeded the recommended thresholds (CR > 0.70; AVE > 0.50), indicating adequate convergent validity (Fornell & Larcker, 1981). At the second-order level, both constructs also demonstrated acceptable CR (DL = 0.847; ICT = 0.849) and AVE (DL = 0.526; ICT = 0.533). All factor loadings exceeded 0.60 and were statistically significant ($p < .001$). The overall confirmatory factor model (CFA) demonstrated good fit: $\chi^2/df = 1.153$, CFI = 0.988, TLI = 0.988, SRMR = 0.038, RMSEA = 0.020 (Bentler, 1990; Whittaker & Schumacker, 2022).

Discriminant validity was supported. The square root of each construct's AVE exceeded its correlations with other constructs, satisfying the Fornell-Larcker criterion. The HTMT results provided further support. All first-order HTMT values were below 0.85 (Henseler et al., 2015), ranging from 0.295 to 0.630, as shown in **Table 2**. The higher-order HTMT value between digital leadership and ICT competency was 0.645, also below the 0.85 threshold. Notably, the HTMT values between the support-oriented leadership dimensions and the ISR dimension were low (EL-ISR = 0.379; SD-ISR = 0.369), indicating that perceived digital leadership and perceived support were empirically distinct.

Common method bias was assessed procedurally and statistically. A full collinearity test (Kock, 2015) returned variance inflation factor (VIF) values below the 3.3 threshold. In addition, an unmeasured latent method construct (ULMC) was added to the CFA, loading on all indicators and constrained to be orthogonal to the substantive constructs. This model fit the data well ($\chi^2/df = 1.154$, CFI = 0.988, TLI = 0.987, SRMR = 0.040). Comparisons between the baseline CFA model and the ULMC showed that all changes in standardized factor loadings were below 0.20 (Podsakoff et al., 2003), ranging from 0.04 to 0.10. These results indicate that common method bias was unlikely to pose a serious threat to the validity of the findings.

Structural Model Analysis

The second-order SEM demonstrated good model fit ($\chi^2/df = 1.153$, CFI = 0.988, TLI = 0.988, SRMR = 0.038, RMSEA = 0.020), meeting recommended criteria (Whittaker & Schumacker, 2022), as shown in **Figure 1**. Digital leadership was positively associated with teachers' ICT competency ($\beta = 0.724$, $p < .001$). **H1** was supported.

The dimension-level model fit the data well ($\chi^2/df = 1.142$, CFI = 0.989, TLI = 0.988, SRMR = 0.034, RMSEA = 0.019), as shown in **Figure 2**. All five leadership dimensions were positively associated with ICT competency ($\beta = 0.143$-0.255, all $p < .05$), supporting **H2**.

To examine whether the associations differed in strength, the freely estimated model was compared with a model constraining the five dimension-level paths to equality. The constraint did not significantly worsen model fit ($\Delta\chi^2$ (4) = 3.577, p = .466). The five dimensions, therefore, did not differ significantly in the strength

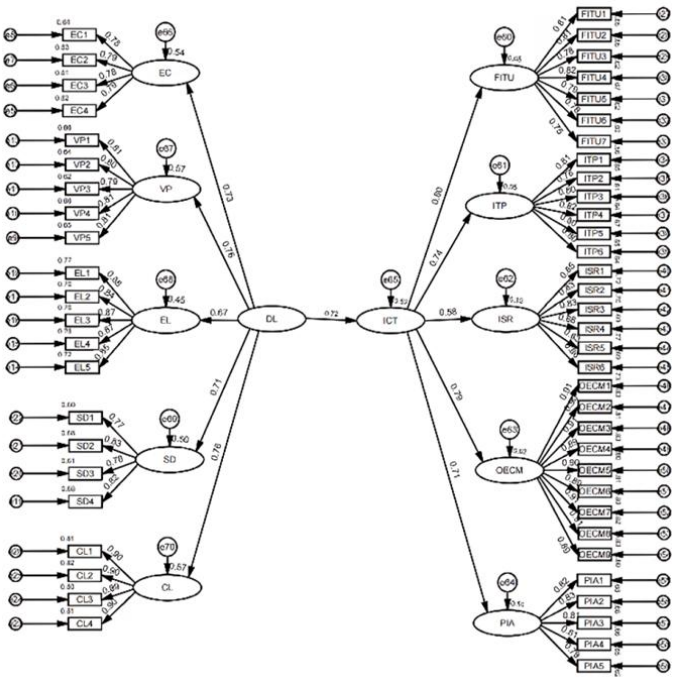

Figure 1. Second-order structural model of digital leadership and ICT competency (the authors' own elaboration)

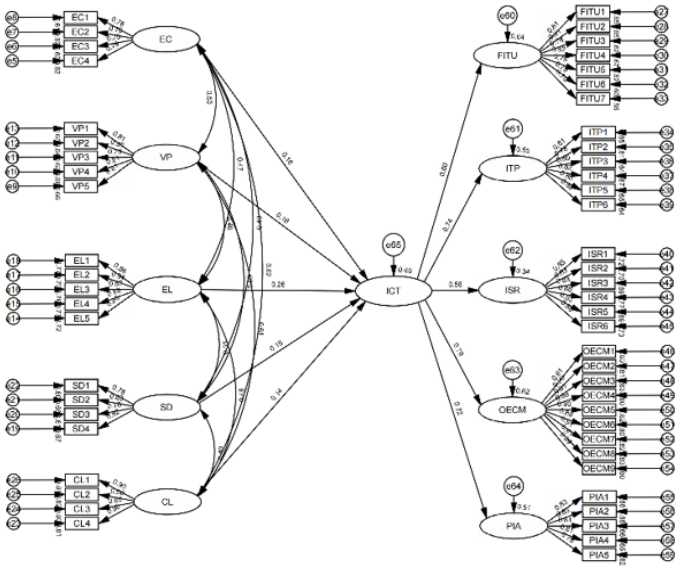

Figure 2. Dimension-level SEM of digital leadership and teachers' ICT competency (the authors' own elaboration)

of their associations with ICT competency. Although the Empowering Leader showed the largest point estimate (β = 0.255), this difference was not statistically significant, indicating that the leadership dimensions were comparably associated with ICT competency.

The moderating role of teaching experience was tested using composite-score regression. Digital leadership and ICT competency were represented by composite scores computed from their respective dimensions. Teaching experience was dichotomized at 10 years, yielding two relatively balanced groups (45.0% vs. 55.0%). This threshold is consistent with prior research treating the first 10 years of teaching as an early-to-mid-career period (Brunetti & Marston, 2018). It was dummy-coded as 0 = low teaching experience (10 years or below) and 1 = high teaching experience (11 years or above), and digital leadership was mean-centered before forming the interaction term.

Table 3. Composite-score regression for the moderating role of teaching experience

Predictor	B	Standard error	t	p
DL	0.822	0.044	18.567	< .001
TE	-0.237	0.062	-3.834	< .001
Digital leadership × teaching experience	-0.655	0.077	-8.457	< .001

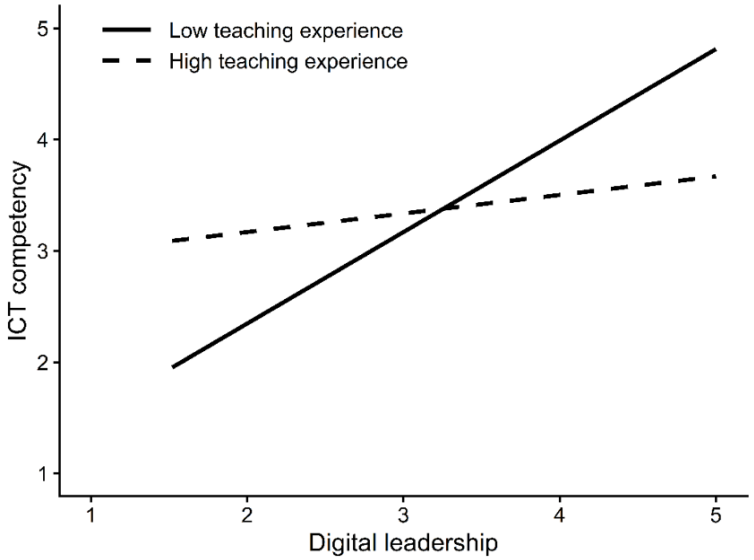

Figure 3. Simple slopes of the digital leadership-ICT competency association by teaching experience (the authors' own elaboration)

As shown in **Table 3**, the model was significant, F (3, 393) = 122.70, p < .001, explaining 48.4% of the variance in ICT competency. The interaction between digital leadership and teaching experience was negative and significant (B = -0.655, SE = 0.077, t = -8.457, p < .001), indicating that the association between digital leadership and ICT competency weakened as teaching experience increased.

Simple-slope analysis confirmed this pattern. As shown in **Figure 3**, the association was strong among less-experienced teachers (B = 0.822, p < .001) but considerably weaker among more-experienced teachers (B = 0.167, p = .033). Digital leadership accounted for a far larger share of variance in ICT competency among less-experienced teachers (R^2 = .829) than among more-experienced teachers (R^2 = .021). **H3** was supported.

The ISR dimension of ICT competency captures teachers' perceptions of institutional support and facilitation. Because such perceptions could be regarded as conceptually proximate to perceived digital leadership, three robustness analyses re-estimated the models with ISR removed, using a four-dimension ICT competency construct. First, the second-order path was re-estimated. The model fit well (χ^2/df = 1.151, CFI = 0.990, TLI = 0.989, RMSEA = 0.020, SRMR = 0.038), and the association between digital leadership and ICT competency remained positive and significant (β = 0.714, p < .001), close to the original estimate. Second, the dimension-level model was re-estimated (χ^2/df = 1.138, CFI = 0.991, TLI = 0.990, RMSEA = 0.019, SRMR = 0.033); all five dimensions remained positively associated with ICT competency (β = 0.132-0.245, all p < .05), consistent with **H2**. Third, the moderation was re-estimated; the interaction between digital leadership and teaching experience remained negative and significant (B = -0.686, p < .001), and the simple slopes retained the same pattern (low experience B = 0.862, p < .001; high experience B = 0.176, p = .039). The findings were therefore robust to the exclusion of ISR, indicating that any conceptual overlap between perceived institutional support and perceived digital leadership did not drive them.

DISCUSSION

This study examined whether digital leadership was associated with university teachers' ICT competency, whether the five leadership dimensions differed in their associations with ICT competency, and whether teaching experience moderated the overall association. Three findings emerged. First, digital leadership was positively associated with teachers' ICT competency. Second, the five leadership dimensions were positive but

comparably associated with ICT competency, and no dimension showed a statistically stronger association than the others. Third, teaching experience moderated the overall association. The association was strong among less-experienced teachers and considerably weaker among more-experienced teachers.

Digital Leadership and Teachers' ICT Competency

The positive association between digital leadership and teachers' ICT competency indicates that teachers who perceive stronger digital leadership also report higher ICT competency. Within the TOE framework, digital leadership functions as an organizational condition that shapes the environment for technology-supported teaching. Because leadership was measured through teachers' perceptions, SCT further suggests that this association reflects how teachers interpret institutional conditions. The robustness analyses, excluding ISR, further support this interpretation, as the main associations remained stable after removing the ICT competency dimension that is most conceptually proximate to institutional support.

This finding is broadly consistent with international research linking supportive leadership to teachers' technology integration. School-based studies of principals' technology and digital leadership, including evidence from Malaysia, have reported positive associations with teachers' ICT use and technology integration (Hamzah et al., 2021; Raman et al., 2019). Reviews of educational leadership and teacher professional development also suggest that leadership can shape teachers' professional learning and technology-related practice (Daniëls et al., 2019; Fernández-Batanero et al., 2022; Leithwood et al., 2020). The present results are consistent with this evidence and suggest that a similar association can be observed at the institutional level within this higher-education sample.

This finding should also be interpreted in relation to Chinese higher education. In this policy-oriented context, digital leadership appears relevant not simply as the provision of technology, but as institutional coordination that connects digital transformation agendas with teachers' ICT-related practice (Xiao, 2019, 2023).

Dimensional Associations of Digital Leadership

Each of the five dimensions of digital leadership was positively associated with teachers' ICT competency. Within the TOE framework, this indicates that the organizational condition represented by digital leadership operates through multiple and complementary facets. The fact that every dimension was positively associated with ICT competency suggests that teachers' ICT competency is embedded in a broad institutional environment for technology-supported teaching, rather than dependent on any single form of leadership support.

Beyond their individual associations, the five dimensions did not differ significantly in strength. This pattern suggests that the five dimensions represent interrelated facets of the organizational environment for technology-supported teaching. From an SCT perspective, teachers may respond to an overall perception of institutional leadership coherence, rather than to discrete leadership functions in isolation.

Many prior studies have examined digital leadership or leadership support at the aggregate level (Eberl & Drews, 2021; Tondeur et al., 2018), while other studies foreground specific functions such as vision-setting or empowerment (Leithwood et al., 2020). The present results support a multidimensional conceptualization of digital leadership. However, they do not support the view that particular functions are inherently more consequential than others for teachers' ICT competency. Although the Empowering Leader produced the largest point estimate, the equality-constraint test showed no statistically significant differences among the five paths. Its larger coefficient should therefore be interpreted as a descriptive result, not as evidence that this dimension was more important than the other leadership dimensions. The dimensional results, therefore, support a multidimensional but non-hierarchical interpretation of digital leadership.

The Moderating Role of Teaching Experience

Teaching experience moderated the association between digital leadership and teachers' ICT competency. The association was much stronger among less-experienced teachers than among more-experienced teachers. The slope for less-experienced teachers was nearly five times that for more-experienced teachers. This indicates that perceived digital leadership was much more closely linked to ICT competency among teachers in earlier career stages.

This pattern is consistent with SCT. Less-experienced teachers may rely more on institutional cues, structured support, and professional learning because their ICT-related routines are still developing. More-experienced teachers may draw more on accumulated pedagogical expertise, peer networks, and discipline-specific routines. The weaker association among more-experienced teachers should therefore not be interpreted as resistance to digital innovation. It may instead indicate that experienced teachers' ICT competency is less dependent on perceived institutional leadership.

This moderation helps account for the mixed findings in prior research. Studies report associations between leadership and teachers' technology practice that range from strong to weak (Hamzah et al., 2021; Ninković et al., 2023), yet the role of teacher characteristics has received limited attention. The present results indicate that the strength of the leadership-competency association depends on career stage. Prior work links experience to teachers' confidence, concerns, and ICT-related self-efficacy (Dele-Ajayi et al., 2021; Farjon et al., 2019; Kruskopf et al., 2024). The present study suggests that teaching experience is also associated with how teachers interpret institutional leadership, not only with how they use technology directly.

Implications

This study has theoretical and practical implications for research on digital transformation in higher education.

Theoretically, the study contributes in three ways. First, it integrates the TOE framework with SCT to explain how an organizational condition is associated with an individual-level professional capacity. The TOE framework positions digital leadership as part of the organizational environment for technology-supported teaching, while SCT explains why teachers may interpret and respond to this environment differently according to teaching experience. Second, the study refines the conceptualization of digital leadership. The five dimensions were all positively associated with ICT competency, but they did not differ significantly in strength. This supports a multidimensional but non-hierarchical interpretation of digital leadership. Third, the study identifies teaching experience as a boundary condition. The leadership-competency association was substantially stronger among less-experienced teachers than among more-experienced teachers. This finding suggests that career stage should be considered when explaining variation in the association between leadership and teachers' ICT competency.

Practically, the findings suggest that universities should treat digital leadership as coordinated pedagogical support, not as technology provision alone. First, this requires mechanisms that connect digital vision, resources, training, technical support, and evaluation. For example, universities may establish cross-unit digital teaching groups involving academic leaders, teaching-development centers, IT staff, and teacher representatives. Such arrangements are consistent with prior work showing that digital transformation depends on coordinated leadership practices rather than technology procurement alone (Ghamrawi & Tamim, 2023; Tang et al., 2025).

Second, because the five leadership dimensions were comparably associated with ICT competency, universities should avoid privileging a single leadership function. This may involve aligning platform design with teaching needs, ensuring fair access to digital tools, and linking training provision with curriculum-level implementation. This balanced approach is consistent with studies emphasizing the coordination of vision, resources, instructional models, and evaluation in higher education digital transformation (Tang et al., 2025).

Third, support should be differentiated by teaching experience. Less-experienced teachers may need structured induction, mentoring, model course examples, and step-by-step training in online course management and ICT-supported assessment. More-experienced teachers may benefit more from advanced workshops, discipline-specific consultation, peer-led communities, and greater autonomy to adapt digital tools to established pedagogical routines. This implication is consistent with evidence that early-career teachers develop professional digital competence through sustained support and situated professional learning (Masoumi & Noroozi, 2025). Finally, regular feedback mechanisms, such as teacher surveys, focus groups, and departmental review meetings, can help universities adjust digital leadership practices to teachers' changing needs across career stages (Tang et al., 2025).

Limitations and Recommendations for Further Research

This study has several limitations that should guide future research. First, the cross-sectional survey design limits the ability to establish causal relationships. The findings, therefore, indicate associations rather than causal effects. Future research should use longitudinal, quasi-experimental, or intervention-based designs to examine how digital leadership and teachers' ICT competency develop over time.

Second, the sample was drawn from universities in north-eastern China, and it is not nationally representative. The findings should therefore be generalized with caution beyond comparable Chinese higher education contexts. Future studies should include universities from more diverse regions, institutional tiers, and policy environments.

Third, the study measured both digital leadership and teachers' ICT competency through teachers' perceptions. This design was appropriate for examining perceived organizational conditions, but it cannot capture objective leadership practices or actual ICT use. In addition, the ISR dimension of ICT competency is conceptually close to institutional support. Although robustness analyses showed that the main findings remained stable after removing ISR, future research should further validate the construct boundary between leadership conditions and ICT competency.

Fourth, teaching experience was examined as the moderator in the leadership-competency association. This approach captured broad career-stage differences, but it did not explain the specific psychological or organizational mechanisms through which experience shapes teachers' responses to digital leadership. Future research could examine the mechanisms underlying this moderation, such as self-efficacy, professional learning participation, perceived autonomy, and disciplinary teaching culture, and test whether they operate differently across career stages.

CONCLUSION

This study examined the association between digital leadership and university teachers' ICT competency in Chinese higher education, using the TOE framework and SCT as complementary lenses. Digital leadership was positively associated with ICT competency, and its five dimensions were positively and comparably associated with ICT competency, with no statistically significant differences in path strength. Teaching experience moderated the overall association, which was stronger among less-experienced teachers and weaker among more-experienced teachers. The study contributes by specifying an organization-to-individual account of digital transformation, refining digital leadership as a multidimensional but non-hierarchical construct, and identifying teaching experience as a boundary condition in the leadership-competency association. These findings suggest that digital transformation in higher education should be understood not only as the provision of technology, but also as a process associated with institutional leadership and teachers' career stages. Future research should extend this work through longitudinal and multi-source designs and examine the mechanisms through which teachers at different career stages respond to digital leadership.

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