

Teachers' Technological Leadership and Digital Transformation Implementation in Higher Education Institutions in Gansu Province, China

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Abstract

This study examined teachers' technological leadership and the extent of digital transformation implementation in five higher education institutions in Gansu Province, China, and assessed whether technological leadership predicted institutional digital transformation. The analytic dataset contained 362 eligible, consenting full-time teachers selected through proportionate stratified sampling. A researcher-developed four-point questionnaire measured five dimensions of technological leadership and five domains of digital transformation implementation. Descriptive statistics, group comparisons, Pearson correlation, and linear regression were applied. Teachers' technological leadership was high overall ($M = 3.05$, $SD = 0.26$), while digital transformation was implemented to a great extent ($M = 2.99$, $SD = 0.29$). Digital vision and ethical citizenship had the highest leadership mean ($M = 3.09$); digital teaching and curriculum had the highest transformation mean ($M = 3.07$), whereas infrastructure and resource construction was lowest ($M = 2.90$). Overall technological leadership was positively related to digital transformation ($r = 0.270$, $p < 0.001$) and explained 7.3% of its variance. In the five-dimension regression model, peer collaboration and mentoring, data-driven educational decision making, and institutional digital reform advocacy were significant positive predictors. Access to institutional digital training resources was also associated with higher transformation scores. The findings support professional development that strengthens collaborative mentoring, evidence use, reform participation, and equitable access to training while recognizing the continuing importance of institutional infrastructure.

Keywords

Technological Leadership; Digital Transformation; Higher Education; Teacher Professional Development; Gansu Province; Digital Governance

1. Introduction

Digital transformation in higher education is not simply the conversion of paper-based activities into electronic form. It involves coordinated changes in curriculum, pedagogy, assessment, professional learning, infrastructure, governance, and organizational culture. Research on higher education digitalization therefore treats transformation as a socio-technical process in which technology, people, strategy, and institutional arrangements must develop together [1,2]. When these elements are disconnected, institutions may acquire platforms without improving learning or may reproduce inefficient practices in digital form. Sustainable change also depends on reliable support, teacher confidence, ethical safeguards, and leadership that can convert technology adoption into continuing educational improvement [3,4].

International frameworks place teachers at the center of this process. DigCompEdu and the UNESCO ICT Competency Framework for Teachers connect professional engagement, digital resources, teaching and learning, assessment, learner empowerment, organization, and continuing professional development [5,6]. Recent UNESCO guidance on generative artificial intelligence further emphasizes human agency, ethical responsibility, safe use, pedagogical judgment, and lifelong professional learning [7,8]. These frameworks imply that teachers are not merely technology users; their choices help determine whether digital tools advance quality, equity, accessibility, and responsible participation.

China has embedded similar expectations in national policy. The Digital Literacy of Teachers standard identifies digital awareness, knowledge and skills, application, social responsibility, and professional development as core aspects of teacher practice [9]. National policy on accelerating educational digitalization calls for integrated platforms, intelligent applications, digitally transformed teaching, improved governance, and stronger digital capabilities [10]. In Gansu Province, policy on artificial intelligence in higher education identifies teaching, talent cultivation, research, management, and institutional capacity as coordinated areas for development [11]. These policy directions create a strong mandate, but their implementation depends on what teachers and institutions can do in specific contexts.

The present study conceptualizes teachers' technological leadership as intentional influence exercised through professional practice rather than only through formal administrative position. This view is consistent with distributed leadership, in which leadership activity is stretched across people, expertise, tasks, and situations [12]. It is also consistent with reviews of digital leadership in higher education that call for attention to leadership practice beyond senior management roles [13]. Five dimensions were examined: digital vision and ethical citizenship; technology-integrated instruction; peer collaboration and mentoring; data-driven educational decision making; and institutional digital reform advocacy. Together, these dimensions represent ethical direction, instructional modeling, reciprocal

professional support, evidence use, and participation in institutional change.

Digital transformation implementation was assessed across five domains: digital teaching and curriculum; digital research and academic support; institutional digital infrastructure and resource construction; the digital competency training system; and digital governance and student inclusive service. Prior research indicates that teacher competence, self-efficacy, facilitating conditions, and access to professional learning are associated with meaningful technology use, although opportunities remain uneven across institutions and professional groups [14-16]. Research on data use likewise emphasizes that educational evidence should be interpreted in context and combined with professional judgment rather than treated as an automatic basis for high-stakes decisions [17,18].

A continuing gap is the separation between studies of individual digital competence and studies of institutional digital transformation. Competence studies often focus on whether teachers can use digital tools, while transformation studies may focus on platforms, strategy, or senior leadership. Less attention has been given to how teacher-level technological leadership relates to implementation across multiple institutional domains. This study addresses that gap in selected higher education institutions in Gansu Province, China. It aimed to determine the level of teachers' technological leadership, assess the extent of digital transformation implementation, examine differences according to teacher profile, and test whether technological leadership predicts digital transformation. The evidence is intended to inform a professional development plan without treating demographic characteristics as fixed explanations of capability.

2. Materials and Methods

2.1. Research Design and Sample

The study used a quantitative descriptive-comparative, correlational, and predictive design. It was nonexperimental and cross-sectional: variables were measured as they occurred naturally, and statistical associations were not interpreted as evidence of causation. This design is consistent with the dissertation framework and with quantitative research approaches used to describe status, compare groups, examine associations, and estimate predictive contributions [19].

The target population comprised 6,083 eligible full-time teachers from five higher education institutions in Gansu Province. Proportionate stratified sampling allocated 71, 68, 59, 85, and 79 respondents to Universities A through E, respectively, for a total sample of 362. Eligibility required full-time teaching status and at least one higher education course taught during the current academic year. The supplied analytic dataset contained 362 cases, and all were coded as eligible and consenting.

Table 1 summarizes the principal characteristics of the analytic sample. Women represented 51.7% of respondents and men 47.5%; mean age was 41.72 years ($SD =$

8.07; range 26-63). Most respondents held master's (52.5%) or doctoral (41.4%) degrees, and 78.7% reported access to institutional digital training resources.

Table 1. Summary profile of the 362 respondents

Profile variable	Summary
Institutional strata	University A: 71; B: 68; C: 59; D: 85; E: 79
Sex	Male: 172 (47.5%); Female: 187 (51.7%); Prefer not to say: 3 (0.8%)
Age	M = 41.72 years; SD = 8.07; range = 26-63
Highest education	Bachelor's: 18 (5.0%); Master's: 190 (52.5%); Doctorate: 150 (41.4%); Other: 4 (1.1%)
Academic rank	Assistant: 26 (7.2%); Lecturer: 98 (27.1%); Associate Professor: 148 (40.9%); Professor: 80 (22.1%); Other: 10 (2.8%)
Years teaching in HEI	<=5: 47 (13.0%); 6-10: 54 (14.9%); 11-15: 73 (20.2%); 16-20: 93 (25.7%); >=21: 95 (26.2%)
Specialization	13 categories; largest groups: Science 54 (14.9%), Engineering 47 (13.0%), Management 40 (11.0%), Education 38 (10.5%); remaining nine categories: 183 (50.6%)
Digital training access	Yes: 285 (78.7%); No: 77 (21.3%)

2.2. Instrument and Scoring

The researcher-developed bilingual questionnaire had three parts. Part I collected profile information. Part II measured teachers' technological leadership through 57 items distributed across five dimensions: digital vision and ethical citizenship (12 items), technology-integrated instruction (10), peer collaboration and mentoring (10), data-driven educational decision making (12), and institutional digital reform advocacy (13). Part III measured digital transformation implementation through 55 items across digital teaching and curriculum (12), digital research and academic support (10), infrastructure and resource construction (11), digital competency training system (10), and digital governance and student inclusive service (12). Responses used a four-point scale from 1 to 4.

The dissertation protocol specified adviser review, Chinese translation, bilingual equivalence review, expert validation, and pilot testing, with Cronbach's alpha planned for internal consistency assessment. Because the supplied dissertation version does not report the pilot reliability coefficients, no pilot alpha values are claimed in this manuscript. Instead, internal consistency was recalculated from the 362-case analytic dataset. The overall technological leadership scale had alpha = 0.809 and the digital transformation scale had alpha = 0.837; dimension-level coefficients are reported in Table 2. Cronbach's alpha is reported as a measure of internal consistency, with interpretation requiring attention to scale purpose and item structure [20].

Composite means followed the dissertation's interpretation rules. For technological leadership, 3.26-4.00 was Very High, 2.51-3.25 High, 1.76-2.50 Low, and 1.00-1.75 Very Low. For digital transformation, the corresponding labels were Very Great Extent, Great Extent, Slight Extent, and Very Slight Extent.

2.3. Statistical Analysis

Frequencies and percentages summarized categorical profile variables, while age was summarized using the mean, standard deviation, and range. Means and standard deviations described each leadership dimension, transformation domain, and overall scale. One-way analysis of variance was used for profile variables with three or more categories; an independent-samples t-test was used for digital training access. Age was examined as a continuous variable using Pearson correlation. Tukey's honestly significant difference procedure followed a significant omnibus analysis of variance. Pearson correlation assessed the overall association between technological leadership and digital transformation. Simple linear regression estimated the contribution of overall technological leadership, and multiple linear regression tested the five leadership dimensions simultaneously. Statistical significance was evaluated at $\alpha = 0.05$.

3. Results

3.1. Technological Leadership and Digital Transformation

Table 2 shows that all five technological leadership dimensions fell within the High range. The overall mean was 3.05 (SD = 0.26). Digital vision and ethical citizenship had the highest mean ($M = 3.09$), followed closely by peer collaboration and mentoring ($M = 3.08$). Technology-integrated instruction had the lowest leadership mean ($M = 3.02$), although it remained in the High range.

All five digital transformation domains were assessed as implemented to a Great Extent, with an overall mean of 2.99 (SD = 0.29). Digital teaching and curriculum was highest ($M = 3.07$), while institutional digital infrastructure and resource construction was lowest ($M = 2.90$). Thus, the data indicate relatively consistent positive perceptions across domains, but infrastructure and resource construction remained the comparatively weakest area.

Table 2. Descriptive statistics and internal consistency of study constructs

Construct	Items	M	SD	alpha	Interpretation
TL: Digital vision and ethical citizenship	12	3.087	0.495	0.806	High
TL: Technology-integrated instruction	10	3.019	0.495	0.755	High
TL: Peer collaboration and mentoring	10	3.081	0.515	0.795	High
TL: Data-driven educational decision	12	3.038	0.451	0.745	High
TL: Institutional digital reform advocacy	13	3.029	0.487	0.815	High
Technological leadership overall	57	3.050	0.256	0.809	High
DT: Digital teaching and curriculum	12	3.067	0.480	0.785	Great Extent
DT: Digital research and academic support	10	2.978	0.502	0.754	Great Extent
DT: Infrastructure and resource construction	11	2.903	0.477	0.746	Great Extent
DT: Digital competency training system	10	2.986	0.501	0.755	Great Extent
DT: Digital governance and student inclusive service	12	3.012	0.507	0.806	Great Extent
Digital transformation overall	55	2.991	0.286	0.837	Great Extent

3.2. Differences by Respondent Profile

Most profile variables were not associated with significant differences in the overall

technological leadership or digital transformation scores. Age was not significantly related to technological leadership ($r = 0.014$, $p = 0.790$) or digital transformation ($r = -0.025$, $p = 0.634$). Sex, educational attainment, academic rank, and years of teaching also showed no significant omnibus differences on either overall scale (Table 3).

Area of specialization produced a significant omnibus difference for overall technological leadership, $F(12, 349) = 2.30$, $p = 0.008$, $\eta^2 = 0.073$. However, Tukey-adjusted pairwise comparisons did not identify any individual specialization pair that remained significant at the 0.05 level, so the omnibus result should not be used to rank specific disciplines. Specialization was not significant for digital transformation, $F(12, 349) = 0.72$, $p = 0.728$.

Access to institutional digital training resources did not significantly differentiate technological leadership, $t(360) = 0.45$, $p = 0.653$, $d = 0.058$. It did differentiate digital transformation: respondents with access reported a higher overall transformation mean ($M = 3.014$) than those without access ($M = 2.907$), $t(360) = 2.93$, $p = 0.004$, $d = 0.377$. The effect was small to moderate and indicates an association rather than a causal effect.

Table 3. Profile-based tests for overall technological leadership and digital transformation

Profile variable	Technological leadership	Digital transformation
Age (Pearson r)	$r = 0.014$, $p = 0.790$	$r = -0.025$, $p = 0.634$
Sex (ANOVA)	$p = 0.910$	$p = 0.276$
Highest education (ANOVA)	$p = 0.237$	$p = 0.155$
Academic rank (ANOVA)	$p = 0.666$	$p = 0.385$
Years teaching in HEI (ANOVA)	$p = 0.617$	$p = 0.634$
Specialization (ANOVA)	$p = 0.008$; $\eta^2 = 0.073$	$p = 0.728$; $\eta^2 = 0.024$
Digital training access (t-test)	$p = 0.653$; $d = 0.058$	$p = 0.004$; $d = 0.377$

3.3. Relationship and Predictive Contribution

Overall technological leadership was positively correlated with overall digital transformation, $r = 0.270$, $p < 0.001$. The relationship was statistically significant but modest in magnitude. In a simple linear regression, technological leadership significantly predicted digital transformation, $B = 0.301$, $SE = 0.057$, $t = 5.31$, $p < 0.001$, 95% CI [0.189, 0.412]. The model explained 7.3% of the variance in digital transformation ($R^2 = 0.073$; adjusted $R^2 = 0.070$), $F(1, 360) = 28.22$, $p < 0.001$.

When the five technological leadership dimensions were entered simultaneously, the model remained significant, $F(5, 356) = 5.97$, $p < 0.001$, with $R^2 = 0.077$ and adjusted $R^2 = 0.064$. Peer collaboration and mentoring, data-driven educational decision making, and institutional digital reform advocacy were significant positive unique predictors. Digital vision and ethical citizenship and technology-integrated instruction were not significant unique predictors after the other leadership dimensions were controlled (Table 4).

Table 4. Multiple regression predicting overall digital transformation from technological leadership dimensions

Predictor	B	SE	beta	p	95% CI for B
Digital vision and ethical citizenship	0.037	0.030	0.065	0.209	[-0.021, 0.096]
Technology-integrated instruction	0.038	0.030	0.066	0.206	[-0.021, 0.097]
Peer collaboration and mentoring	0.078	0.029	0.141	0.006	[0.022, 0.134]
Data-driven educational decision	0.071	0.033	0.111	0.033	[0.006, 0.136]
Institutional digital reform advocacy	0.079	0.031	0.134	0.010	[0.019, 0.139]

Note. N = 362. Model R-squared = 0.077; adjusted R-squared = 0.064.

4. Discussion

4.1. Leadership and Transformation Levels

The study found high levels of perceived technological leadership across all five dimensions and a great extent of digital transformation implementation across all five institutional domains. The pattern is consistent with a context in which digital practices are already established but not uniformly mature. The highest leadership mean for digital vision and ethical citizenship is notable because current international frameworks emphasize responsible, human-centered, inclusive, and ethically governed technology use [5-8]. At the same time, the lower mean for technology-integrated instruction suggests that translating shared digital values into sustained instructional design remains an area for continued development.

For digital transformation, digital teaching and curriculum received the strongest assessment, whereas infrastructure and resource construction received the lowest. This pattern supports the socio-technical view that transformation cannot be reduced to teacher competence or classroom adoption alone [1,2,4]. Even when teachers report positive leadership practices, institutional connectivity, interoperability, cybersecurity, technical support, devices, repositories, and procurement conditions may constrain the pace or consistency of implementation. The comparatively lower infrastructure score therefore points to an institutional responsibility that professional development alone cannot resolve.

4.2. Profile Differences and Access to Support

The absence of significant differences by sex, age, educational attainment, academic rank, and years of teaching suggests that the central leadership and transformation challenges are not confined to a single demographic or career-stage group. This finding supports a development approach that avoids deficit assumptions about particular groups. However, it does not imply that all teachers have identical needs; differentiated professional learning may still be appropriate because digital confidence, disciplinary requirements, and access opportunities vary [14-16].

The significant omnibus specialization effect on technological leadership should be interpreted cautiously because no Tukey-adjusted pairwise difference remained significant. The result indicates some overall between-specialization variation, but

the evidence is insufficient to claim that any specific discipline is definitively higher or lower. This is important for program planning because it argues against discipline-based ranking without further evidence.

The clearest profile-related finding concerned access to institutional digital training resources. Teachers with access reported higher digital transformation implementation than those without access. This association is consistent with research showing that facilitating conditions and professional development opportunities matter for teachers' digital practice [14-16,21]. Because the design is cross-sectional, access cannot be treated as the cause of higher transformation scores; institutions with stronger digital transformation may also be more likely to provide training. Nevertheless, the result identifies access to professional learning as a practical equity issue that can be addressed through institutional policy.

4.3. Predictive Role of Teacher Technological Leadership

Technological leadership was a significant positive predictor of digital transformation, but the explained variance was modest. This result is theoretically plausible. Teacher leadership can influence pedagogical practice, peer learning, data use, and institutional feedback, but higher education transformation also depends on budgets, systems architecture, governance, technical staffing, procurement, cybersecurity, policy, and organizational coordination [1,2,4]. The small R-squared therefore does not make teacher leadership unimportant; rather, it indicates that teacher leadership is one component of a broader institutional system.

Three leadership dimensions showed significant unique contributions in the multivariable model. Peer collaboration and mentoring was the strongest standardized predictor, followed by institutional digital reform advocacy and data-driven educational decision making. These findings align with distributed leadership theory, which treats influence as a collective practice rather than a function of formal title [12], and with research emphasizing the importance of contextualized evidence use in educational improvement [17,18]. They also suggest that transformation benefits when teachers help one another, interpret evidence carefully, and communicate recurring barriers and feasible reform needs to institutional decision makers.

Digital vision and ethical citizenship and technology-integrated instruction remained important descriptively but were not significant unique predictors after the other dimensions were included. This does not mean they are unimportant. Their effects may be expressed through other leadership practices, may depend more strongly on institutional conditions, or may operate at the classroom level in ways that are not fully captured by an institution-wide transformation score. The result therefore supports a balanced interpretation: professional development should retain ethical and pedagogical foundations while placing additional emphasis on collaboration, evidence use, and structured participation in reform.

4.4. Implications for Professional Development

The evidence supports four priorities for the dissertation's proposed professional development plan. First, institutions can strengthen peer mentoring and collaborative course design so that teachers can exchange tested practices, observe technology-supported teaching, and discuss unsuccessful experiments without stigma. Second, professional learning can deepen data literacy by emphasizing data quality, contextual interpretation, privacy, uncertainty, student voice, and the appropriate combination of quantitative evidence with professional judgment. Third, institutions can create transparent participation channels through which teachers document recurring digital barriers, propose feasible changes, and receive feedback on reform decisions. Fourth, access to digital professional learning should be widened, particularly for teachers who currently report no access to institutional training resources. These priorities are consistent with research on effective teacher professional development for online and blended learning [21].

Professional development should also be connected to institutional improvement rather than used as a substitute for it. The comparatively low infrastructure score indicates a need for continued attention to reliable platforms, technical support, interoperability, cybersecurity, accessibility, devices, and resource quality. A coherent strategy therefore combines teacher learning with enabling institutional conditions.

5. Conclusion

Among 362 full-time teachers from five higher education institutions in Gansu Province, technological leadership was rated high and digital transformation implementation was rated to a great extent. Teachers' technological leadership was positively associated with digital transformation, although the predictive effect was modest. Peer collaboration and mentoring, data-driven educational decision making, and institutional digital reform advocacy made significant unique contributions to the prediction of transformation. Access to institutional digital training resources was associated with higher transformation assessments, while most other profile variables did not produce significant overall differences. Infrastructure and resource construction was the lowest-rated transformation domain.

These findings support a professional development approach that combines ethical and pedagogical foundations with stronger peer mentoring, evidence-informed decision making, and structured teacher participation in institutional reform. They also indicate that professional learning must be accompanied by institutional investment in infrastructure and support. Because the study relied on self-reported, cross-sectional data from five institutions, the findings should be interpreted as associations rather than causal effects. Future research could add longitudinal designs, classroom observations, interviews, institutional document analysis, and direct indicators of digital service or infrastructure performance.

Ethics Statement

The supplied questionnaire states that participation was voluntary, responses were confidential, and data were intended only for academic research. The supplied dissertation further states that ethics/research approval and institutional permission were to be obtained before data collection. The approval body and reference number are not documented in the files supplied for this manuscript and should be inserted by the author before journal submission.

Data Availability

The statistical analyses in this manuscript were recalculated from the 362-case dataset supplied by the author. A public data-sharing status was not specified in the source materials; the final journal data-availability statement should therefore be completed by the author in accordance with institutional ethics requirements.

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