

TEACHERS' DIGITAL COMPETENCE MODEL FOR HIGHER VOCATIONAL COLLEGES IN SHAANXI PROVINCE*

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Received 12 February 2026; Revised 21 February 2026; Accepted 23 February 2026

Abstract

This research article aims to: 1) assess the level of teachers' digital competence in higher vocational colleges in Shaanxi Province; 2) validate the measurement structure of teachers' digital competence through confirmatory factor analysis; and 3) conduct a convergent mixed-methods research study collecting data from teachers in higher vocational colleges and expert or administrator informants, and analyse the data using descriptive statistics, correlation analysis, and higher-order confirmatory factor analysis complemented by inductive thematic coding to synthesise a context-tailored teachers' digital competence model for vocational institutions. The research results found that: 1) teachers' digital competence in Shaanxi's higher vocational colleges is generally at a comparatively high level across the competence domains, indicating a solid foundation for ongoing digital transformation and instructional improvement; 2) the confirmatory factor analysis supports a coherent higher-order, multidimensional structure, providing evidence that the proposed domains reliably represent an integrated construct

Citation:



* Chenliang Zhang and Thada Siththada. (2026). Teachers' Digital Competence Model For Higher Vocational Colleges In Shaanxi Province. *Modern Academic Development and Promotion Journal*,

4(2), 229-246.;

DOI: <https://doi.org/10.>

<https://so12.tci-thaijo.org/index.php/MADPIADP/>

of teachers' digital competence; and 3) integrating quantitative patterns with qualitative insights yields an eight-domain teachers' digital competence model for Shaanxi's higher vocational context, comprising School Support, Professional Development, Teacher Motivation, Digital Ethics and Security, Communication and Collaboration, Information Literacy, Digital Pedagogical Integration, and Digital Assessment and Feedback, which offers an actionable framework for institutional evaluation, targeted professional development, and policy design.

Keywords: Teachers' Digital Competence, Teachers' Digital Competence Model, Higher Vocational Colleges

Introduction

Digital competence has evolved beyond technical skills to a composite capability encompass knowledge, practices, and dispositions for purposefully leveraging technology for learning, assessment, collaboration, and ethical participation in digital environments. Within higher education, especially in practice-oriented vocational programs, TDC is pivotal to curriculum modernisation, data-informed pedagogy, and students' work-readiness in digitally transformed industries. In higher vocational colleges, teachers must design simulation-rich experiences, manage digital safety and integrity, and utilise analytics to personalise learning while aligning with industry standards and rapidly evolving technologies.

Shaanxi Province, a hub for high-end manufacturing and defense-related industries, hosts a diverse ecosystem of higher vocational colleges engaged in digital transformation to varying degrees. Heterogeneity in institutional support, professional development (PD), infrastructure, and teacher motivation necessitates a context-sensitive measurement and development framework for the TDC.

Objectives

The objectives of this study are as follows:

(1) To examine the level of teachers' digital competence in higher vocational colleges in Shaanxi Province. The study assessed overall and domain-level competence profiles using teachers' survey responses.

(2) To validate the measurement structure of teachers' digital competence in higher vocational colleges in Shaanxi Province through confirmatory factor analysis. The study tested a higher-order factor structure and evaluated model fit and standardized factor loadings.

(3) To propose a teachers' digital competence model for higher vocational colleges in Shaanxi Province. The model was developed by integrating quantitative findings with themes derived from expert and administrator interviews.

Significance of the Study

This study empirically establishes a validated, context-sensitive instrument for vocational education. Practically, the results guide PD design, resource allocation and institutional policy. Theoretically, this study refines multidimensional TDC frameworks for the Chinese vocational context and provides evidence for a second-order structure that integrates eight coherent domains.

Literature Review

1. Conceptualising Digital Competence

Over the last decade, TDC has evolved from a tool-centric ICT skills focus to a multidimensional, context-embedded construct that integrates digital pedagogy, assessment and analytics, communication and collaboration, information literacy, and digital ethics and security. Recent syntheses emphasise

the importance of purposeful and ethical technology use to enhance learning, foster inclusion, and safeguard privacy and data integrity, while also highlighting the need for instruments with robust psychometrics and contextual validity (e.g. DigCompEdu-based measures and their derivatives). Contemporary reviews and validation studies highlight that effective conceptualisations must link competence domains to authentic classroom practices and professional decision-making rather than generic tool proficiency. This includes the explicit treatment of assessment for learning, analytics-supported feedback, and digital responsibility as core threads rather than peripheral add-ons (Basilotta-Gómez-Pablos et al., 2022). In parallel, updated applications of educator competency frameworks emphasise local adaptation to curricular goals, infrastructure conditions, and institutional development pathways, warning against one-size-fits-all models transplanted without attention to context (Wu & Yang, 2024).

Frameworks in Educational Contexts. DigCompEdu remains a widely used reference for defining and assessing TDC in higher education, with recent work providing new evidence of its dimensional structure, measurement invariance, and practical diagnostic value for professional development planning. Studies have validated shortened or adapted instruments, reported good factorial fits, and recommended tighter alignment between measured domains and institutional improvement cycles, such as mentoring, micro-credentials, and curriculum redesign (Cabero-Almenara et al., 2021; Tzafilkou et al., 2023). This stream of research positions educator competence not as an isolated trait but as a set of teachable, improvable capabilities that should be embedded in programmatic PD and evaluation systems.

Vocational education considerations. In TVET and higher vocational contexts, conceptual models must foreground practice orientation, enterprise linkage, and safety-critical environments. Recent scholarship advocates for whole-institution approaches that integrate leadership, infrastructure, teacher development, and learner engagement, aligning with industry standards and

utilising real equipment or simulations. Reviews and empirical studies in VET also highlight gaps: generic higher-education instruments may under-represent production-like tasks, e-assessment in practical settings, and domain-specific digital ethics and security, reinforcing the need for adapted constructs and sector-specific indicators (Zhong & Juwaheer, 2024).

2. Teachers' Digital Competence in Higher Education

Recent evidence portrays TDC in higher education as multidimensional and unevenly distributed across various domains, including pedagogical integration, assessment analytics, collaboration, and digital responsibility. Large-scale reviews since 2020 have reported that university teachers typically feel confident with general technologies but display a weaker capacity for data-informed assessment, learning analytics, and advanced pedagogical uses—areas most closely tied to learning gains and educational quality (Basilotta-Gómez-Pablos et al., 2022). These reviews emphasise that valid measures should extend beyond tool familiarity to encompass ethical practices, feedback processes, and collaborative professional engagement.

A fast-growing stream validates and adapts DigCompEdu for university contexts, showing an acceptable internal structure, diagnostic utility, and suitability for planning professional development. Multi-country and regional studies identify distinct strengths and gaps across domains such as “Digital Resources”, “Teaching and Learning, Assessment”, and “Professional Engagement”, and recommend using the results to steer mentoring, micro-credentials, and curriculum redesign rather than treating TDC as a static trait (Dias-Trindade et al., 2020). Empirical analyses confirm that demographic and institutional factors shape competence, implying the need for context-aware measurement and developmental pathways (Cabero-Almenara et al., 2023).

Beyond Europe and Latin America, recent university studies have emphasised that reliable TDC assessment requires robust psychometrics and

cross-context validity. Systematic reviews of higher-education instruments have pointed to the proliferation of measures since 2013, yet they call for stronger validation, clearer alignment with practice, and the incorporation of domains such as ethics, security, and data analytics (López-Nuñez et al., 2024). Collectively, this literature converges on two design implications: pairing measurement with developmental scaffolds (mentoring, lesson study, programmatic PD) and ensuring institutional coupling so that assessment findings feed into quality assurance and teacher evaluation (Fernández-Morante et al., 2023).

For the vocational segment of higher education, studies caution that general university instruments may underrepresent practice-intensive tasks, simulation environments, and safety-critical ethics. VET-focused research emphasises the importance of enterprise linkage, equipment-specific upskilling, and trustworthy data practices as integral to teachers' competence, thereby reinforcing the need for sector-specific constructs and indicators (Dias-Trindade et al., 2023).

3. Digital Transformation in Chinese Higher Education

China's digital-education agenda has accelerated through the National Education Digitalisation Strategy Action, large-scale platforms, and recurring World Digital Education Conference initiatives that promote system-level modernisation and teacher upskilling. Policy briefings emphasise a whole-of-system approach: upgrading national platforms, deepening application scenarios, and strengthening governance and standards for digital teaching and learning. These initiatives frame digital competence as a lever for curriculum reform, resource sharing, and data-informed quality assurance in higher education.

A pivotal step was the release of the Teachers' Digital Literacy industry standard in late 2022, which articulates nationally aligned domains and implementation guidance to enhance teachers' capacity for technology-

enhanced teaching. Recent empirical work in Chinese universities uses this standard to design and validate instruments, underscoring its practical uptake and signalling a shift from ad hoc training to standards-based development (Feng & Sumettikoon, 2024). The diffusion of the standard aims to address uneven institutional capacity by coupling competence expectations with PD ecosystems and platform support.

Simultaneously, national announcements increasingly position AI and smart-education systems as strategic drivers, with policy communications in 2025 highlighting the integration of AI into teaching, curriculum, and teacher capability building within a broader “strong-education nation” plan. For higher vocational colleges, this intensifies expectations that teachers will harness data analytics, simulations, and digital safety practices aligned with enterprise standards while participating in cross-institutional resource hubs and demonstration zones. These developments heighten the need for diagnostic, context-sensitive TDC models that can translate national mandates into institutional action and targeted professional development, particularly in provinces with strong manufacturing ecosystems, such as Shaanxi.

Taken together, China’s policy trajectory and the international measurement literature converge on a common design logic: credible evaluation of teachers’ digital competence must be paired with system supports—standards, platforms, PD finance, and governance—so that evidence can be operationalised in institutional improvement cycles and vocationally relevant practices.

Methodology

1. Research Design

A convergent mixed-methods design was employed. Quantitative and qualitative data were collected in parallel and integrated during interpretation

to enhance their validity and contextualisation. The quantitative strand validated the TDC measurement model, while the qualitative strand illuminated the mechanisms and contextual factors that influence TDC.

2. Quantitative Methods

Instrument. A structured questionnaire operationalised eight domains: School Support (SS), Professional Development (PD), Teacher Motivation (TM), Digital Ethics and Security (DES), Communication and Collaboration (CC), Information Literacy (IL), Digital Pedagogical Integration (DPI), and Digital Assessment and Feedback (DAF). The items were rated on a five-point Likert scale.

Sampling and participants. The survey targeted full-time teachers from 40 higher vocational colleges in Shaanxi Province. A total of 640 questionnaires were distributed, and 603 valid questionnaires were retained after screening (response rate of 94.22%). The participants represented a diverse range of disciplines, ranks, and experience levels in the study.

Procedures and ethics. Participation was voluntary and anonymous, with informed consent. The data were used solely for research purposes and reported in aggregate.

3. Qualitative Methods

Interviews. Nine semi-structured interviews were conducted with experts and administrators responsible for teacher training, educational technology and digital transformation. The protocol probed institutional supports, PD mechanisms, ethics and security practices, assessment and feedback, collaboration, and barriers/enablers of digital integration.

Data collection. With permission, the interviews were recorded and transcribed, and identifying information was removed.

4. Data Analysis

Quantitative analysis. Descriptive statistics (M and SD) were used to summarise the TDC levels. Interdomain correlation matrices were used to

examine these associations. Confirmatory factor analysis (CFA) was employed to assess dimensionality, including a second-order measurement model that represented the overall TDC. Following common practice, reliability and validity were assessed using Cronbach's α , composite reliability (CR), average variance extracted (AVE), Fornell–Larcker criteria, maximum shared variance (MSV), average shared variance (ASV), and the HTMT.

Qualitative analysis. An inductive coding approach identified themes concerning institutional enablers, PD mechanisms, ethics and security, assessment and feedback, and a collaborative culture.

Integration. Quantitative and qualitative findings were merged through narrative weaving and joint displays, informing a context-tailored TDC development model.

Results

1. Quantitative Findings

Descriptive statistics. On a five-point scale, the mean scores ranged from 3.46 to 3.65, with $SD = 0.997$ – 1.14 , indicating generally positive evaluations and adequate dispersion for discrimination.

Correlations. All eight domains were positively correlated. The strongest associations were DES–DAF ($r = .454$) and PD–DAF ($r = .447$), suggesting that robust ethical security practices and high-quality PD co-occur with stronger digital assessment and feedback practices.

CFA (measurement model). As shown in Figure 4.1, the sampling adequacy was excellent. The second-order CFA yielded a good fit: $CMIN = 534.831$; $df = 456$; $CMIN/df = 1.173$; $GFI = .948$; $AGFI = .940$; $TLI = .985$; $CFI = .986$; $RMR = .031$; $RMSEA = .017$, meeting or surpassing conventional thresholds (e.g. Hu & Bentler, 1999; Kline, 2016; Hair et al., 2019). Standardised loadings were significant and in the expected direction, supporting the eight-

domain second-order structure.

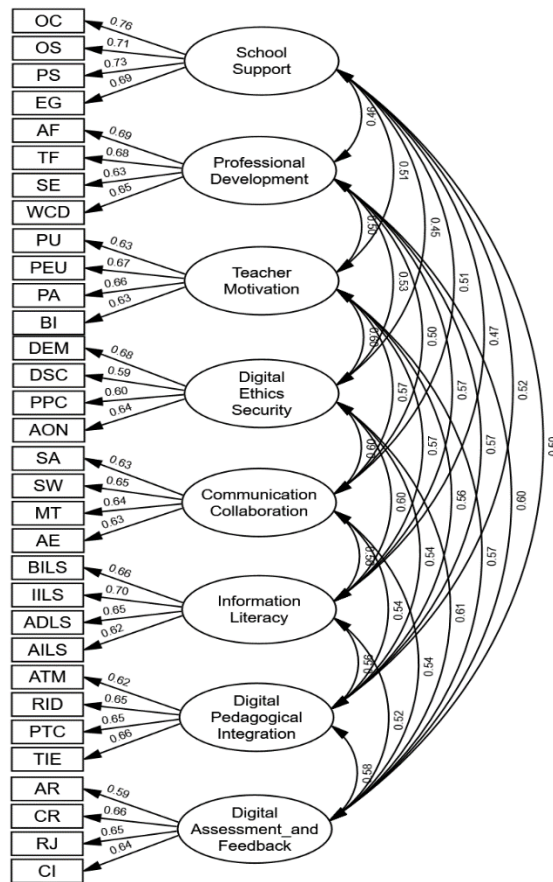


Figure 1 Multiple-Variable Confirmatory Factor Analysis Results

2. Qualitative Insights

Five themes emerged:

Institutional Enablers. Dedicated budgets, platform access, and protected collaboration time increase the adoption and quality of digital practices.

PD Mechanisms. Tiered, hands-on, and course-embedded PD linked to authentic redesign tasks drive sustained improvement.

Ethics & Security. Clear policies, training, and supervision regarding data privacy, cybersecurity, and academic integrity are essential for enterprise-linked

projects.

Assessment & Feedback. Analytics-informed feedback loops and e-assessment practices are promising but require scaffolding, templates and technical support.

Collaboration Culture. Peer observation, lesson studies, and cross-disciplinary design teams accelerate the diffusion of effective digital practices.

Contextual factors. Differences in infrastructure, leadership, and enterprise partnerships shape the pace and depth of integration among colleges.

3. Integrated Teachers' Digital Competence Model

The interview data indicate that the cultivation of teachers' digital competence in higher vocational colleges is shaped by eight interrelated factors. School Support (SS)—through culture, organisation, policy, and infrastructure—creates clear expectations and stable conditions for digital teaching to move from “optional” to “routine.” Professional Development (PD) provides job-embedded pathways (from foundational to advanced) that convert strategies into practical skills and deliverables. Teacher Motivation (TM), anchored in perceived usefulness, ease of use, positive participation attitudes, and strong behavioural intention, sustains engagement and diffusion. Robust Digital Ethics and Security (DES) practices (academic integrity, role-based access, privacy protection, and online norms) ensure the lawful, safe, and trustworthy use of technology. Open Communication and Collaboration (CC), characterised by a sharing attitude, willingness, trust, and active participation, turn scattered innovations into a collective capacity. A progressive Information Literacy (IL) ladder equips teachers to search, evaluate, integrate, and create information, including the responsible use of AI. Effective Digital Pedagogical Integration (DPI) aligns methods, designs, and classroom management to ensure that technology supports learning outcomes. Finally, credible Digital Assessment and Feedback

(DAF)with clear rubrics, calibration, authentic tasks, and multimodal evidence closes the loop for continuous improvement. Together, these dimensions form a coherent chain in which institutional conditions and peer networks enable learning opportunities that, through motivation and competence, translate into high-quality, ethical, and assessable digital teaching.

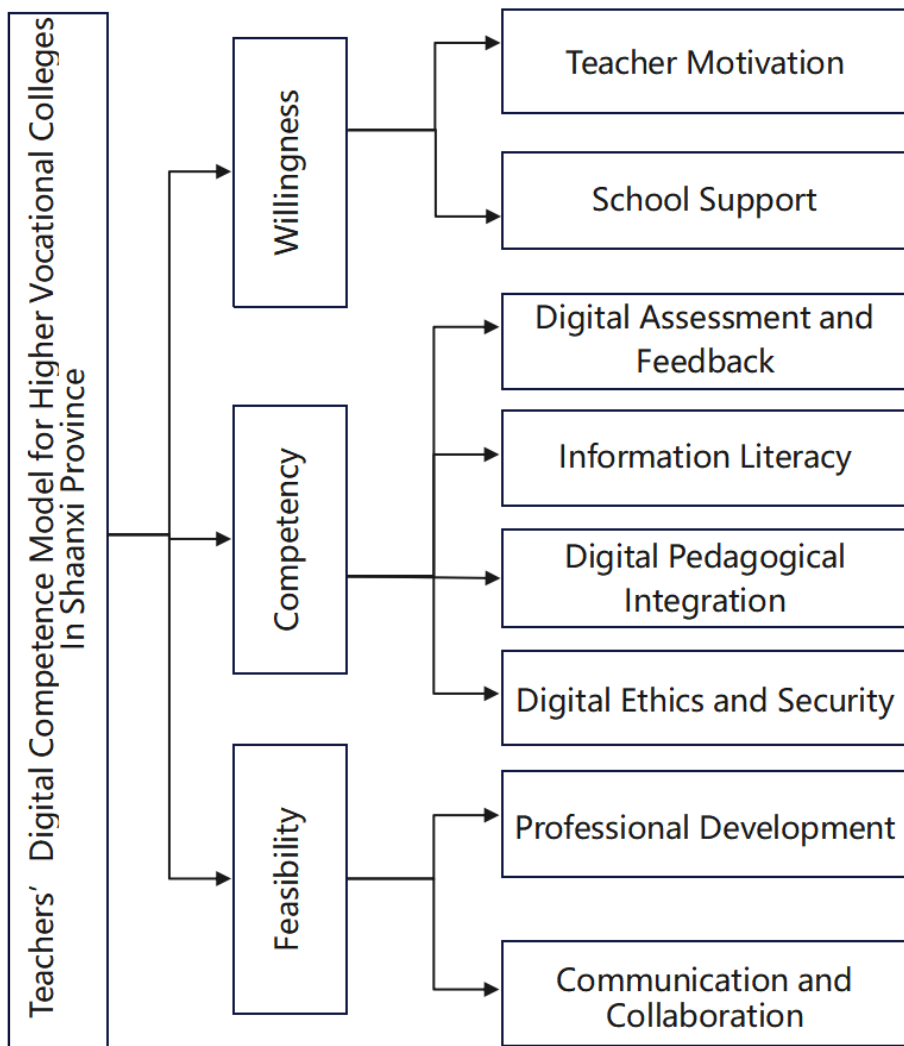


Figure 2 Teachers' Digital Competence model for higher vocational colleges in Shaanxi province

Discussion

1. Interpreting the reported level of teachers' digital competence

The study first examined the overall profile of teachers' digital competence in Shaanxi's higher vocational colleges. The findings suggest a generally favorable competence level across the measured domains, indicating that many institutions have progressed beyond initial technology adoption toward more routine use in teaching-related tasks. This pattern is plausibly linked to China's accelerated education digitalization agenda, the expanding availability of digital platforms and resources, and the increasing normalization of blended and data-supported instructional routines. In the vocational sector, additional momentum may come from industry digitalisation and practice-oriented training requirements, which encourage teachers to engage with simulation tools, digital resources, and competency-based assessment practices that are aligned with workplace demands.

Simultaneously, the favourable overall profile should be interpreted with caution. Self-reported indicators may reflect perceived readiness rather than consistently enacted competence in classroom practice, particularly for complex domains such as analytics-informed assessment and instructional redesign. The interview evidence reinforces that institutional variance in infrastructure, leadership attention, and school-enterprise collaboration can create heterogeneous competence profiles beneath a relatively positive aggregate pattern. Taken together, these findings underscore the importance of treating competence as an organizationally enabled capability that emerges from sustained support, time allocation, and structured professional learning rather than as an isolated personal attribute. For institutional practice, the descriptive profile can serve as a baseline for identifying domain-specific strengths and weaknesses and for monitoring change over time, but it should be complemented by practice-based evidence, such as lesson artefacts,

observation protocols, and assessment outputs, to confirm classroom enactment.

2. Meaning of the validated measurement structure

The second focus of this study was to establish whether teachers' digital competence can be represented as an integrated yet multidimensional construct. Confirmatory factor analysis supported a coherent higher-order structure comprising eight domains, providing evidence that these domains collectively reflect a unified competence while retaining distinct diagnostic value. This result aligns with contemporary competence frameworks that conceptualize digital competence as a constellation of coordinated professional capabilities rather than a single technical skill set. It also reflects the practical reality of teaching: effective digital pedagogy depends not only on tool use but also on information literacy, ethical and secure handling of data, collaborative professional engagement, and the capacity to design assessment and feedback processes that meaningfully inform learning.

From an applied perspective, the higher-order representation offers two advantages for higher vocational colleges. First, it enables benchmarking through an overall competence indicator while still allowing domain-level analysis that can guide targeted professional development planning. Second, it supports more systematic quality assurance by aligning training modules, evaluation criteria, and resource allocation with clearly defined competence domains. Importantly, CFA-based evidence strengthens measurement validity and conceptual clarity; however, it does not imply causal relationships among domains. This implies that institutions can responsibly use the validated structure for evaluation and planning, while future research can build on this foundation to examine development trajectories, subgroup comparability, and the robustness of the structure across contexts.

3. Implications of the context-tailored competence model

By integrating quantitative patterns with qualitative insights, the study proposed an eight-domain teachers' digital competence model tailored to the vocational education context of Shaanxi. The model incorporates institutional enablers, individual drivers, and practice-facing competencies in a configuration that reflects the operational realities of higher vocational colleges. School support and professional development appear as foundational enabling conditions that shape teachers' opportunities to learn and experiment; teacher motivation functions as a sustaining force that influences persistence and iterative improvement; and digital ethics and security serve as a governance backbone that safeguards data practices and maintains trust in digitally mediated teaching and assessment. Communication and collaboration, information literacy, digital pedagogical integration, and digital assessment and feedback represent practice-oriented competencies directly tied to classroom enactment and the vocational emphasis on competency-based learning and evidence-driven feedback.

This configuration is particularly meaningful in simulation-rich and enterprise-linked instructional environments, where digital tools often involve sensitive data, platform-based tracking and high-stakes assessment. The prominence of ethics and security in the model indicates that responsible governance is not peripheral but central to sustainable digital transformation. Likewise, positioning digital assessment and feedback as a core domain is consistent with the vocational need to document competence growth, provide timely formative feedback, and align assessment with workplace standards. For institutional implementation, the model can serve as a roadmap for designing domain-specific professional learning pathways, establishing evaluation indicators, and prioritising resource allocation. Its context-tailored nature also suggests a clear boundary condition: while the model is grounded in Shaanxi's

vocational ecosystem, further work is needed to test its transferability across provinces, institution types, and levels of industrial development.

4. Overall contribution and boundary conditions

Overall, the findings provide a systematic evidence chain from competence profiling to measurement validation and model articulation, offering both a psychometrically supported structure and a practice-oriented framework for development. However, the conclusions should be interpreted within the constraints of the study. The cross-sectional design limits developmental inference, reliance on self-reports may introduce bias, and the regional scope constrains generalisability of the findings. Future studies should triangulate survey evidence with classroom observations, artefact analyses, and learning analytics to examine the stability and comparability of the measurement structure across groups and contexts. Within these boundaries, the present study offers a credible basis for institutional evaluation and targeted capacity building, contributing to the implementation of digital transformation in higher vocational education.

Recommendations

Although this study achieved its aims, several limitations suggest clear next steps. The cross-sectional, self-report design limits causal inference and may introduce response bias; the Shaanxi-based sample constrains generalisability; and we did not include classroom observations or artefact analyses. Future research should expand to multi-region and international samples, employ longitudinal designs to track competence development, and adopt mixed-evidence approaches that triangulate surveys with observations, instructional artefacts, and learning analytics. Studies should also test the measurement invariance across teacher subgroups and institutional types to ensure robust comparisons. Finally, linking teacher digital competence to

student learning, employability indicators, and enterprise performance will build a value case for scalable, high-impact models of professional development and institutional quality management in higher vocational education.

References

- Basilotta-Gómez-Pablos, V., Matarranz, M., Casado-Aranda, L.-A., & Otto, A. (2022). Teachers' digital competencies in higher education: A systematic literature review. *International Journal of Educational Technology in Higher Education*, 19(1), 8. <https://doi.org/10.1186/s41239-021-00312-8>
- Cabero-Almenara, J., Gutiérrez-Castillo, J. J., Palacios-Rodríguez, A., & Barroso-Osuna, J. (2021). Comparative european DigCompEdu framework (JRC) and common framework for teaching digital competence (INTEF) through expert judgment. *Texto Livre*, 14(1), e25740. <https://doi.org/10.35699/1983-3652.2021.25740>
- Cabero-Almenara, J., Gutiérrez-Castillo, J.-J., Barroso-Osuna, J., & Rodríguez-Palacios, A. (2023). Digital teaching competence according to the DigCompEdu framework. Comparative study in different latin american universities. *Journal of New Approaches in Educational Research*, 12(2), 276–291. <https://doi.org/10.7821/naer.2023.7.1452>
- Dias-Trindade, S., Moreira, J. A., & Ferreira, A. G. (2020). Assessment of university teachers on their digital competences. *Qwerty*, 15(1), 50–69. <https://doi.org/10.30557/QW000025>
- Dias-Trindade, S., Moreira, J. A., Huertas, J. G. G., Pintado, P. G., & Miguel, A. M. (2023). Teachers' digital competences in higher education in Portugal and Spain. *Contemporary Educational Technology*, 15(4), ep463. <https://doi.org/10.30935/cedtech/13604>

- Feng, L., & Sumettikoon, P. (2024). An empirical analysis of EFL teachers' digital literacy in chinese higher education institutions. *International Journal of Educational Technology in Higher Education*, 21(1), 42. <https://doi.org/10.1186/s41239-024-00474-1>
- Fernández-Morante, C., López, B. C., Casal-Otero, L., & León, F. M. (2023). Teachers' digital competence. The case of the university system of galicia. *Journal of New Approaches in Educational Research*, 12(1), 62–76. <https://doi.org/10.7821/naer.2023.1.1139>
- López-Nuñez, J.-A., Alonso-García, S., Berral-Ortiz, B., & Victoria-Maldonado, J.-J. (2024). A Systematic Review of Digital Competence Evaluation in Higher Education. *Education Sciences*, 14(11), 1181. <https://doi.org/10.3390/educsci14111181>
- Tzafilkou, K., Perifanou, M., & Economides, A. A. (2023). Assessing teachers' digital competence in primary and secondary education: Applying a new instrument to integrate pedagogical and professional elements for digital education. *Education and Information Technologies*, 1–24. <https://doi.org/10.1007/s10639-023-11848-9>
- Wu, W., & Yang, W. (2024). Methodology for digital transformation in TVET. *Digital Transformation in Global TVET: Methodology and Practices. UNESCO Chair on Digitalization in TVET*, 19–47.
- Zhong, Z., & Juwaheer, S. (2024). Digital competence development in TVET with a competency-based whole-institution approach. *Vocation, Technology & Education*, 1(2). <https://doi.org/10.54844/vte.2024.0591>