

Human Capital Management for Improving Teachers' Digital Competency at Secondary Vocational Schools, Chongzuo City, China

Na Liang¹, Supot Rattanapun^{2*}, Alan Robert White³ & Tubagus Darodjad⁴

¹M-ED program, International College, Rajamangala University of Technology Krungthep, Thailand

²International College, Rajamangala University of Technology Krungthep, Bangkok, Thailand

*Correspondence: International College, Rajamangala University of Technology Krungthep, Bangkok, Thailand.
E-mail: supot.r@mail.rmutk.ac.th. ORCID: <https://orcid.org/0009-0004-4513-0455>

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Abstract

This study examines how human capital management (HCM) methods influence the development of teachers' digital competencies in secondary vocational schools in Chongzuo City, China. The research employs a mixed-methods methodology that includes questionnaires, in-depth interviews, and case analysis. It is situated within the context of the rapidly expanding digital economy and the ongoing digital transformation of vocational education. The study investigates how key human capital management components—strategic planning, curriculum management, teacher development, and resource allocation—enable schools to enhance their digital literacy and skills. The findings provide robust evidence for the essential role of HCM in developing teachers' digital competency. First, substantial gaps were identified between current practices and teacher expectations across all HCM dimensions, with Priority Need Index (PNI) values ranging from 1.07 to 1.26, underscoring the critical need for systematic reform. Second, correlation analysis reveals significant associations between HCM practices and digital competency development, particularly in professional development ($r = 0.787$), performance evaluation ($r = 0.765$), and collaborative structures ($r = 0.743$). Third, PNI analysis demonstrates that performance evaluation and feedback (PNI = 1.26) and digital skill development (PNI = 1.26) constitute the most urgent intervention areas. To address these gaps, the study proposes the Performance Feedback-Driven Skills Enhancement Model (PFSEM), a continuous improvement framework that integrates evaluation, targeted training, guided practice, and reinforcement to enhance both institutional management systems and teachers' digital skill development. The findings underscore the necessity of context-responsive human capital management strategies, particularly in border-region vocational schools where cultural diversity, resource constraints, and infrastructural limitations necessitate adaptable and locally grounded approaches. This study advances understanding of effective human capital management pathways that can accelerate digital transformation and enhance teacher competency in rapidly evolving vocational education contexts.

Keywords: school management, digital literacy, digital skills, secondary vocational education

1. Introduction

1.1 Introduction to the Problem

The rapid growth of the digital economy and digital technology has transformed labor skill requirements, placing unprecedented pressure on vocational education institutions to produce digitally proficient graduates. Secondary vocational schools in China supply skilled labor for regional industrial upgrading, intelligent manufacturing, and digitally integrated services. Education Informatization 2.0 and the Digital China Strategy emphasize teachers' digital competencies as critical to vocational education modernization. The evidence suggests that many secondary vocational schools, particularly those in border and ethnic minority regions, continue to struggle with fragmented implementation, uneven teacher capacity, and limited managerial coordination in digital transformation processes (Li et al., 2022; OECD, 2023).

Teachers' digital competency encompasses digital literacy, pedagogical integration of technology, and the capacity to adapt to digitally mediated teaching and learning environments (Redecker, 2017; Tondeur et al., 2018). Much of the

literature conceptualizes digital competency as an individual attribute, emphasizing training programs, self-efficacy, or attitudes toward technology use (Instefjord & Munthe, 2017; Scherer et al., 2021). These studies have yielded valuable insights, yet they frequently overlook the organizational and managerial contexts that enable teachers to sustain and apply digital competencies in institutional practice.

Recent research indicates that educational digitalization constitutes a systemic organizational change process involving leadership, strategic alignment, resource orchestration, and human capital management (Fullan et al., 2020; OECD, 2023). Human capital theory conceptualizes teachers' digital competencies as the outcome of deliberate investment, institutional support, and strategic capability development, rather than short-term training initiatives (Becker, 1993; Teece, 2018). However, empirical studies that explicitly link school-level management mechanisms such as strategic planning, curriculum governance, teacher development systems, and resource allocation to teachers' digital competency development remain scarce, particularly in secondary vocational education.

This research deficit is especially pronounced in border and economically disadvantaged regions such as Chongzuo City, Guangxi Zhuang Autonomous Region. These vocational schools face distinctive structural constraints, including inadequate access to contemporary digital infrastructure, inconsistent industry–education collaboration, and difficulty recruiting and retaining digitally skilled teachers (Zhang & Yang, 2023). Chongzuo's cross-border economic position intensifies demand for digitally competent vocational graduates, necessitating effective institutional management of teachers' digital competencies. Despite their strategic importance, Scopus- and WoS-indexed research rarely examines regional vocational school human resource management practices.

This study conceptualizes teachers' digital competency enhancement as a human capital management outcome shaped by interconnected school management mechanisms to address a significant theoretical and empirical gap. The study investigates how strategic planning, curriculum management, teacher development, and resource allocation influence secondary vocational school teachers' digital literacy and skills, drawing upon human capital theory (Becker, 1993), strategic capability theory (Teece, 2018), and digital transformation frameworks in education (Fullan et al., 2020; OECD, 2023).

This mixed-methods study employs quantitative and qualitative approaches to enhance analytical rigor and contextual richness. Questionnaire data reveal how management practices influence teachers' digital competencies, while in-depth interviews and case analyses illuminate institutional processes and implementation dynamics. This mixed-methods approach adheres to recent guidelines for evaluating complex educational transformations and organizational capability development (Creswell & Plano Clark, 2018).

Accordingly, this study examines how human capital management enhances teachers' digital competency in secondary vocational schools in Chongzuo City, China, and proposes evidence-based management optimization strategies. The study advances digital competency and vocational education research by shifting from individual to organizational and managerial perspectives. The findings inform school leaders and policymakers in developing digital transformation roadmaps, strengthened industry–education integration mechanisms, and dynamic evaluation systems to improve the quality and sustainability of digital talent cultivation in vocational education, particularly in border and ethnic minority regions.

1.2 Research Questions

1. What are the levels of current status and desirability of human capitals management (Professional Development and Training, Performance Evaluation and Feedback, Collaboration and Team Building) for Enhancing teacher digital competency at Secondary Vocational Schools in Chongzuo City, China?
2. What is the level of current status and desirability of teacher digital competency at Secondary Vocational Schools in Chongzuo City, China?
3. What are the impacts of human capitals management (Professional Development and Training, Performance

1.3 Research Objectives

1. To explore the levels of current status and desirability conditions of human capitals management (Professional Development and Training, Performance Evaluation and Feedback, Collaboration and Team Building) for Enhancing teacher digital competency at Secondary Vocational Schools in Chongzuo City, China.
2. To investigate needs of of human capitals management for improving teacher digital competency at Secondary Vocational Schools in Chongzuo City, China.
3. To improve teachers' digital competencies in secondary vocational schools in ChongZuo, China.

2. Literature Reviews

2.1 Research Related on Professional Development Direct Impact on Teacher Digital Competency.

The rapid development of ChatGPT is driving a wave of educational innovation, and determining how to utilize artificial intelligence technology to support teachers' professional development constitutes a core issue in constructing a high-quality education system. Teachers' professional development represents a critical foundation for the construction of the entire education system. Therefore, within the context of digital transformation in education, it is imperative to leverage ChatGPT to enhance the professional development of primary school teachers. Teacher professional development encounters both opportunities and challenges posed by artificial intelligence in terms of professional knowledge, skills, and emotions (Li & Chen, 2023). Consequently, ChatGPT supports teachers' professional development through establishing guarantee mechanisms for human-machine collaborative education, teacher ethics and conduct, digital literacy, and related dimensions. Second, creating digital support through the campus learning environment, campus learning atmosphere, and technical support teams establishes the foundation for ChatGPT to enhance the professional development of primary school teachers. Third, reconstructing the training model in terms of digital literacy, ethical literacy, teaching methods, and related aspects proves essential. Additionally, teachers should adopt a tolerant and open attitude, establish reasonable and sound concepts, cultivate critical thinking, and advance their professional development.

In the era of digitization, enhancing the information literacy of mathematics teachers is crucial. Schools and educational authorities should regularly organize information technology training to assist teachers in mastering the latest digital tools and technologies and improving their teaching abilities through participation in relevant technical lectures and seminars. Specialized lectures and practical courses enable teachers to systematically learn how to efficiently utilize various digital teaching tools such as mathematical graphing software and online homework platforms. Subsequently, teachers should emphasize applying the acquired techniques to practical teaching. In classroom instruction, teachers can employ mathematical software to create courseware and utilize virtual reality (VR) technology to display complex geometric shapes, enabling students to comprehend abstract concepts more intuitively. When applying acquired technology, teachers need to continuously adjust and optimize their teaching methods to ensure that technology genuinely serves pedagogical objectives. This integration of learning and application enhances teachers' information literacy, facilitates better adaptation to the teaching demands of the digital age, and provides students with higher quality educational services (Zhang & Yang, 2023).

In today's increasingly advanced information technology environment, teachers can access the latest educational concepts and teaching methods through online platforms, online seminars, and teaching resource repositories, providing them with a platform for continuous learning and self-improvement. Teachers utilize digital tools to conduct classroom design, interactive teaching, and evaluation feedback activities, progressively acquiring more diverse teaching skills and developing innovative thinking and technological application capabilities (Wang, 2025). Digital technology provides teachers with broader platforms for collaboration, enabling them to exchange experiences and share resources with colleagues in other subjects or schools. This not only expands teachers' perspectives but also stimulates continuous reflection on and improvement of their own teaching practices.

2.2 A Study the Impact on Performance Evaluation and Feedback Direct Impacts on Teacher Digital Competency

Through teacher performance evaluation, deficiencies and gaps in various aspects such as teaching proficiency, work attitude, learning capacity, and knowledge and skills can be identified for each teacher (Teece, 2018). School administrators can develop various incentive measures to address these deficiencies and gaps, enhance teachers' motivation to improve their work, and elevate performance. Additionally, within the incentive system formulated by the school, school managers should link the results of performance evaluation with the distribution of salaries and bonuses, determining the proportion of performance-based compensation in total salary to reflect the degree of teacher motivation based on performance evaluation outcomes.

Teacher performance evaluation fulfills guiding and motivating roles in teacher work, directing the focus and orientation of teachers' efforts (Scherer et al., 2021). The focus of attention and emphasis from the evaluation body enables teachers to clarify the direction of the school's developmental goals, which assists teachers in understanding their responsibilities and recognizing that their continuous progress and improvement are not only grounded in personal aspirations but also constitute inevitable requirements for the school's development, thereby helping them comprehend what constitutes excellent performance. Furthermore, utilizing effective feedback can not only stimulate teachers' enthusiasm for work but also enable them to develop comprehensive self-understanding and improve their future teaching work during the performance evaluation process. The effective application of the feedback mechanism for teacher performance evaluation can stimulate teachers' consciousness and initiative in acquiring

professional knowledge, continuously enhance their professional competence, and promote their self-development and improvement, comprehensively elevating their overall quality.

If education and training schools seek to ensure the scientific, equitable, and motivating nature of organizational compensation systems, they must rely on scientifically sound and reasonable teacher performance evaluation systems. Based on the results of teacher performance evaluation, a teacher compensation system should be established, further realizing the innovative development of performance evaluation work in training schools. A complete performance evaluation system should also incorporate performance feedback, which creates a closed loop in the entire performance evaluation process, enables timely reflection on shortcomings, facilitates analysis of underlying causes, and identifies solutions to ensure the appropriateness and effectiveness of the performance evaluation system.

As a critical component of personnel management in universities, the teacher performance evaluation mechanism can not only ensure the quality of education and teaching and enhance teacher competence but also guide teaching practice activities to optimize the school's human resource configuration. Therefore, a reasonable and efficient performance evaluation mechanism for university teachers possesses significant academic and practical implications for objectively and accurately assessing their performance achievements.

2.3 A Study on the Impact on Collaboration and Team Building Direct Impact on Teacher Digital Competency

Currently, teacher teaching innovation teams are flourishing in vocational colleges across various provinces and cities throughout the country, yet they remain a relatively new phenomenon in the implementation of vocational education reform and lack mature experience for reference. Many vocational colleges regard the construction of teacher teaching innovation teams merely as a phased project and view task completion as the ultimate goal of innovation construction. Limited research and practice exists on how to establish a normalized, sustainable, and mature experiential mechanism for the construction of teacher teaching innovation teams. The construction of a teacher teaching innovation team is not simply an achievement but rather a process of transformation from macro to micro, from abstract to concrete. For vocational colleges to achieve genuinely transformative and leapfrog development, they must build teacher teaching innovation teams characterized by high theoretical literacy, strong practical capability, robust research competence, and innovative consciousness, while striving to enhance teachers' digital skills and related competencies (Wen & Ba, 2024).

Teacher teaching innovation teams possess common developmental goals, with team members guided by the objectives of education and teaching (Wu, 2025). These constitute organizations formed through individual role division and positioning of team teachers during the process of completing team-building tasks, characterized by mutual interaction and cooperation. The study not only defined the concept of teaching innovation teams but also analyzed the task requirements for constructing teacher innovation teams, further confirming that teamwork benefits the development of teachers' digital competencies.

Teacher teamwork can exert a positive promoting effect on teachers' innovative teaching behavior. The collaborative mechanism of the team provides abundant resources for teachers' learning and constitutes an important source of inspiration for creative teaching, ensuring the continuous generation of innovative teaching behaviors. Teacher teamwork indirectly influences teaching innovation through innovative self-efficacy and teacher achievement motivation. Teamwork learning activities can enhance teachers' confidence in completing innovative teaching tasks and facilitate the smooth translation of their inherent willingness for teaching innovation into concrete teaching innovation actions. Collaborative learning among teachers can attenuate negative impacts on teaching innovation by influencing their motivation to avoid failure. The collective strength of teamwork can reinforce teachers' conviction in accomplishing creative teaching, thereby effectively enhancing their achievement motivation and promoting the generation of teaching innovation.

In summary, teacher team collaboration holds considerable significance for the future development of innovative teaching behavior. Education managers should approach this from multiple levels, strengthen the construction of teacher team cooperation, stimulate teachers to achieve teaching innovation, and thereby generate higher quality education.

2.4 A Study on the Impact of Human Capitals Management on Teacher Digital Competency

Education and teaching research constitute important pathways for teachers' professional growth. To achieve the goal of revitalizing and strengthening schools through scientific research, schools should employ scientific approaches to promote teachers' professional development and growth, thereby enhancing the effectiveness of teaching and research. In particular, it is necessary to address problems of incomplete systems, unclear pathways, and unreasonable organizational forms in scientific research by optimizing management models, triggering teachers'

"authentic thinking," stimulating their enthusiasm for independent engagement in "genuine research," and achieving effective support for teachers' professional growth through educational research, as well as the long-term development of schools, to align with current educational and pedagogical development concepts (OECD, 2023).

With the development of technologies such as big data and artificial intelligence, teachers not only need to possess profound disciplinary knowledge but also must learn how to utilize digital tools appropriately within the context of the technological era, improve teaching efficiency, adapt to new teaching environments and technologies, and maintain immersive classroom instruction. Teachers should not only be capable of adapting to the teaching demands of the digital age and addressing issues such as information overload and network security but also assist students in developing critical thinking and the capacity to use online media appropriately (Xin, Tang, & Mou, 2024).

The practical implementation of digital transformation in education requires schools as the primary arena, with teaching as the breakthrough point, commencing from the actual needs of frontline instruction, and promoting the deep integration of digital technology with education and teaching. Although primary and secondary schools attach considerable importance to the digital transformation of education, current academic research focuses predominantly on the field of higher education, with relatively insufficient attention to basic education. Although the academic community has conducted extensive theoretical discussions on the conceptual foundations, driving mechanisms, goal orientations, and action pathways of digital transformation in education, empirical research grounded in practical evidence remains lacking regarding its effectiveness and impact. Therefore, to advance the implementation and development of digital transformation in basic education, it is necessary to commence at the school level, comprehensively reviewing, synthesizing, and analyzing the practice of digital transformation in education to generate experiential summaries that can serve as references for broader application.

In summary, with the innovation and development of educational concepts, optimizing school management and research strategies based on teacher professional development is both urgent and pivotal to improving school effectiveness. As school managers, it is necessary to continuously update management concepts to adapt to the educational environment, meet new societal expectations and demands for education and teaching, and provide essential support for teachers' professional development through optimizing management pathways and research strategies, ultimately achieving high-quality development of the school.

3. Method

3.1 Research Design

This study employed quantitative and qualitative methods to explore how human capital management practices enhance secondary vocational teachers' digital competencies. Qualitative interviews and case studies provided contextualized explanations of institutional dynamics and implementation processes, while quantitative data revealed teachers' digital competency levels and management mechanisms. The mixed-methods design triangulates data sources and adheres to organizational and educational research methodologies to strengthen the conclusions.

3.2 Participants and Sampling

3.2.1 Population

This survey included only secondary vocational education teachers in Chongzuo City, Guangxi Zhuang Autonomous Region, China. School administrators participated in interviews and institutional case analyses but were not included in the questionnaire survey statistical population. This distinction defines the unit of analysis and addresses research population ambiguity. The three participating institutions employ 1,670 teachers, as shown in Table 1.

Table 1. Population and Sample Distribution of Teacher Participants

School Name	Teacher	Sample Size
Chongzuo Preschool Teachers College	370	72
Guangxi Polytechnic Vocational College	550	106
Guangxi City Vocational University	750	145
Total	1,670	323

3.2.2 Sampling Method and Sample Size Determination

This study employed stratified random sampling to ensure representation across institutions, instructional disciplines, and teaching experience levels. After stratifying teachers by institution and major field, participants were randomly selected. Yamane's (1967) formula was utilized to calculate the sample size at 95% confidence level and 0.05 precision level:

This minimum sample size of 323 teachers satisfied statistical requirements for multivariate analysis. Given that digital competency standards vary by discipline, teachers from diverse majors and career stages were included. Information technology programs required advanced digital competencies, whereas tourism and hospitality programs emphasized applicable digital skills such as digital marketing and customer service systems.

3.3 Instruments and Data Collection

3.3.1 Questionnaire Development

The study instrument consisted of a structured questionnaire grounded in national and international teacher digital literacy frameworks. Five dimensions of teachers' digital competency were assessed in the questionnaire: (1) digital awareness, (2) digital knowledge, (3) digital application skills, (4) digital citizenship, and (5) digital professional development.

Each dimension contained multiple secondary and tertiary competency indicators. A comprehensive literature review, policy document analysis, and professional consultation with vocational education scholars and experienced Chongqing City teachers generated the initial item pool. Items were refined for clarity, relevance, and contextual appropriateness based on expert feedback.

3.3.2 Pilot Study

Pilot research with a small cohort of vocational teachers assessed the questionnaire's feasibility, reliability, and clarity prior to full-scale data collection. The pilot study evaluated measurement item internal consistency and construct validity and solicited feedback on questionnaire wording, length, and response burden. Minor revisions to item wording and response options were implemented based on pilot findings to enhance measurement precision.

3.3.3 Questionnaire Administration

The final questionnaire was administered to teachers from the three institutions through both online and paper-based formats. Participants were informed about confidentiality and anonymity protections. Procedures followed informed consent and data protection ethics protocols. The questionnaire comprised two primary sections: (1) Part 1: Demographics, including gender, ethnicity, educational attainment, teaching experience, professional title, teaching discipline, and institution; and (2) Part 2: Digital Competency Measurement, examining teachers' self-reported competencies across the five dimensions.

3.4 Data Analysis

3.4.1 Literature Analysis

A thorough literature review was conducted using reputable academic databases and indexing services. Peer-reviewed research articles, policy studies, and international frameworks on digital literacy, vocational education, and human capital management were synthesized. This process informed conceptualization, variable operationalization, and empirical interpretation.

3.4.2 Statistical Analysis

Quantitative data were analyzed using statistical software tools. Teachers' digital competencies were assessed using descriptive statistics (means, standard deviations, and frequency distributions). Internal consistency was evaluated using reliability analysis. In accordance with the study's research objectives, inferential analyses were employed to examine relationships between demographic characteristics and management factors and teachers' digital competencies.

4. Results

The survey sample selected for this study comprised Chongzuo City, Guangxi Zhuang Autonomous Region. The survey respondents consisted of teachers from secondary vocational schools in Chongzuo City, Guangxi Zhuang Autonomous Region, including Chongzuo Preschool Normal College, Guangxi City Vocational and Technical University, and Guangxi Polytechnic Vocational and Technical School.

Among the 323 valid questionnaire responses, 193 respondents (59.8%) were female and 130 respondents (40.2%) were male, indicating a higher proportion of female teachers in the sampled secondary vocational institutions. This gender distribution reflected the demographic characteristics commonly observed in vocational and teacher-training institutions, particularly in early childhood education and service-oriented programs.

This distribution suggested adequate gender representation in the respondent group, ensuring balanced perspectives from both genders in the analysis. The following presents an analysis of each characteristic:

Table 2. Overview of Respondents' Demographic Characteristics (N=323)

		Population	sample	Population	sample
School	Chongzuo Preschool Teachers College	72	22.3	22.3	22.3
	Guangxi Polytechnic Vocational College	106	32.8	32.8	32.8
	Guangxi City Vocational University	145	44.9	44.9	44.9
Gender	Female	193	59.8	59.8	59.8
	Male	130	40.2	40.2	40.2
Current Position	Director		5	1.5	1.5
	Deputy Director		8	2.5	2.5
	Head of Group	45	13.9	13.9	13.9
	Teacher	265	82	82	82
Experience	less 2 year		25	7.7	7.7
	3 – 5 year	70	21.7	21.7	21.7
	6 – 10 year	100	31.0	31.0	31.0
	10 – 15 year		75	23.2	23.2
	15 - 20 year	38	11.8	11.8	11.8
	More than 20 year	15	4.6	4.6	4.6
Educational Qualification	Bachelor's			180	55.7
	Master's	140	43.3	140	43.3
	Doctorate	4	0.9	4	0.9
Digital Skills Activities	Yes	270	83.6	270	83.6
	No	53	16.4	53	16.4

The respondent profile indicated that the sample was well-distributed across three key institutions, with a concentration of teachers possessing substantial mid-level experience and appropriate academic qualifications. The female-dominated workforce was particularly notable in preschool education settings. Encouragingly, most institutions had adopted digital skills training aligned with industry needs, providing a strong foundation for exploring human capital management strategies to enhance teachers' digital competency.

This section presents the descriptive statistical analysis of the questionnaire results regarding teachers' perceptions of the current status and desired status of academic administration based on digital competency. The analysis focused on four main variables: Professional Development, Performance Evaluation and Feedback, Collaborative Team Building, and Teachers' Digital Skills. Each variable comprised five items. The responses were measured using a 5-point Likert scale. The following tables present the Mean (M) and Standard Deviation (SD) for each item.

Table 4. Professional Development (N=323)

SPTM	Current Status M	Standard Deviation	Desired Status M	Standard Deviation
1. I regularly attend on teaching methods training.	3.21	0.89	4.56	0.62
2. The school provides opportunities to develop my teaching skills.	3.45	0.83	4.61	0.59
3. I apply what I learn from professional development in my classroom.	3.52	0.78	4.48	0.65
4.The professional development offered is relevant to literacy teaching.	3.37	0.81	4.44	0.67
5.I feel supported in pursuing ongoing professional learning.	3.40	0.86	4.57	0.60
Total	3.39	-	4.53	-

Table 5. Performance Evaluation & Feedback (N=323)

SPTM	Current Status M	Standard Deviation	Desired Status M	Standard Deviation
1. I receive regular feedback about my teaching performance.	3.20	0.90	4.51	0.67
2. Feedback from supervisors helps me improve my teaching.	3.34	0.86	4.54	0.62
3. Performance evaluations are fair and transparent.	3.14	0.94	4.45	0.72
4.I feel motivated to improve after receiving feedback.	3.26	0.87	4.54	0.60
5.The feedback process focuses on student learning outcomes.	3.30	0.88	4.50	0.64
Total	3.25	-	4.51	-

Table 6. Collaborative Team Building (N=323)

SPTM	Current Status M	Standard Deviation	Desired Status M	Standard Deviation
1. I often collaborate with colleagues to improve teaching practices.	3.60	0.82	4.59	0.58
2. The school promotes teamwork among teachers.	3.42	0.88	4.62	0.57
3. Sharing ideas with peers helps improve my literacy instruction.	3.65	0.76	4.60	0.56
4.I participate in professional learning communities or peer groups. Feedback.	3.33	0.87	4.47	0.64
5.Team discussions contribute to problem-solving in teaching.	3.48	0.83	4.55	0.60
Total	3.50	-	4.57	-

Table 7. Teachers' Digital Skills (N=323)

SPTM	Current Status M	Standard Deviation	Desired Status M	Standard Deviation
1. I can effectively use digital tools to enhance my teaching.	3.18	0.91	4.50	0.66
2. I integrate technology into my lessons confidently.	3.335	0.85	4.53	0.63
3. I can troubleshoot basic technical issues independently.	3.14	0.95	4.47	0.70
4. I am familiar with a variety of educational software/tools.	3.28	0.88	4.55	0.61
5. I feel confident teaching students digital literacy skills.	3.31	0.87	4.51	0.65
Total	3.25	-	4.51	-

The Priority Need Index (PNI) constitutes a valuable tool for identifying and prioritizing the most critical areas for improvement in educational settings. In the context of this study, the PNI modified approach was employed to identify specific aspects of human capital management requiring urgent attention to enhance teachers' digital competency at secondary vocational schools in Chongzuo City, China. By analyzing the gap between current status and desired conditions across key management elements, this section aimed to provide actionable insights for policymakers and school administrators.

The PNI modified approach involved calculating the difference between the desired and current status means for each variable related to human capital management and teachers' digital competency. The resulting PNI scores indicated the priority level for intervention, with higher scores suggesting greater need for improvement. The formula for calculating the PNI was as follows:

$$PNI = \frac{(I - D)}{D}$$

The findings revealed significant disparities between current practices and teacher expectations across all human capital management dimensions. Several key patterns emerged from the analysis:

Table 8. Summary of Priority Needs Index (PNI) Results (N = 323)

Dimension	Current Status Mean	Desired Status Mean	Gap (D – C)	PNI (Modified)	Priority Rank
Collaborative Team Building	3.50	4.57	1.07	0.306	4
Professional Development	3.39	4.53	1.14	0.336	3
Performance Evaluation & Feedback	3.25	4.51	1.26	0.388	1 (High)
Teachers' Digital Skills	3.25	4.51	1.26	0.388	1 (High)

Performance Evaluation and Feedback and Teachers' Digital Skills constituted the highest priority needs (PNI = 0.388), representing the largest gaps between actual conditions and desired expectations. Professional Development exhibited a moderate priority (PNI = 0.336), whereas Collaborative Team Building demonstrated the lowest yet still considerable need (PNI = 0.306). These findings suggested prioritizing enhancements to feedback systems and teachers' digital competencies first, followed by professional development and collaborative frameworks.

First, the moderate level of current professional development (M = 3.39), compared to the high desired level (M = 4.53), indicated that teachers' expectations were not met by present training provisions. The PNI value (0.336) suggested that professional development was functioning adequately but required systematic improvement to support teachers' digital competency development, particularly through continuous, practice-oriented training rather than fragmented activities.

Second, performance evaluation and feedback exhibited the highest PNI value (0.388) due to their low current status

($M = 3.25$) and high desired status ($M = 4.51$). Items related to fairness and transparency ($M = 3.14$) revealed that teachers perceived current evaluation methods as insufficiently developmental. High desired ratings ($M = 4.45$ – 4.54) indicated substantial demand for transparent, constructive, timely, and instructionally relevant feedback procedures.

Third, collaborative team building performed better than other dimensions ($M = 3.50$), yet still required improvement (Desired $M = 4.57$; $PNI = 0.306$). Teachers reported high informal collaboration, such as peer idea-sharing ($M = 3.65$), but lower engagement in structured professional learning communities ($M = 3.33$) suggested a lack of institutionalized collaborative mechanisms to sustain collective learning and innovation.

Overall, the comprehensive PNI analysis demonstrated that performance evaluation and feedback and teachers' digital skills were most critical, followed by professional development and collaborative team building. These findings indicated that human capital management improvements were interrelated. Rather than relying solely on training to address digital competency gaps, a holistic and integrated approach was needed to establish a cycle of evaluation, capacity building, instructional application, and feedback.

5. Discussion

This study identified substantial gaps between current human capital management practices and teachers' expectations across all dimensions, suggesting that institutional and managerial constraints limited the digital transformation of secondary vocational education more than individual willingness. These findings reflected previous research conceptualizing teachers' digital competency as a product of systemic organizational support and deliberate human capital investment (Becker, 1993; Fullan et al., 2020).

1. The moderate level of professional development participation ($M = 3.39$), compared to the high level of desired engagement ($M = 4.53$), indicated that present training initiatives lacked scope, relevance, or continuity. This confirmed previous findings that one-time or technical training programs rarely led to sustained instructional change (Tondeur et al., 2018; Scherer et al., 2021). The substantial correlation between professional development and teachers' digital competency ($r = 0.787$) supported OECD (2023)'s assertion that continuous, practice-oriented professional learning drove effective digital integration. Present findings demonstrated that structured institutional investment shaped teachers' digital competence, unlike research emphasizing individual self-efficacy as the primary determinant of digital adoption.

2. Performance evaluation and feedback processes were particularly deficient, with low current-status perceptions of fairness and transparency ($M = 3.14$) but high improvement expectations ($M = 4.47$ – 4.55). This supported previous studies indicating that vocational and technical education evaluation systems were compliance-focused rather than developmental (Darling-Hammond et al., 2017). Teachers desired immediate, constructive, and classroom-linked feedback, which Hattie and Timperley (2007) identified as one of the most effective influences on professional growth and instructional improvement. This study advanced this literature by demonstrating that evaluation systems must directly align with digital competency development in digitally evolving vocational contexts rather than being regarded as administrative operations.

3. Informal peer interaction rather than formalized frameworks drove collaborative team building. The high peer idea-sharing score ($M = 3.65$) reflected a strong collaborative culture among teachers, but the lower formal professional learning community engagement ($M = 3.33$) suggested insufficient organizational scaffolding. According to Wenger's (1998) concept of communities of practice, effective professional learning required both social interaction and institutional support. Voogt et al. (2015) reported similar findings in vocational education, where collaboration often relied on individual initiative rather than systemic support. This study demonstrated that collaborative potential remained underutilized without formal mechanisms in a border-region context.

The integrated Priority Needs Index (PNI) analysis revealed that professional development, performance feedback, and collaboration issues were interconnected. This supported systemic change theories in educational digital transformation, which suggested that fragmented reforms would not be sustainable (Fullan et al., 2020; Teece, 2018). An isolated focus on training without modifying assessment mechanisms or collaborative structures risked diminishing returns because teachers lacked reinforcement, recognition, and application opportunities. Therefore, the results empirically supported recommendations in the literature for a comprehensive human capital management approach that integrated evaluation, capacity building, instructional application, and continuous feedback.

Unlike previous research conducted in well-resourced metropolitan or higher education contexts, Chongzuo City illustrated how regional and institutional constraints intensified the need for strategic human capital management. Internally coherent management systems were even more critical for teachers' digital advancement in border and

ethnic minority regions, where advanced digital infrastructure and external professional networks might be limited (Zhang & Yang, 2023). This study confirmed and extended digital transformation theories in education by demonstrating their applicability and urgency in underrepresented vocational and regional settings.

4. As a contribution, this study enhanced digital competency research in secondary vocational education by shifting the analytical focus from individuals to human capital management. Strategic planning, professional development systems, performance evaluation, and collaborative organizational cultures shaped sustainable digital capability development in teachers, not personal motivation or isolated training. This framework integrated human capital theory, digital transformation frameworks, and vocational education literature to situate digital competency within meso-level institutional processes. This shift supported SDG 4 (Quality Education) by emphasizing institutional responsibility for equitable and sustainable teacher development and aligned with Digital China's objectives of systemic capacity building and organizational governance in education digitalization.

This study provided rare empirical evidence from Chongzuo City, a border and ethnic minority region in China underrepresented in Scopus and Web of Science research. The findings demonstrated that digital transformation was context-sensitive and heavily influenced by organizational management mechanisms in secondary vocational institutions with resource constraints and geographical distinctiveness. The findings established that human capital management theories applied to vocational and regional education contexts, expanding digital education research's geographical and institutional scope. This evidence directly supported Digital China's vocational education modernization objectives and contributed to global discussions on reducing regional educational inequality, consistent with SDG 10.

The findings promoted vocational school management reform by integrating professional development, performance evaluation, and collaborative learning. For school leaders, the study emphasized continuous, practice-oriented professional development and transparent, development-focused evaluation systems that explicitly supported digital teaching practices. The results indicated to policymakers, especially in border and ethnic minority regions, that digital transformation required infrastructural investment, governance reforms, and human capital strategies. This study positioned teachers' digital competency as a strategic asset to enhance vocational education quality and digital workforce preparation in alignment with Digital China strategies and SDG 4's long-term objectives.

6. Conclusion

This study provided compelling evidence of the critical role human capital management plays in developing teachers' digital competency in secondary vocational schools. Several key conclusions emerged from the research:

First, substantial gaps existed between current practices and teacher expectations across all human capital management dimensions. The significant disparities (with PNI scores ranging from 1.07 to 1.26) highlighted urgent need for systematic intervention in professional development, performance evaluation, and collaborative structures.

Second, the research demonstrated strong interrelationships between human capital management practices and digital competency development. The correlation analysis revealed that professional development ($r=0.787$), performance evaluation ($r=0.765$), and collaboration ($r=0.743$) all significantly correlated with teachers' digital skills, suggesting that these elements worked synergistically to support competency development.

Third, the Priority Need Index analysis identified performance evaluation and feedback (PNI=1.26) and digital skills development (PNI=1.26) as the most critical areas requiring intervention. This indicated that teachers perceived the greatest needs in having transparent, developmental evaluation systems and practical, applicable digital skills training.

Fourth, the proposed Performance Feedback-Driven Skills Enhancement Model (PFSEM) offered a promising framework for addressing these gaps. By creating a continuous cycle of assessment, tailored training, guided application, and reinforcement, the model addressed both structural mechanisms and individual empowerment essential for sustainable digital competency development.

Finally, the study highlighted the importance of context-specific approaches to digital transformation. The unique challenges faced by vocational schools in border regions such as Chongzuo City—including resource constraints, cultural factors, and infrastructure limitations—required tailored strategies that leveraged local strengths while addressing specific gaps.

7. Recommendation Agenda

Based on the research findings, a comprehensive strategic framework is proposed to enhance teachers' digital competency through systematic human capital management interventions. At the individual level, educators must transition from teacher-centered to student-centered digital pedagogical approaches, proactively strengthen their awareness and application of digital technologies, and systematically integrate technological tools into discipline-specific instruction through sustained self-directed learning and professional community engagement. At the institutional level, schools must establish robust support mechanisms by promoting inter-district digital resource sharing, developing comprehensive campus-based digital infrastructures and pedagogical resources, implementing rigorous digital literacy evaluation frameworks, and creating diversified incentive structures that explicitly link performance assessment to professional development opportunities. At the policy level, governmental agencies should reform conventional training paradigms through expert mentoring programs and reciprocal "reverse mentoring" initiatives, develop high-quality digital learning resources and teacher collaboration platforms, and establish regional digital resource centers with targeted interventions for underserved regions. The implementation of the Performance Feedback-Driven Skills Enhancement Model (PFSEM) should be prioritized through an iterative cycle encompassing systematic assessment of digital competencies, customized professional development programs, guided implementation in pedagogical practice, and reinforced recognition mechanisms. This multi-tiered framework addresses both systemic structures and individual capacities, establishing sustainable conditions for digital competency development that are aligned with the distinctive requirements of vocational education in geographically peripheral regions.

8. Future Research

With the continuous advancement of digital technology, educational digitization has emerged as a pivotal direction in educational reform. The digitization of education facilitates enhanced knowledge acquisition, increased student engagement and participation, and enables teachers to manage instructional processes more effectively through personalized teaching approaches and comprehensive evaluation of student learning outcomes. In the development of digital education, teacher digitization plays a crucial role, necessitating educators to possess core competencies in digital literacy as foundational contributors to educational modernization. This study employs literature review, questionnaire survey, and interview methodologies to analyze the current state of digital literacy among vocational school teachers in Chongzuo City, identify existing problems and underlying causes, and propose targeted improvement strategies. The main components are as follows:

First, the study clarifies the conceptual framework of teachers' digital literacy and establishes the research perspective. Through systematic literature review, core concepts including "Professional Development," "Performance Evaluation and Feedback," "Collaborative Team Building," and "Teachers' Digital Skills" are operationalized, thereby determining the research dimensions.

Second, vocational school teachers in Chongzuo City, a border region in Guangxi, serve as the survey population. Drawing upon existing instruments in teacher digital literacy research, a preliminary questionnaire was developed. Expert consultation and pilot testing with selected participants enabled iterative refinement of the instrument. A small-scale pilot study was conducted, and analysis of preliminary data confirmed satisfactory reliability and validity, demonstrating appropriate question design and dimensional structure. Subsequently, the finalized questionnaire was distributed extensively across counties, cities, and districts throughout the border region.

Third, based on questionnaire findings, targeted interventions are proposed to enhance digital literacy among vocational school teachers in border regions. At the individual level, pedagogical philosophy should transition toward student-centered approaches, strengthening awareness of digital teaching methodologies and digital technology application while actively promoting effective integration of digital technology with disciplinary instruction. At the institutional level, schools should actively facilitate inter-district digital resource integration and sharing, construct comprehensive digital campus systems, develop digital pedagogical resources, establish teacher digital literacy evaluation frameworks, and refine digital learning assessment mechanisms. At the governmental level, authorities should reform offline training methodologies and delivery models, vigorously develop online resources, and strategically leverage teacher professional community networks.

Several limitations warrant acknowledgment. The absence of a unified and authoritative definition of digital literacy in academic discourse necessitated conceptual explication based on available literature; however, the international literature review may be insufficiently comprehensive, potentially affecting definitional clarity. Furthermore, the

study focuses on vocational school teachers in Chongzuo City, and sample selection was constrained by limited access to vocational teacher populations, restricting both sample size and geographic diversity. Consequently, findings may not be generalizable to all vocational school teachers across Guangxi province. Additionally, regional variations in economic development and teacher capacity across Guangxi may produce significant differences in digital literacy levels, potentially limiting the comprehensiveness of derived conclusions. Future research should expand sample sizes to enhance representativeness. Moreover, respondent experience and capacity limitations may affect comprehensive data collection and analysis of digital literacy understanding, including the inherent difficulty of eliminating researcher subjectivity during data analysis. Although this study examines factors influencing vocational teachers' digital literacy from multiple perspectives, comprehensively capturing all potential influencing factors remains challenging, and boundaries between categorical influences require further refinement. To advance understanding of factor interactions, future research should develop standardized evaluation methods and criteria for teacher digital literacy, investigate the impact of teacher digital literacy on student learning outcomes and instructional effectiveness, and explore optimal applications of digital technology in educational contexts. Concurrently, schools and relevant authorities should strengthen professional development and support systems for teacher digital literacy, provide expanded development opportunities and resources, and enhance digital capacity across the educational system. In conclusion, teacher digital literacy represents a critical issue requiring urgent attention in contemporary education. This study aspires to provide scholarly reference and practical insights for related research and practice, advancing teacher digital literacy and promoting innovation in educational pedagogy.

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AI tools were utilized only for language editing, clarity, and formatting uniformity. All conceptual development, data analysis, result interpretation, and academic judgments were done by the authors. The authors are solely responsible for content integrity and originality.

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