

Improving Digital Literacy of Rural Primary School Teachers: A Case Study in Northern Guangdong, China

Jiao Zeng

South China Business College of Guangdong University of Foreign Studies, Guangzhou, 510545, China

Abstract: This study investigates the digital literacy of rural primary school teachers in northern Guangdong, China, where rapid educational digitization coexists with persistent urban-rural disparities. Through a questionnaire-based research approach (N=192 valid responses) and institutional analysis, we identify three critical bottlenecks: (1) a cognitive-practical dissonance (awareness mean=3.73 vs. application mean=3.25), (2) adaptive barriers in technology integration (only 28.6% problem-solving success rate), and (3) motivational-innovative disconnection (84.1% value lifelong learning but 10.8% demonstrate innovative teaching). Multidimensional assessment reveals a hierarchical competence pattern: digital ethics (M=4.62) > technical knowledge (M=4.05) > application skills (M=3.80). The findings highlight systemic constraints including aged teacher demographics, resource scarcity, and homogeneous training models.

Keywords: Rural Teachers' Digital Literacy, Urban-Rural Digital Divide, Teacher Professional Development, Chinese Educational Inequality.

1. Introduction

The rapid integration of digital technologies into education has profoundly transformed global pedagogical practices, making teachers' digital literacy competencies increasingly critical. [1] However, rural educators often face systemic challenges in adapting to this transformation, including inadequate infrastructure, limited training opportunities, and socioeconomic disparities. [2] In China, despite national initiatives such as the *Strengthening Teacher Development in Basic Education for the New Era Plan* (2022), which proposed establishing a "Teacher Digital Literacy Development Index" monitoring system, [3] and the Ministry of Education's 2023 Key Tasks, which emphasized implementing the "National Primary and Secondary School Teachers' ICT Application Capacity Enhancement Project 3.0," [4] regional inequalities persist—particularly in underdeveloped areas like northern Guangdong Province. This study investigates the current state of digital literacy among rural primary school teachers in this region, explores its influencing factors, and proposes targeted improvement strategies.

Existing research indicates that rural teachers' digital competencies are shaped by both individual factors (e.g., age, self-efficacy) and institutional conditions (e.g., resource availability, professional development opportunities). [5] However, few studies have focused on the unique socioeconomic and cultural context of rural Guangdong, where rapid urbanization coexists with persistent educational disparities. Through a survey of primary school teachers in X County, northern Guangdong, this study addresses two key research questions: (1) What is the current level of digital literacy among rural primary school teachers in northern Guangdong? (2) How do institutional, individual, and community-level factors interact to shape these competencies?

The findings contribute empirically to the discourse on educational equity by providing data from an under-researched region. Practically, the recommendations may inform policymakers and school administrators in designing precision interventions—such as localized training programs or

infrastructure upgrades—to bridge the urban-rural digital divide. This aligns with the United Nations Sustainable Development Goal 4 (SDG 4), which advocates for inclusive and quality education through technological empowerment. [6]

2. Research Design

2.1. Research Methods

This study primarily employed a questionnaire-based method to collect data. The design of the questionnaire options was based on the *Teacher Digital Literacy Industry Standard* (2022). [4] There are five primary dimensions of the standard: Digital Awareness, Digital Technology Knowledge and Skills, Digital Application, Digital Social Responsibility and Professional Development. Most items utilized a five-point Likert scale, with response options ranging from *Completely Disagree* (1 point) to *Mostly Disagree* (2 point), *Neutral* (3 point), *Mostly Agree* (4 point), and *Completely Agree* (5 point). Higher scores indicated greater teacher agreement with the statements, thereby measuring their performance across various dimensions.

After a small-scale preliminary test, the questionnaire was revised and converted into an electronic format using the *Wenjuanxing* (a popular online survey tool in China) platform. It was then distributed to primary school teachers in rural areas of X County via online platforms such as WeChat and QQ, with 200 questionnaires issued. Upon retrieval, the responses were organized, screened, and analyzed, resulting in 192 valid questionnaires after excluding 8 invalid ones—a validity rate of 96%.

Subsequent data analysis was conducted using SPSS software. The results showed that: Cronbach's $\alpha=0.917$, The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.926, and Bartlett's test of sphericity yielded an approximate chi-square value of 2057.371 with 407 degrees of freedom, reaching a significance level below 0.05. These results confirm that the questionnaire data exhibit good validity.

2.2. Basic Information of the Survey Subjects

This study selected primary school teachers in rural towns within X County as the research subjects and randomly distributed questionnaires to obtain first-hand research data. Located in the north-central part of Guangdong Province, X County covers a total area of 1,967.45 square kilometers, with a registered population of 265,500. It currently administers 6 towns, 1 subdistrict, 141 administrative villages, and 18 residential community committees (data from the 2025 government website).

2.3. Statistical Analysis of Sample Characteristics

The analysis of the questionnaire data revealed the following demographic characteristics of the study sample. In terms of gender distribution, female teachers accounted for 64% of respondents while male teachers comprised 36%. The age structure showed that 17% of teachers were aged 20-29, 16% were 30-39 years old, and 19% fell into the 40-49 age group. Notably, teachers aged 50 and above represented 48% of respondents, nearly half of the total sample, indicating a pronounced aging trend among rural primary school teachers in this region. Regarding educational qualifications, 81% of teachers held a bachelor's degree while 19% had an associate degree, demonstrating that undergraduate education has become the predominant academic qualification. The distribution across teaching grades was relatively balanced, with 35% teaching grades 5-6, 31% teaching grades 3-4, and 34% teaching grades 1-2, suggesting stable student enrollment in recent years. For subject distribution, Chinese language teachers constituted 36% of the sample, mathematics teachers accounted for 34%, English teachers represented 10%, and teachers of other subjects (including music, physical education, and art) made up the remaining 20%.

3. A Multidimensional Analysis of Digital Literacy Levels Among Rural Primary School Teachers

This study investigated the current status of digital literacy among rural primary school teachers across five core dimensions, each demonstrating distinct developmental characteristics. In the digital awareness dimension ($M=3.73$, $SD=0.841$), which comprised three measurement items, "understanding the importance of digital technologies" ($M=4.01$) and "willingness to use digital technologies" ($M=3.94$) scored relatively high, indicating strong value recognition and acceptance of digital technologies among teachers. However, "addressing challenges in digital practice" ($M=3.25$) scored significantly lower than other items, revealing notable deficiencies in teachers' ability to overcome practical technological barriers. The relatively large standard deviation (0.841) further confirmed significant individual differences in digital awareness among teachers.

The digital technology knowledge and skills dimension ($M=4.05$, $SD=0.678$) maintained high scores across both measured items. "Understanding technical concepts" ($M=3.95$) and "selecting appropriate technological resources" ($M=4.14$) demonstrated teachers' fundamental operational competence with digital technologies. The comparatively small standard deviation suggested relatively balanced performance in this dimension. Notably, the "selecting

appropriate technological resources" score exceeded 4 points, indicating that most teachers could effectively choose suitable technological tools based on instructional needs.

The digital application dimension ($M=3.80$, $SD=0.689$) exhibited notable internal disparities. While "resource management capability" ($M=4.18$) demonstrated outstanding performance, "application of digital assessment tools" ($M=3.55$) remained relatively weak, with a significant score gap of 0.63 points. This divergence suggests that teachers demonstrate proficiency in basic technical operations (e.g., PowerPoint creation) but require substantial improvement in areas demanding higher-level technological integration, particularly evaluation and analysis.

The digital social responsibility dimension ($M=4.62$, $SD=0.510$) emerged as the strongest performing dimension, with near-perfect scores in "online behavior norms" ($M=4.60$) and "privacy protection awareness" ($M=4.64$). However, "continuous learning" ($M=3.58$) scored markedly lower, creating a striking contrast. The small standard deviation (0.510) indicates highly consistent understanding of digital ethics among the teacher cohort.

In the professional development dimension ($M=3.71$, $SD=0.741$), "professional community participation" ($M=3.8$) outperformed "teaching model innovation" ($M=3.69$), revealing teachers' preference for collective collaboration over individual exploration in professional growth. The moderate dispersion trend ($SD=0.741$) reflects certain variations in teachers' approaches to professional development.

In summary, the overall digital literacy level of rural primary school teachers ($M=3.98$) falls within the upper-medium range, yet demonstrates uneven development across dimensions. The findings reveal a hierarchical pattern of "ethical awareness > technical knowledge > application competence", with the capacity for deep integration of digital technologies into teaching (particularly in evaluation analysis and innovative practice) emerging as a distinct weakness. These results provide empirical evidence to inform targeted intervention strategies.

4. Constrained Development of Digital Literacy Among Rural Primary School Teachers

4.1. Cognitive-Practical Dissonance in Digital Literacy Competence

Analysis based on survey data reveals that rural primary school teachers demonstrate relatively high cognitive levels ($M=3.73$) in the digital awareness dimension of digital literacy. Specifically, approximately 68.1% of teachers recognize the importance of digital technology for educational development, while 77.9% exhibit positive attitudes toward learning and applying digital technology resources. These findings indicate that most rural primary school teachers have fully acknowledged the pivotal role of digital technology in promoting educational digital transformation and enhancing teaching quality, demonstrating strong willingness to engage in technological learning.

However, the survey data simultaneously uncovers significant disparities in teachers' digital technology application competencies. Although the majority can essentially select and utilize digital resources for instructional

purposes, only 11.1% report proficiency in applying relevant technologies. This notably low percentage reflects a pronounced disconnect between teachers' digital awareness and practical technological skills, highlighting the prevailing challenge of weak digital application competencies among rural primary school teachers.

This cognitive-practical asymmetry exerts a direct impact on instructional effectiveness. The study reveals that teachers with stronger digital application competencies tend to design diverse, highly interactive teaching activities that effectively enhance student engagement. In contrast, teachers with weaker technological proficiency remain heavily reliant on traditional teaching methods (e.g., printed materials, chalkboard instruction), resulting in limited classroom innovation. [7] Students exposed to such monotonous learning environments over extended periods are prone to develop academic burnout, which subsequently undermines their learning motivation. Furthermore, current teacher applications of digital technologies remain predominantly confined to basic operations (e.g., PowerPoint creation), while demonstrating notable deficiencies in advanced implementation areas such as home-school collaboration, learning analytics, and personalized feedback. This limitation substantially constrains the potential of digital technologies to truly transform educational practices.

In conclusion, rural primary school teachers' digital literacy exhibits a characteristic "high awareness, low implementation" pattern. Bridging this cognition-practice gap thus emerges as the critical challenge in enhancing their digital competence.

4.2. Adaptive Challenges in Digital Teaching Practices

Empirical data analysis reveals significant adaptive challenges among rural primary school teachers in addressing digital education practices. Specifically, only 41.7% of teachers proactively seek solutions to digital teaching problems, with an even lower success rate (28.6%) in actual problem resolution. These findings indicate that nearly 60% of teachers exhibit pronounced efficacy deficits when confronting technological implementation difficulties, highlighting structural deficiencies in their adaptive capacity for digital practices.

In-depth analysis reveals that teachers' adaptive challenges primarily manifest as a passive-dependent problem-solving mode. When encountering technical difficulties, most teachers tend to immediately seek external assistance (e.g., from colleagues or IT staff) rather than engaging in self-directed solution exploration. This reliance on external support results in insufficient individual engagement in the problem-solving process, thereby hindering substantive development of teachers' digital troubleshooting competencies.

From a social cognitive theory perspective, this passive coping mechanism creates a vicious cycle: repeated experiences of technological frustration coupled with inadequate guidance progressively erodes teachers' self-efficacy. Over time, this dynamic may foster digital anxiety and resistance, ultimately diminishing their motivation to participate in educational digital transformation initiatives.

More critically, these adaptive challenges are exerting profound impacts on educational digitalization. Teachers' lack of confidence in technology application not only slows the digital transformation of classroom instruction but may also

negatively influence students' technology acceptance through modeling effects, ultimately constraining the overall effectiveness of regional educational informatization initiatives. [8] Consequently, overcoming teachers' adaptive barriers to digital practice has emerged as a pivotal challenge requiring urgent resolution in advancing rural education digital transformation.

4.3. The Transformation Dilemma of Learning Motivation into Innovative Efficacy

Empirical evidence indicates a pronounced motivation-innovation translation dilemma in rural primary school teachers' digital professional development. The survey data reveal that while 84.1% of teachers recognize the imperative of lifelong learning, merely 38.1% have established systematic digital technology learning plans, demonstrating a marked "sustained learning deficit." This fragmented and intermittent learning pattern substantially impedes teachers' capacity to keep pace with rapidly evolving digital technologies.

More critically, structural deficiencies in innovative implementation capabilities are evident. Only 10.8% of teachers demonstrate proficiency in innovative instructional practices, whereas 63.1% remain confined to basic application levels. This "efficacy attrition" phenomenon manifests through three distinct dimensions: (1) Instrumentalization of technological applications. (2) Absence of cross-disciplinary pedagogical innovation. (3) Persistent challenges in transforming traditional teaching paradigms.

From a capacity development perspective, learning motivation and innovative efficacy should theoretically form a virtuous cycle. However, rural teachers exhibit a "dual-diminishment" dilemma: insufficient learning continuity constrains innovative knowledge accumulation, while inadequate innovation experience undermines learning specificity. This vicious cycle is further exacerbated by deficient external support systems, creating multidimensional impacts. At the micro level, it impedes individual professional growth; at the macro level, it triggers a "teacher innovation deficiency → classroom transformation lag → student digital literacy deficit" transmission mechanism that ultimately hinders regional educational digitalization. Addressing this complex challenge requires establishing an ecosystem for sustainable digital literacy development.

5. Enhancement Pathways for Digital Literacy among Rural Primary School Teachers

5.1. Establishing a Differentiated Digital Literacy Training Framework

Building upon previous findings that reveal significant deficiencies in rural primary school teachers' digital technology application competencies and problem-solving capacities, this study advocates for establishing a differentiated digital literacy training system. Current training models demonstrate pronounced homogeneity, characterized by content that lacks specificity and fails to address the diverse developmental needs across teacher proficiency levels. Specifically, novice teachers encounter fundamental knowledge acquisition barriers, while proficient educators face inadequate training depth—a dual challenge that underscores the urgency of implementing tiered professional

development interventions.[9]

This study proposes a stratified and targeted training approach to address these challenges. First, diagnostic assessment using standardized evaluation tools should be conducted to establish individualized digital competency profiles for teachers. Second, a three-tiered training framework should be implemented based on assessment results: (1) foundational digital literacy training focusing on basic operational skills for novice teachers, (2) intermediate programs emphasizing technology integration in subject-specific pedagogy, and (3) advanced modules cultivating innovative digital teaching capabilities. Notably, since current training systems disproportionately emphasize theory over practice, the new framework should significantly increase hands-on, practice-oriented components to ensure practical competency development.

To ensure training effectiveness, a dynamic management mechanism should be established, incorporating three key components: (1) a formative evaluation system to monitor teacher progress in real-time, (2) flexible content adjustment protocols responsive to participant mastery levels, and (3) sustained post-training support including technical consultation and professional mentoring. This integrated "assessment-training-support" professional development model enhances both the precision and efficacy of digital literacy training, directly addressing teachers' practical challenges in technology implementation.

5.2. Establishing Professional Learning Communities and Incentive Mechanisms

Building upon the identified deficiencies in rural teachers' sustained learning capacity and digital pedagogical innovation, this study proposes a dual-driven professional development support system. This integrated approach combines the establishment of professional learning communities with the optimization of incentive mechanisms to address these challenges comprehensively.

From a resource perspective, rural areas face relative scarcity in educational digital resources, with teachers having limited access to high-quality digital materials—an objective constraint that directly impedes digital literacy development and significantly contributes to the urban-rural digital competence gap. Empirical data reveal that while rural teachers participate in various teaching-research activities, few such initiatives facilitate differentiated exchanges tailored to specific subject domains, grade levels, or pedagogical needs.

The establishment of professional learning communities (PLCs) can effectively address these challenges. By creating discipline-specific, grade-level, or pedagogy-focused collaborative networks, teachers gain: (1) structured platforms for professional discourse, (2) mechanisms for joint inquiry into common instructional challenges, (3) channels for sharing digital teaching resources and practical experiences, and (4) opportunities to co-develop contextually appropriate teaching models. This professional development approach demonstrates three distinctive advantages: cost-effectiveness requiring minimal additional funding, teacher autonomy in self-organized participation based on authentic needs, and sustainable long-term support through organic professional networks.

Regarding incentive mechanism development, we recommend implementing diversified motivational strategies: (1) material incentives (e.g., awards for innovative digital

teaching practices), (2) recognition incentives (e.g., honorary titles like "Digital Teaching Expert"), (3) developmental incentives (e.g., advanced training opportunities), and (4) self-motivation mechanisms (e.g., reflective teaching portfolios).

Collectively, this dual-driven "community-incentive" model effectively activates teachers' intrinsic learning motivation and innovation capacity, facilitating sustainable digital literacy enhancement. By establishing supportive organizational environments and positive reinforcement systems, it helps teachers overcome professional development barriers and achieve substantial growth in digital pedagogical competencies.

5.3. Optimizing School Digital Infrastructure and Resource Allocation

Research demonstrates that school hardware conditions significantly influence the development of digital literacy among rural primary school teachers. While basic digital equipment in rural schools generally meets conventional teaching requirements, substantial disparities persist in both the provision and utilization of advanced instructional technologies compared to urban institutions. This infrastructure inequality exacerbates the urban-rural digital competence gap. To address this situation, simultaneous improvements in both hardware and software dimensions are recommended.

Regarding hardware infrastructure development, establishing a sustainable investment mechanism with prioritized allocation to rural schools is imperative. This should include: (1) procurement of intelligent teaching equipment meeting contemporary educational requirements, (2) implementation of regular technology refresh cycles and maintenance protocols, and (3) strategic selection of user-friendly devices with low operational costs to ensure practical utility.

For software development, we recommend establishing school-based digital resource platforms with distinctive local characteristics. These platforms should incorporate four core functional modules: (1) resource management systems, (2) collaborative development spaces, (3) learning support systems, and (4) interactive communities. Platform design must emphasize usability, openness, interactivity, and sustainability.

This comprehensive environmental optimization approach not only enhances digital teaching conditions in rural schools but also provides robust support for teacher digital literacy development. We propose a phased implementation strategy: initial pilot testing followed by gradual scaling, ultimately achieving holistic improvement of digital teaching environments across rural schools.

5.4. Cultivating Teachers' Intrinsic Motivation and Self-Efficacy

Research indicates that the insufficient endogenous drive hindering digital literacy development among rural primary school teachers requires systematic cultivation mechanisms. A multi-tiered professional development system should be established, incorporating: (1) thematic workshops, (2) expert guidance, and (3) peer collaboration. The program design must balance cutting-edge knowledge with practical applicability, enabling teachers to comprehensively understand both the inevitable trends in educational digital transformation and their evolving professional demands. This

interactive, participatory learning approach not only facilitates the transfer of practical knowledge but also effectively stimulates teachers' intrinsic developmental motivation.

Furthermore, schools should cultivate supportive digital learning cultures through a tripartite strategy comprising: (1) regular awareness campaigns, (2) exemplary case demonstrations, and (3) proactive environment shaping. This approach deepens teachers' recognition of digital literacy's value while fostering organizational cultures of lifelong learning. Concurrently, teachers should be guided to establish a professional growth cycle of "practice-reflection-evaluation-improvement", employing SMART principles to set personalized development goals and utilizing formative assessments to continuously optimize progression pathways. This integrated cultivation model combines external support with internal drive, following an intervention logic of "cognitive awakening → affective motivation → behavioral reinforcement." It systematically enhances teachers' self-efficacy, ultimately achieving sustainable digital literacy development.

6. Conclusion

This study systematically examines the digital literacy status of rural primary school teachers, revealing structural contradictions across cognitive-practical and adaptive-innovative dimensions. The findings demonstrate that teacher digital literacy development is influenced by multifaceted factors including individual competence, organizational environment, and social support, exhibiting characteristic "high awareness-low implementation" and "strong willingness-weak innovation" patterns. To address these issues, we propose an integrated enhancement framework incorporating: (1) differentiated training systems, (2) professional learning communities, (3) digital environment optimization, and (4) intrinsic motivation cultivation. These strategies emphasize both infrastructural improvements and teacher agency activation, fostering sustainable digital literacy development through synergistic external-internal interactions. Future research should explore new paradigms for teacher professional development in digital transformation contexts, providing deeper theoretical and practical insights for bridging urban-rural educational divides. Ultimately, educational digital transformation represents not merely technological adoption but profound pedagogical restructuring, requiring coordinated efforts among governments, schools, teachers, and society to realize

education modernization.

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