The Current Status and Improvement Path of Digital Teaching Competence of Normal University Students in the Eastern, Western, and Northern Regions of Guangdong

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Abstract: In the context of the rapid development of digital technology, digital transformation has become a necessary path. As the core reserve force for the future teaching workforce, the digital literacy level of teacher education students directly impacts the implementation quality of digital practices in basic education. This study investigated the current status of digital teaching competencies among 300 teacher education students in Guangdong Province through questionnaire surveys. Results indicate: (1) Overall digital literacy levels are above average; (2) Internal imbalances exist across different dimensions, with grade-level differences showing a pattern of "initial increase followed by stabilization," highlighting significant disparities in digital teaching competencies among students of different grades; (3) Issues exist across five key dimensions of digital teaching competencies: awareness of digital teaching, digital teaching design, and digital teaching implementation, digital teaching evaluation and reflection, and digital teaching ethics. Based on these findings, this study proposes cultivation strategies to align pre-service teachers' digital teaching competencies with the digital demands of basic education, which aims to contribute talent development to the national strategy for educational digitization.

Keywords: Eastern Western and Northern Guangdong Regions; Pre-Service Teachers; Digital Teaching Competencies; Current Status of Competencies; Cultivation Paths

1. Introduction

Currently, educational digital transformation has become the core direction of China's educational development, with the advancement of educational digitization and the building of an education powerhouse emerging as key national strategic priorities. In recent years, the Chinese government has placed high importance on developing teachers' digital competencies, successively issuing policy documents such as the Professional Competency Standards for Secondary Education Teacher Candidates (Trial), Professional Competency Standards for Primary Education Teacher Candidates (Trial), and Teacher Digital Literacy (JY/T 0646-2022). These explicitly incorporate digital teaching competencies as core indicators in teacher candidate training. Teacher education students represent the reserve force for the future teaching workforce and serve as a crucial link between policy requirements and teaching practice. [1]

Digital teaching competency is a new type of comprehensive ability characterized by complexity, contextuality, and developmental nature. At its core, it constitutes five fundamental dimensions: First, digital teaching awareness—the recognition of the educational value of digital technologies, the willingness to proactively apply them, and the conviction to overcome practical challenges. Second, digital instructional design, which involves selecting digital resources to create blended learning environments and integrating technology into teaching activities based on learning objectives and student characteristics. Third, digital instructional implementation encompassed the ability to organize teaching using digital tools, streamline instruction for personalized learning. Fourth, digital instructional assessment and reflection, meaning the capacity to collect academic data through digital tools, conduct an analysis of the data, and develop corresponding visualizations, and subsequently reflect on and improve teaching practices. Fifth, digital teaching ethics and responsibility encompass digital social responsibilities such as complying with digital laws and regulations, safeguarding individual and student privacy, and maintaining

a healthy online environment. This competency represents the synthesis of information literacy and data literacy, requiring teacher candidates to dialectically acquire, manage, express, and innovate with digital information while making informed decisions in teaching. Its formation and development align with the core framework of "foundational technical literacy," "technology supporting learning," and "technology supporting teaching" outlined in the Standards for Information-Based Teaching Competencies of Teacher Candidates.

However, a significant contradiction exists in practice: while China's primary and secondary schools have increasingly improved digital teaching infrastructure, such as smart classrooms and high-speed networks, teacher education students generally exhibit superficial application of digital technologies and weak foundational skills, failing to meet frontline teaching demands. More notably, current research predominantly focuses on enhancing the digital capabilities of in-service teachers, with relatively scarce specialized studies targeting teacher education students [2], making it difficult to support the optimization of teacher training systems.

Guided by policy direction and practical needs, this study preliminarily categorizes pre-service teachers' digital teaching competencies into five dimensions, laying the groundwork for subsequent framework development and questionnaire design. Current training for teacher education students' digital competencies faces challenges such as fragmented curricula, insufficient practical training, and static, outdated traditional evaluation methods. [3] Therefore, thoroughly examining the current state of their digital teaching abilities and constructing a scientific training system is crucial for addressing technological challenges and enhancing teaching quality. [4] It also offers new perspectives for research in this field, combining theoretical value with practical urgency.

2. Research Methodology

2.1 Research Subjects

This investigation employed a sample of undergraduate students majoring in teacher education. Participants were selected from universities in the eastern, western, and northern areas of Guangdong to account for regional variation. Guangdong, East, West, and North are the collective names for the three geographical areas outside the core area of the Pearl River Delta in Guangdong Province. In terms of economic and educational development, there is a significant gap between the east, west, and north regions of Guangdong and the Pearl River Delta. The reason why we chose normal students from universities in this region as the research object is mainly because this region embodies the main problems faced by my country's underdeveloped areas in the digital transformation of education, such as a shortage of resources and insufficient teachers' digital literacy, and it has a certain degree of representativeness. This study adopted online questionnaire distribution, answering, and recycling methods. After sorting and analysis, a total of 300 valid questionnaires were obtained.

The descriptive statistical results of the demographic variables are as follows: the gender distribution is 67 boys (22.33%) and 233 girls (77.67%); grade distribution is 97 freshmen (32.33%) and 54 sophomores (18%). , 105 are juniors (35%), and 44 are seniors (14.67%); the distribution of subject majors is 217 (72.33%) in liberal arts, 67 (22.33%) in science and engineering, and 16 (5.33%) in arts and sports. The statistical results are shown in Table 1:

Table 1. Descriptive Statistical Analysis of Digital Teaching Capabilities and Adaptation

Dimension	specific classification	sample size (person)	proportion
Gender	Male	67	22.33%
	Female	233	77.67%
Academic Year	Freshman	97	32.33%
	Sophomore	54	18%
	Junior	105	35%
	Senior	44	14.67%
Major	Liberal arts (education, Chinese language, etc.)	217	72.33%
	Science and engineering (mathematics, computer, etc.)	67	22.33%
	Arts and sports (sports, music, etc.)	16	5.33%

2.2 Research Instruments

This study refers to the "Questionnaire on the Current Situation and Influencing Factors of Primary School Teachers' Digital Application

Ability" compiled by Wang Yijie as a research tool. The primary results are summarized as follows: the first part collects demographic information, covering basic variables such as gender, grade, major, and digital teaching training experience; the second part is a core evaluation scale, covering five dimensions: digital teaching awareness, digital teaching design, digital teaching implementation, digital teaching evaluation and reflection, and digital teaching ethics and responsibility, using the internationally accepted five-point Likert scoring method (1=strongly disagree, 2=disagree, 3=basically agree, 4=somewhat agree, 5=strongly agree). It has been verified that the questionnaire has a reasonable structure, clear dimensions, strong correlation and internal consistency among the items of the scale, and showed good reliability in this study (Cronbach's α coefficient = 0.946).

3. Results

This study conducted an empirical study on the digital teaching ability of normal college students and related situations through a questionnaire survey. A total of 300 valid questionnaires were collected. Combined with five-point scale data statistics and dimensional analysis, the core results are as follows:

3.1 The Overall Status of the Digital Teaching Ability of Normal College Students

As shown in Table 2, the digital teaching ability of normal college students is generally at an above-average level. In the subsequent further analysis of each dimension, it was further explained that the digital teaching ability of normal students in the east, West, and North of Guangdong is relatively good.

Table 2. Descriptive Statistical Analysis of Digital Teaching Abilities of Normal College Students in Various Dimensions

Dimension	N	Min	Max	Mean
Digital teaching awareness	300	1	5	3.88
Digital teaching design	300	1	5	3.72
Digital teaching implementation	300	1	5	3.75
Digital academic evaluation and reflection	300	1	5	3.78
Digital teaching ethics and responsibility	300	1	5	3.85
Total	300	1	5	3.80

In the dimension of digital teaching awareness (Table 3), 53.34% (38.67% said they somewhat agreed and 14.67% said they strongly agreed) said they were concerned about the cutting-edge dynamics of digital development in the education field (A1). When it comes to encountering unfamiliar digital technologies, 69.33% (of which 49% agree somewhat and 20.33% strongly agree) are confident that they can master it through self-study or asking for help (A4). At the same time, the proportion of students who believe that digital teaching ability is an essential core competency for future teachers (A2) and are willing to actively spend their spare time learning new digital teaching tools and methods (A3) has increased.

Table 3. Descriptive Statistical Results of Digital Teaching Awareness of Normal College Students

Item	Mean	Standard Deviation	Strongly Disagree	Disagree	Basically Agree	Somewhat Agree	Strongly Agree
A1	3.597	0.846	0.67%	7%	39%	38.67%	14.67%
A2	4.17	0.746	0.33%	0.67%	16.67%	46.33%	36%
A3	3.88	0.775	0.33%	2.33%	27.67%	48.33%	21.33%
A4	3.853	0.792	0.33%	3.67%	26.67%	49%	20.33%

Starting from the dimension of digital teaching design (Table 4), 68.00% (49.67% somewhat agree, 18.33% strongly agree) students can independently choose appropriate digital teaching tools based on teaching goals and student characteristics (B1). As many as 64.00% of students can skillfully use digital tools to visually present and structure teaching content to support the design of teaching activities (49.67% somewhat agree, 14.33% strongly agree) (B3). However, when asked about their proficiency in finding, filtering and obtaining high-quality teaching materials from the Internet or digital resource libraries, only 54.67% of students expressed proficiency, and the proportions of "somewhat agree" and "strongly agree" dropped significantly (B2).

In the dimension of digital teaching implementation (Table 5), 63.00% (47% somewhat agree, 16% strongly agree) students

can skillfully operate commonly used teaching digital technology equipment in the classroom to optimize teaching processes (C1), and 63.33% of students believe that they can effectively organize and guide students to participate in learning activities based on digital platforms (of which 48% somewhat agree, 15.33% strongly agree). Students all showed above-average levels in this dimension (C2).

Table 4. Descriptive Statistical Results of Digital Teaching Design for Normal College Students

Item	Mean	Standard Deviation	Strongly Disagree	Disagree	Basically Agree	Somewhat Agree	Strongly Agree
B1	3.823	0.779	0.67%	2.67%	28.67%	49.67%	18.33%
B2	3.613	0.820	1%	5%	39.33%	41%	13.67%
B3	3.730	0.783	1%	3.33%	31.67%	49.67%	14.33%

Table 5. Descriptive Statistical Results of Digital Teaching Implementation for Normal College Students

Item	Mean	Standard Deviation	Strongly Disagree	Disagree	Basically Agree	Somewhat Agree	Strongly Agree
C1	3.757	0.761	0.33%	2.67%	34%	47%	16%
C2	3.740	0.775	0.33%	4%	32.33%	48%	15.33%

In the dimension of digital academic reflection and evaluation (Table 6), 66.00% of students (49.33% somewhat agree and 16.67% strongly agree) said that evaluation data collection tools can be used to collect and organize students' learning data (D1).67.33% of the students further chose to apply the data analysis model to the collected student learning data for preliminary academic data analysis to understand the students' learning status (50% said they somewhat agreed, and 17.33% said they strongly agreed) (D2). Regarding the issue of using digital records to reflect on teaching and improve their own teaching design, 63.33% (48.33% said they somewhat agreed and 15% said they strongly agreed) said they could do it (D3).

Table 6. Descriptive Statistical Results of Reflection and Evaluation of Digital Studies of Normal College Students

Item	Mean	Standard Deviation	Strongly Disagree	Disagree	Basically Agree	Somewhat Agree	Strongly Agree
D1	3.787	0.768	0.33%	3.33%	30.33%	49.33%	16.67%
D2	3.810	0.759	0	3.67%	29%	50%	17.33%
D3	3.743	0.757	0	4%	32.67%	48.33%	15%

In the dimension of ethics and responsibility in digital teaching (Table 7), 68.67% (49% said they somewhat agreed and 19.67% said they strongly agreed) said they would emphasize and demonstrate how to use digital technology responsibly and ethically in teaching.

Table 7. Descriptive Statistical Results of Digital Teaching Ethics and Responsibility for Normal College Students

Item	Mean	Standard Deviation	Strongly Disagree	Disagree	Basically Agree	Somewhat Agree	Strongly Agree
E1	3.853	0.762	0	3%	28.33%	49%	19.67%

3.2 Analysis of Differences in Digital Teaching Abilities of Normal College Students in Various Dimensions under Different Variables

This study employs an independent sample t-test and one-way ANOVA to identify the prominent and more representative grades and major types in the sample as core grouping variables, focusing on testing whether there are differences in the teaching abilities of each dimension under different variables.

3.2.1 Gender difference analysis

This study conducted an independent sample t-test for the gender variable (Table 8). The results show that the digital abilities of normal college students are consistent across all dimensions of gender, with no significant differences. In all dimensions of digital teaching ability of normal college students, the mean

value of male normal college students is slightly higher than or equal to that of female normal college students.

Table 8. Analysis of Differences in Digital Teaching Abilities Among Normal School Students of Different Genders

	Gender (Mean ± SD)		t	p
	Male(n=67)	Female(n=233)		
Teaching awareness	3.92±0.62	3.86±0.64	0.624	0.533
Teaching design	3.78±0.60	3.76±0.62	0.266	0.791
Teaching implementation	3.89±0.72	3.71±0.68	1.876	0. 062
Teaching Evaluation Reflection	3.80±0.75	3.77±0.64	0.293	0.77
Teaching ethics and responsibility	3.90±0.82	3.84±0.75	0.514	0.608
* p<0. 05 ** p<0. 01				

3.2.2 Analysis of grade differences

This study conducted a one-way analysis of variance (Table 9) on the grade difference variables. The results showed that there was no significant difference in the digital teaching ability of normal school students by grade, except in the dimension of teaching awareness, where samples from different grades had varying opinions on teaching. There is a significant difference in the dimension of academic awareness, which is mainly reflected in the situation of freshmen＞seniors＞juniors ＞sophomores. Among all dimensions of digital teaching ability in normal college students, the mean value for freshmen is slightly higher than or equal to that of other grades.

Table 9. Analysis of the Differences in Digital Teaching Ability of Normal College Students.

	Academic Year (Mean ± SD)				F	p
	Freshman(n=97)	Sophomore(n=54)	Junior(n=105)	Senior(n=44)		
Teaching awareness	4.05±0.66	3.76±0.60	3.78±0.61	3.87±0.65	3.837	0.010*
Teaching design	3.81±0.69	3.73±0.59	3.74±0.56	3.73±0.60	0.295	0.829
Teaching implementation	3.79±0.76	3.66±0.70	3.76±0.65	3.73±0.65	0.471	0.702
Teaching Evaluation Reflection	3.86±0.75	3.74±0.64	3.80±0.61	3.61±0.61	1.534	0.206
Teaching ethics and responsibility	3.97±0.81	3.87±0.73	3.83±0.74	3.64±0.72	2.002	0.114
* p<0. 05 ** p<0. 01						

3.2.3 Analysis of Differences in Digital Teaching Competencies Among Pre-service Teachers from Different Disciplines

This study conducted a one-way ANOVA on the discipline variable (Table 10). Results indicate that pre-service teachers' digital competencies showed consistency across all disciplines, with no significant differences. Regarding the teaching awareness dimension of digital teaching competency, humanities education majors exhibited a marginally higher mean than other majors. In the teaching evaluation and reflection dimension, science and engineering majors scored highest among the three groups, potentially reflecting greater access to digital technology resources and learning opportunities inherent to their disciplines. Meanwhile, arts and physical education majors scored marginally lower than other groups in all dimensions except teaching implementation, where they performed slightly better.

Table 10. Analysis of Differences in Digital Teaching Competency Among Pre-service Teachers from Different Disciplines

	Major (Mean ± SD)			F	P
	Liberal arts (n=217)	Science and engineering (n=67)	Arts and sports (n=16)		
Teaching awareness	3.90±0.62	3.88±0.64	3. 55±0.79	2.266	0.106
Teaching design	3.77±0.64	3.77±0.47	3. 57±0.81	0.777	0.461
Teaching implementation	3.72±0.70	3.82±0.63	3.84±0.89	0.710	0.492
Teaching Evaluation Reflection	3.77±0.70	3.84±0.56	3.69±0.60	0.415	0.660
Teaching ethics and responsibility	3.88±0.79	3.82±0.69	3.69±0.60	0.531	0.589
* p<0. 05 ** p<0. 01					

4. Research Findings and Conclusions Based on Empirical Data, this Study Draws the Following Core Conclusions:

4.1 The Digital Teaching Ability of Normal College Students is Generally Above the Average Level: Self-Awareness Needs to be Strengthened

Overall, the five core dimensions achieved a combined average score of 3.80. Among these, only 16% of pre-service teachers rated their abilities as “strong/very strong,” while 62.33% self-assessed as “moderate.” This discrepancy contrasts with the upper-moderate level indicated by objective scales, revealing a mismatch between this group's “cognitive recognition” and “competency confidence” regarding digital teaching abilities.

This indicates that pre-service teachers have unclear perceptions of the evaluation criteria for digital teaching competencies. Teachers' digital teaching abilities serve as the core driving force for educational digital transformation. [5] As the core reserve force for the future teaching workforce, most pre-service teachers simplistically equate digital teaching competencies with “tool usage skills,” overlooking the value of core dimensions such as digital instructional design, digital resource development and optimization, digital teaching evaluation, and digital education ethics. Consequently, they underestimate their overall proficiency. Additionally, there is a lack of practical validation and positive feedback in authentic teaching scenarios. Prospective teachers' digital teaching competencies are primarily developed through coursework and simulated training, without sufficient application and refinement in real classroom settings. They lack experience addressing complex teaching situations—such as variations in students' digital learning abilities, unexpected technical failures, and interdisciplinary digital teaching integration—and have not received explicit affirmation or targeted guidance from students or mentors. This hinders the development of stable confidence in their abilities.

The rapid pace of innovation in digital teaching tools, technological applications, and educational philosophies often leaves teacher candidates anxious about knowledge gaps and skill deficiencies during their studies. They worry their current abilities may fail to meet future educational demands, and this concern about the future further diminishes their recognition of their present competency. If this self-perception bias persists over time, it may undermine pre-service teachers' courage to experiment in future teaching practice. They may hesitate to proactively explore innovative digital teaching models in actual classrooms, struggle to fully leverage their existing digital teaching competencies, or even avoid digital teaching scenarios altogether. Ultimately, this hinders the further development of their digital teaching abilities and impedes their adaptation to the heightened demands placed on educators' digital teaching competencies in the digital age.

4.2 Dimension of Digital Teaching Awareness: Outstanding Value Recognition, Frontier Attention Needs to be Improved

Teacher education students in eastern, western, and northern Guangdong demonstrate a high level of awareness regarding digital teaching, including recognition of the essential nature of digital teaching competencies, willingness to proactively learn digital teaching tools and methods, and confidence in mastering unfamiliar technologies. This reflects their initiative in embracing digital teaching, making this dimension a relative strength in their digital teaching capabilities.

However, the mean score for “keeping abreast of cutting-edge developments in educational digitalization” within this dimension was only 3.597. This indicates that teacher education students' emphasis on digital teaching remains largely confined to recognizing its necessity, without translating into an intrinsic drive to proactively track advancements. Their understanding of digital teaching still leans toward “instrumental application,” lacking in-depth engagement with the field's developmental trends.

Digital education curricula at some teacher training institutions in eastern, western, and northern Guangdong regions emphasize foundational theory and tool application while insufficiently incorporating cutting-edge developments and innovative case studies. Furthermore, teacher trainees often focus their learning efforts on meeting immediate goals like course assessments and internship requirements, lacking awareness of long-term planning for their own digital teaching competency development. Consequently, while teacher

education students have established recognition of the value of digital teaching, this recognition has not yet extended to proactive engagement with cutting-edge developments in digital education. Targeted guidance is needed to establish knowledge acquisition channels, strengthen long-term development awareness, and propel teacher education students' recognition of digital teaching toward exploration of the forefront.

4.3 Dimension of Digital Teaching Design: Resource Integration Capabilities Need to be Strengthened

Digital teaching resources are rich and interactive, which can help stimulate students' interest in learning and improve learning effectiveness. Teachers who master digital teaching skills can use these resources more efficiently. [6] However, there are deficiencies in digital teaching design among normal college students in the east, West, and North of Guangdong. The detailed results are presented below: the ability to search, filter, and obtain high-quality teaching materials from the Internet or digital resource libraries is weak.

Only 54.67% of normal school students can complete relevant operations proficiently, which is significantly lower than other ability performances. This is closely related to the core requirements of teaching design.

4.4 Digital Teaching Implementation Dimension: Basic Operation and Organizational Capabilities Reach a High Level

Teacher education students are immersed in diverse learning environments created by different instructors, providing abundant opportunities to indirectly gain teaching experience and skills through observing teachers' instructional demonstrations. [7] Prospective teachers from eastern, western, and northern Guangdong demonstrated above-average capabilities in implementing digital teaching. Over 63% could proficiently operate common digital teaching equipment to optimize instructional processes, while 63.33% possessed the ability to effectively organize student participation in digital platform learning activities. The high recognition of these two competencies indicates that this cohort has acquired foundational literacy for practical digital teaching implementation, enabling them to preliminarily execute technical equipment operations and organize digital learning activities.

However, their current competency advantages remain confined to the execution stage, lacking exploration into the deep integration of disciplinary characteristics with digital technologies and the innovation of digital teaching models. It is necessary to strengthen training in the deep integration of disciplines and digital technologies, designing specialized practical tasks tailored to different disciplinary features. Teacher education students should be encouraged to explore innovative digital teaching models, cultivating their ability to utilize digital means to address teaching challenges and achieve personalized education, thereby advancing digital teaching toward disciplinary integration and pedagogical innovation.

4.5 Group difference Characteristics: The Teaching Awareness Dimension of Grades Shows Fluctuation Characteristics

Single-factor analysis of variance revealed no significant group differences in digital teaching competencies. However, fluctuations in teaching awareness across grade levels warrant attention. From the perspectives of gender and major, no statistically significant differences were observed in competencies across dimensions among different groups (P>0. 05). Regarding grade level, significant differentiation emerged in teaching awareness (F=3.837, P=0. 010<0. 05). First-year teacher education students, having recently encountered teacher education, exhibited the highest novelty and enthusiasm toward digital teaching. In contrast, second- and third-year students may experience diminished enthusiasm due to academic pressures and limited practical experience. P=0. 010<0. 05). First-year teacher education students, newly exposed to pedagogical training, exhibited the highest novelty and enthusiasm toward digital teaching. Enthusiasm declined among second- and third-year students, potentially influenced by academic pressures and limited practical experience. Fourth-year students showed renewed cognitive engagement as they approached teaching practicals. This pattern provides clear evidence for implementing phased cultivation strategies.

The digital teaching awareness of pre-service teachers across different academic years exhibits

distinct phased characteristics influenced by factors such as learning stage, task priorities, and practical experience. This allows for the implementation of targeted, phased cultivation strategies to precisely nurture their capabilities. Such an approach can fully leverage the collective strengths of pre-service teachers in digital teaching, thereby driving the enhancement of their digital teaching competencies.

5. Discussion and Suggestions

Based on the current situation and problems revealed in this study, to further improve the digital teaching ability of normal students in the east, West, and North of Guangdong, make up for the shortcomings caused by digital teaching awareness, digital teaching design, and group differences, and ensure that normal students receive targeted training:

5.1 Build a "University-Primary and Secondary School-Enterprise" Collaborative Support Mechanism to Improve Multidimensional Empowerment Capabilities

Building an intelligent, interactive digital teaching environment is the cornerstone for enhancing university faculty's awareness and capabilities in digital teaching. [8] To elevate pre-service teachers' digital teaching awareness and competencies, a collaborative support mechanism involving universities, K-12 schools, and enterprises must be established. This mechanism should promote multidimensional empowerment for pre-service teachers, helping them identify their strengths and advancement paths while reducing underestimation of their abilities due to cognitive ambiguity.

During pre-service training, digital skills often remain theoretical, lacking application in real teaching scenarios. Practical activities like teaching practicals still lack clear digital teaching requirements. [9] While pre-service teachers in eastern, western, and northern Guangdong recognize the importance of digital teaching, they lack awareness of cutting-edge technologies and practical feedback from real teaching contexts. This results in insufficient sustainable learning and hinders the deepening of their digital teaching awareness. Therefore, establishing a collaborative support mechanism among universities, K-12 schools, and enterprises holds significant practical importance.

Universities, as the primary institutions for training teacher candidates, should spearhead the establishment of collaborative platforms. These platforms should regularly invite frontline K-12 teachers and technical experts from edtech companies to conduct digital teaching training sessions. Through practical case studies shared by teachers, teacher candidates can gain direct insights into the effectiveness and potential challenges of digital teaching in real classrooms, moving beyond merely “tool-based application.” Experts from edtech companies can introduce teaching adaptation solutions for cutting-edge technologies like artificial intelligence and big data analytics, showcasing innovative applications of digital teaching tools. This helps teacher trainees broaden their technological horizons and bridge the information gap regarding the forefront of educational technology development. Simultaneously, the collaborative mechanism can establish long-term practical cooperation models. For instance:

Organizing teacher trainees to intern at K-12 schools, participating in the full design and implementation of digital classrooms; Encourage teacher education students to undertake instructional technology R&D projects, enabling them to experience the deep integration of technology and pedagogy in practice. This transforms value recognition into an intrinsic motivation for proactive exploration, extending digital teaching awareness toward “cutting-edge exploration.” This collaborative model aligns closely with the research conclusions proposed by Mei Fusheng and others regarding “multi-party collaboration to cultivate teachers' digital capabilities.” It effectively addresses the challenges of disconnect between theory and practice, as well as the fragmentation between technology and pedagogy, that arise under a single training entity.

5.2 Optimize the Curriculum System and Consolidate Basic Support for Digital Teaching

The curriculum system serves as the core vehicle for cultivating digital teaching competencies among teacher education students. However, these students lack sufficient exposure to information technology during their studies, and their experience integrating digital technologies with teaching and learning

practices remains underdeveloped. [10] To address the identified issues—such as weak resource integration skills and inadequate alignment between curriculum content and student learning needs—the curriculum system can be optimized through two approaches: refining course content and enhancing specialized resource repository development.

Regarding curriculum content refinement, specialized modules such as “Digital Resource Retrieval and Evaluation,” “Digital Teaching Ethics,” and “Frontier Technology Applications in Instruction” should be introduced, referencing the Teacher Digital Literacy Standards. These modules should systematically teach the selection, integration, and copyright compliance of online teaching resources, addressing current deficiencies in pre-service teachers' ability to acquire instructional materials. Simultaneously, reduce repetitive foundational tool operation courses and increase comprehensive content like digital instructional design and interdisciplinary teaching integration. This helps teacher candidates establish the core concept that “technology serves instructional objectives,” correcting the misconception that equates digital teaching competence solely with tool usage skills.

Regarding resource repository development, leverage the regional characteristics of Guangdong's eastern, western, and northern areas. Collaborate with local education departments and K-12 schools to establish locally distinctive digital resource repositories. These repositories should contain teaching materials precisely aligned with regional folk culture and student learning contexts, addressing the disconnect between generic digital resources and local instructional needs. This approach to building locally distinctive resource pools not only responds to research perspectives like those proposed by Liang Yunzhen et al. (2025)—that “digital transformation in teaching must adapt to local realities”—but also provides teacher education students with more targeted practical materials, enhancing the alignment between their digital instructional design and local teaching demands.

5.3 Strengthen Practical Teaching Links and Focus on Deep Integration and Model Innovation

Practical teaching in universities still lags theoretical instruction, failing not only to meet current societal development needs, but also falling significantly short of the latest industry concepts. [11] Practical application is the critical link in transforming digital teaching competencies from theory into practice. The core of teachers' digital teaching abilities lies not merely in technical operations, but in the deep integration of technology with subject content and the innovative application of teaching models. This study reveals that pre-service teachers in eastern, western, and northern Guangdong demonstrate competency advantages primarily at the general technology execution level. However, they exhibit insufficient exploration and creativity in areas such as deeply integrating technology with specific disciplines and utilizing technological innovations to address teaching challenges. Consequently, strengthening the targeted and innovative aspects of practical teaching are essential.

Implement specialized training integrating digital tools with subject-specific disciplines. Design differentiated practical tasks tailored to the disciplinary characteristics of students from various majors, leveraging digital technology to support aesthetic cultivation and skill development. Simultaneously, encourage exploration and application of innovative digital teaching models. Drawing on Zhou Xin et al. ‘s (2025) findings regarding “factors influencing teachers’ digital teaching competencies,” provide students with practical platforms for innovative approaches such as project-based learning, flipped classrooms, and blended instruction. Organize teacher education students into groups to design digital innovation teaching plans centered on specific teaching challenges. Validate these plans through practice in microteaching labs or partner K-12 schools, continuously refining them based on classroom feedback. Finally, introduce a digital teaching innovation competition mechanism to motivate students to proactively explore the application value of technology in addressing teaching pain points, cultivating their ability to creatively utilize digital tools.

5.4 Implement Phased Training and Build a Step-By-Step Capability Development Path

Digital teaching competency is a critical skill for educators during the era of educational digital transformation. [12] As the future backbone of the teaching profession, pre-service teachers

must develop these competencies in accordance with the objective laws of individual growth and skill acquisition, avoiding the pitfall of a one-size-fits-all training approach. Pre-service teachers exhibit differences in task priorities, cognitive levels, and practical foundations across various stages of their education. This study reveals that pre-service teachers' awareness of digital teaching exhibits distinct fluctuations across different academic years, providing empirical support for designing phased training pathways. By integrating the characteristics of each academic year, a phased training pathway can be constructed.

During freshman year, capitalize on students' novelty and enthusiasm toward digital teaching to initiate cognitive awareness and foundational skill training. Offer introductory courses on digital pedagogy, organize lectures on educational digitalization policies, and conduct hands-on training with basic teaching tools to help students develop a systematic understanding of digital teaching competencies, thereby establishing a solid foundation in both awareness and technical skills. In sophomore and junior years, students face increased academic pressure, which may dampen their enthusiasm for digital learning. Digital competency training must be deeply integrated into specialized coursework. Modules such as digital teaching case studies and instructional design practice should be incorporated into curricula to organically combine professional learning with digital skill enhancement. Concurrently, diverse practical platforms—including on-campus microteaching labs, short-term industry-academia collaborations, and K-12 teaching observances—should be established. These experiential opportunities reignite learning enthusiasm while prioritizing the development of digital instructional design, resource integration, and foundational implementation capabilities. During their senior year, student teachers enter the educational internship phase, possessing the conditions to translate theory into practice. This stage should focus on cultivating practical digital teaching competencies. Student teachers should be required to complete a specified number of digital teaching sessions during their internship, utilizing resource repositories built through collaborative mechanisms and the integrated methodologies they have learned to design and implement digital teaching plans.

A dual feedback mechanism involving both internship mentors and university supervisors is established. This provides precise guidance on students' performance in integrating technology with subjects and innovating teaching models, helping them synthesize experiences, address shortcomings, and transform phased competencies into sustainable teaching competencies. This lays the foundation for rapid adaptation to digital teaching demands upon entering the profession.

6. Conclusion

This study focuses on the relatively educationally underdeveloped regions of eastern, western Guangdong, and northern Guangdong, examining the current state and challenges of digital teaching competencies among teacher education students in these areas. Through an empirical survey of 300 teacher education students, it explores the underlying logic and key factors influencing their digital teaching capabilities. Results indicate that while overall digital teaching competency among teacher education students is above average, structural imbalances exist across different dimensions. These include mismatches between self-perception and objective proficiency, insufficient awareness of cutting-edge digital teaching practices, weak resource integration capabilities in digital instructional design, and fluctuating awareness of grade-level teaching requirements.

Based on these findings, the study proposes phased, practice-oriented development strategies: strengthening competency awareness guidance, establishing diversified platforms for cutting-edge practice exchange, fostering multi-stakeholder collaboration among enterprises, universities, and K-12 schools, and implementing stage-specific cultivation across grade levels. These strategies aim to systematically address deficiencies, promote structural balance within dimensions, enhance the digital teaching competencies of future teachers in the region, and support their adaptation to the digital education transformation. This research not only enriches the body of knowledge on pre-service teachers' digital teaching competencies and provides empirical evidence for the eastern, western, and northern regions of Guangdong Province but also offers new insights into the formation

mechanisms by revealing dynamic variations across different dimensions.

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