

Improving Teachers' Digital Competence at Nanjing Xiaozhuang University

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Abstract: The research objectives were 1) to analyse teachers' current and expected levels of digital competence and identify priority areas for improvement, 2) to explore approaches for improving teachers' digital competence at Nanjing Xiaozhuang University. The study employed an explanatory sequential mixed-methods design. The quantitative sample comprised 147 full-time teachers selected through simple random sampling from a population of 238. The qualitative phase involved nine experts who participated in a focus group discussion. The instruments included a 44-item questionnaire covering 22 competences across the six DigCompEdu areas and a focus group discussion protocol. Quantitative data were analysed using frequency, percentage, mean, standard deviation, and the Modified Priority Needs Index. Qualitative data were analysed through content analysis. The findings revealed that 1) the overall current level of teachers' digital competence was moderate (Mean = 3.34, S.D. = 0.49), whereas the overall expected level was high (Mean = 4.45, S.D. = 0.29). Assessment had the highest priority need (PNI modified = 0.473), followed by Facilitating Learners' Digital Competence (0.453) and Empowering Learners (0.403); 2) four proposed approaches were identified: strengthening digital assessment competence, facilitating students' digital competence, advancing learner-centred digital teaching, and establishing institutional support for sustainable development. These approaches were integrated into an evidence-informed framework for future professional development.

Keywords: Teachers' Digital Competence; DigCompEdu Framework; Priority Needs; Higher Education

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1. Background and Significance of Research

University teaching increasingly takes place in digital environments supported by artificial intelligence, cloud services, learning platforms, and data-analysis tools. These technologies give teachers more options for organising instruction and responding to students' learning needs. However, access to technology does not guarantee its effective educational use. Teachers must decide when a digital tool is appropriate, how it supports learning, and how its effects should be evaluated. Digital competence therefore involves pedagogical judgement, assessment, professional communication, reflection, and responsible technology use^[1].

This growing responsibility is also reflected in international and national education policies. The UNESCO ICT Competency Framework for Teachers connects technology use with curriculum, pedagogy, assessment, administration, and continuing professional learning^[2]. In China, the Digital Literacy of Teachers standard identifies digital awareness, knowledge and skills, digital application, social responsibility, and professional development as essential dimensions of teachers' digital competence^[3].

These requirements are particularly relevant to Nanjing Xiaozhuang University because of its role as a regional teacher-education university responsible for preparing future teachers. Although the university has expanded its digital infrastructure and promoted technology-supported teaching, the use of digital technologies does not necessarily indicate that they have been fully integrated into pedagogy. Teachers may use digital platforms effectively for communication, resource distribution, and content delivery while experiencing greater difficulty in digital assessment, learner participation, personalisation, and the development of students' digital competence. Such differences cannot be addressed effectively through general technology training alone. The university therefore needs clear evidence showing which areas of teachers' digital competence are relatively well developed and which require priority support.

Research from other countries and universities offers useful evidence, but it does not establish the priorities of teachers at Nanjing Xiaozhuang University. Definitions and measurement methods also vary across higher-education studies^[4]. Few studies have combined current and expected competence levels, priority-needs analysis, and expert interpretation within one teacher-education institution. This study uses DigCompEdu and the Modified Priority Needs Index to examine this local need.

1.1. Research Questions

1. What are the current level and the expected level of teachers' digital competence at Nanjing Xiaozhuang University, China?
2. What approaches can be developed to enhance teachers' digital competence at Nanjing Xiaozhuang University, China?

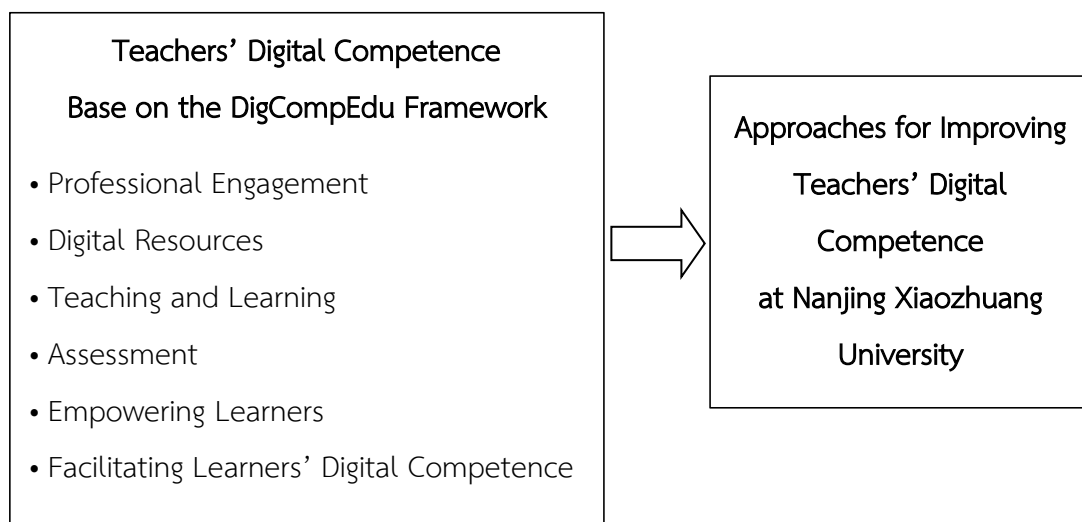
1.2. Research Objectives

1. To analyse the current level and the expected level of teachers' digital competence and identify priority areas for improvement at Nanjing Xiaozhuang University, China.
2. To explore approaches for improving teachers' digital competence at Nanjing Xiaozhuang University, China.

2. Conceptual Framework

The conceptual framework was based on DigCompEdu. It examines teachers' digital competence through six areas: Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence^[5]. The

questionnaire measured teachers' current and expected competence levels, and the Modified Priority Needs Index ranked the identified gaps. These priorities then guided the focus group discussion, in which the experts developed approaches suited to Nanjing Xiaozhuang University.



3. Literature Review

3.1. Teachers' Digital Competence in Higher Education

Teachers' digital competence involves informed decisions about the selection and educational use of technology. It combines technical knowledge with pedagogical judgement, assessment, professional communication, reflection, and ethical practice.

Existing frameworks emphasise different aspects of this professional capacity. DigCompEdu organises 22 competences into six areas: Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence. Its structure covers both teachers' professional use of technology and its application to student learning.

Higher-education research supports this broader view. The HeDiCom framework connects digital teaching practice with student empowerment, teachers' digital literacy, and continuing professional development^[6]. Zhao et al. also found substantial variation in the definitions and measures used across higher-education studies. A multidimensional framework is therefore more suitable than an assessment based only on technical skills.

3.2. Current Status of Teachers' Digital Competence in Higher Education

Previous research indicates that university teachers' digital competence is often uneven across different competence areas. Cabero-Almenara et al.^[7] using data from 6,664 university teachers in Latin America, found an intermediate overall level of digital teaching competence and significant differences associated with participant characteristics. A teacher may manage common digital tasks successfully but feel less prepared when technology must be used for assessment or instructional design.

Differences among competence areas have also been observed within individual university systems. Fernández-Morante et al.^[8] reported uneven development across the digital competence dimensions of university teachers in Galicia. The distinction between frequency of use and pedagogical depth is important here. Uploading materials, communicating online, or sharing

resources does not involve the same demands as personalising instruction, involving students in digital activities or assessing learning through technology. Frequent use alone cannot show whether teachers are confident in more complex tasks.

Teachers' competence is also influenced by personal and institutional conditions. Lucas et al.^[9] found that the number of digital tools used, perceived ease of use, confidence, and openness to technology were associated with in-service teachers' digital competence. Singun^[10] drew attention to another side of the issue: weak infrastructure, limited training, insufficient leadership, and inadequate organisational support may restrict what teachers can do. Competence levels therefore reflect not only individual experience but also the opportunities and support available in the workplace.

3.3. Improvement of Teachers' Digital Competence

The improvement of teachers' digital competence should be approached as a continuing professional-learning process rather than as one-time training in the operation of digital tools. A systematic review conducted by Ahadi et al.^[11] indicated that effective technology-focused professional development should connect technological knowledge with classroom practice and provide teachers with sustained opportunities for application, reflection, and support.

Competence assessment can provide an important evidence base for professional development. Ghomi and Redecker^[12] demonstrated that a DigCompEdu-based self-assessment instrument can help teachers recognise their competence levels and identify areas requiring further improvement. Zhang et al.^[13] additionally identified training courses, active teaching methodologies, webinars, social-media activities, and blended-learning support as commonly used approaches for improving university teachers' digital competence. These findings suggest that development activities should respond to identified competence gaps instead of providing the same general technology training to all teachers.

Digital assessment and the interpretation of learning evidence are particularly important areas of professional development. Ifenthaler and Yau^[14] found that learning analytics can contribute to student success when information about learners and learning processes is interpreted appropriately. Teachers therefore require support not only in operating digital assessment platforms but also in analysing evidence, providing effective feedback, and using assessment results to adjust subsequent teaching.

The development of teachers' competence must also be connected with students' digital learning. Teachers need to design activities through which students evaluate information, create digital content, collaborate in online environments, and solve authentic problems. At the same time, universities must provide continuing professional development, technical assistance, appropriate infrastructure, leadership support, and professional learning communities. Such institutional conditions enable teachers to apply newly acquired competence in actual teaching practice and sustain development over time.

Existing research has therefore identified several relevant directions for improving teachers' digital competence. However, general recommendations cannot determine which areas should receive priority at Nanjing Xiaozhuang University. The present study addresses this limitation by comparing teachers' current and expected competence levels, applying the Modified Priority Needs Index to identify the most urgent gaps, and using expert discussion to develop improvement approaches appropriate to the university context.

4. Methodology

4.1. Research Design

An explanatory sequential mixed-methods design was used. The study proceeded in two stages. In the quantitative phase, a questionnaire was used to examine teachers' current and expected levels of digital competence across the six DigCompEdu areas, and descriptive statistics and the Modified Priority Needs Index were used to identify the relative urgency of development needs. In the qualitative phase, the quantitative results were used to guide a focus group discussion with experts. The results were then taken to the expert group. During the discussion, the experts considered what the priorities meant for the university and proposed possible responses.

4.2. Research Participants

The quantitative population included 238 full-time teachers from the Teacher Education College at Nanjing Xiaozhuang University. The sample size of 147 was determined with reference to Krejcie and Morgan^[15]. A complete list of the 238 full-time teachers was obtained, and each teacher was assigned an identification number. For the qualitative phase, nine experts were selected according to predefined criteria. Each expert held at least a master's degree, had more than five years of relevant professional experience, and possessed expertise in educational administration, teacher education, teacher professional development, digital education, educational technology, curriculum and instruction, higher education management, educational innovation, information technology, or a related field.

4.3. Research Instruments

The research instruments consisted of a questionnaire and a focus group discussion protocol. Developed based on the DigCompEdu framework, the questionnaire contained respondents' demographic information and 44 statements covering 22 competences across six areas. Each statement was rated separately for the current and expected levels using a five-point Likert scale. Three experts reviewed the questionnaire for content validity. The resulting IOC values ranged from 0.67 to 1.00. A pilot test was then conducted with 30 teachers who did not join the main study. Reliability was calculated separately for the current and expected scales. The calculation covered each dimension and the complete 44-item scale. Table 1 reports the coefficients. The focus group discussion protocol was used to interpret the quantitative findings and identify appropriate approaches for improving teachers' digital competence.

Table 1. Reliability Results of the Current-Level and Expected-Level Scales

Dimension	Number of Items	Current Level α	Expected Level α
Professional Engagement	8	0.91	0.86
Digital Resources	6	0.89	0.81
Teaching and Learning	8	0.93	0.90
Assessment	6	0.90	0.92
Empowering Learners	6	0.91	0.84
Facilitating Learners' Digital Competence	10	0.94	0.89
Overall Scale	44	0.95	0.92

4.4. Data Collection

Questionnaire data were collected over four weeks from the 147 teachers selected for the quantitative phase. The questionnaire was distributed through Questionnaire Star links shared via WeChat and in printed form to ensure accessibility for participants with different response preferences. All 147 selected teachers completed the questionnaire, and all questionnaires were reviewed and retained as valid responses. Therefore, the final quantitative dataset comprised 147 valid questionnaires, representing a valid-response rate of 100%. After the questionnaire data had been analysed and the priority competence gaps had been identified, a focus group discussion was conducted with nine experts. The discussion focused on interpreting the differences between teachers' current and expected competence levels, examining the priority needs identified through the PNI analysis, and proposing practical approaches appropriate to the university context. Detailed written records were produced during and immediately after the discussion to preserve the experts' main statements, explanations, and recommendations for subsequent content analysis.

4.5. Data Analysis Methods

Quantitative and qualitative data were analysed using methods appropriate to the two phases of the study. Frequency and percentage were used to describe respondents' demographic characteristics, while mean and standard deviation were used to determine teachers' current and expected levels of digital competence. Mean scores were classified into five categories proposed by Srisa-ard[16]: highest (4.51–5.00), high (3.51–4.50), moderate (2.51–3.50), low (1.51–2.50), and lowest (1.00–1.50). The Modified Priority Needs Index was calculated using the formula $PNI_{modified} = (I - D) / D$, where I represented the expected mean and D represented the current mean. The PNI modified calculation used the full-precision means. Only the means reported in the tables were rounded to two decimal places. The resulting PNI modified values were ranked from highest to lowest to determine the relative priorities for improvement. Qualitative data from the focus group discussion were analysed using content analysis. The written discussion records were read repeatedly, and statements relevant to the identified competence gaps and possible improvement approaches were coded. Codes expressing similar ideas were grouped into categories, and the categories were compared with the quantitative priority needs. Through this process, four final themes were identified: digital assessment competence, students' digital competence facilitation, learner-centred digital teaching, and institutional support for sustainable development. These themes provided the basis for the proposed development approaches.

4.6. Ethical Considerations

Participation in the questionnaire survey and focus group discussion was voluntary. Before data collection, participants were informed of the purpose of the study, the research procedures, the intended academic use of the data, and the confidentiality of their responses. Participants agreed to take part before completing the questionnaire or joining the focus group discussion. No personally identifying information was included in the analysis or reporting of the findings, and the collected information was used solely for academic research purposes.

5. Findings

The results are reported in two parts. The first addresses teachers' current and expected competence levels and the priorities identified from the differences between them. The second presents the approaches developed through the focus group discussion.

5.1. Current and Expected Levels of Teachers' Digital Competence

Table 2. Current and Expected Levels of Teachers' Digital Competence by DigCompEdu Dimensions

Dimension	Current Mean	S.D.	Level	Expected Mean	S.D.	Level
Professional Engagement	3.70	0.56	High	4.34	0.38	High
Digital Resources	3.57	0.61	High	4.34	0.38	High
Teaching and Learning	3.39	0.61	Moderate	4.47	0.34	High
Assessment	3.09	0.60	Moderate	4.55	0.34	Highest
Empowering Learners	3.22	0.55	Moderate	4.51	0.38	Highest
Facilitating Learners' Digital Competence	3.09	0.55	Moderate	4.49	0.33	High
Total	3.34	0.49	Moderate	4.45	0.29	High

Teachers reported high expectations across all six DigCompEdu dimensions. Assessment and Empowering Learners reached the highest level, and the overall expected mean was 4.45 (S.D. = 0.29). Current ratings presented a different pattern. The overall current level was moderate (Mean = 3.34, S.D. = 0.49). Only Professional Engagement and Digital Resources reached a high current level, while the other four dimensions remained moderate.

Table 3. Priority Needs Index by DigCompEdu Dimension

Dimension	Current (D)	Expected (I)	PNI modified	Priority
Assessment	3.09	4.55	0.473	1
Facilitating Learners' Digital Competence	3.09	4.49	0.453	2
Empowering Learners	3.22	4.51	0.403	3
Teaching and Learning	3.39	4.47	0.318	4
Digital Resources	3.57	4.34	0.215	5
Professional Engagement	3.70	4.34	0.173	6

The widest differences between expected and current competence occurred in Assessment (PNI modified = 0.473), Facilitating Learners' Digital Competence (0.453), and Empowering Learners (0.403). Teaching and Learning ranked fourth. Smaller differences were Digital Resources and Professional Engagement.

Table 4. Top Five Priority Needs at the Specific-Competence Level

Specific Competence	Current (D)	Expected (I)	PNI modified	Rank
6.5 Digital Problem Solving	2.89	4.54	0.569	1
4.2 Analysing Evidence	2.99	4.57	0.531	2
4.3 Feedback and Planning	3.05	4.55	0.490	3
6.3 Digital Content Creation	3.06	4.51	0.473	4
5.2 Differentiation and Personalisation	3.19	4.63	0.450	5

The five highest-ranked specific competences were Digital Problem Solving, Analysing Evidence, Feedback and Planning, Digital Content Creation, and Differentiation and Personalisation. Each belonged to one of the three dimensions with the highest priority. The focus group discussion was organised around these competence needs.

5.2. Development Approaches and Implementation Directions

The focus group began with a review of the priorities reported in Tables 3 and 4. The experts discussed the difficulties represented by these gaps and considered the forms of support available within the university. Four approaches emerged from the discussion, as presented in Table 5.

Table 5. Summary of Focus Group Findings

Quantitative Priorities	Expert Interpretation	Proposed Approach
Analysing Evidence; Feedback and Planning	Teachers require stronger competence in interpreting digital assessment information, providing feedback, and using evidence to improve teaching.	Strengthening Digital Assessment Competence
Digital Problem Solving; Digital Content Creation	Teachers need support in designing activities that develop students' digital problem-solving and digital content-creation abilities.	Facilitating Students' Digital Competence
Differentiation and Personalisation; related needs in Self-Regulated Learning	Digital technologies should be used to support personalised learning, learner autonomy, and active participation.	Advancing Learner-Centred Digital Teaching
Quantitative Priorities	Expert Interpretation	Proposed Approach
Cross-cutting needs affecting multiple competence areas	Sustainable development requires continuous professional learning, technical assistance, leadership, infrastructure, and professional communities.	Establishing Institutional Support for Sustainable Development

The experts regarded digital assessment as the most immediate concern. They proposed support for interpreting learning evidence, improving feedback, and using assessment results in subsequent teaching. Other proposals focused on activities that develop students' digital problem-solving and content-creation abilities. The experts also linked learner-centred digital teaching with differentiation, personalisation, and self-regulated learning. At the university level, they identified training, technical assistance, infrastructure, peer collaboration, and professional learning communities as the main forms of continuing support.

6. Conclusion

This study reached two main conclusions. First, teachers reported a high overall expected level of digital competence (Mean = 4.45, S.D. = 0.29), while their overall current level was moderate (Mean = 3.34, S.D. = 0.49). Assessment, Facilitating Learners' Digital Competence, and Empowering Learners were the principal priorities for improvement. These results show that future development should focus on the pedagogical use of digital technologies rather than routine technology operation alone. Second, the study identified four interconnected approaches: strengthening digital assessment competence, facilitating students' digital competence, advancing learner-centred digital teaching, and establishing institutional support for sustainable development. The first three approaches respond directly to the identified competence gaps. The fourth provides the professional and organisational support needed to sustain teachers' digital competence development at Nanjing Xiaozhuang University.

7. Discussion

7.1. Discussion of Current and Expected Levels and Priority Needs

The findings related to the first research objective showed that teachers' overall current level of digital competence was moderate (Mean = 3.34, S.D. = 0.49), whereas their overall expected level was high (Mean = 4.45, S.D. = 0.29). Professional Engagement and Digital Resources achieved higher current levels than the other four DigCompEdu areas, indicating that teachers were relatively familiar with using digital technologies for professional communication, collaboration, and resource management. However, their competence was less developed in areas requiring the advanced pedagogical application of technology. This pattern is consistent with Cabero-Almenara et al. who reported an intermediate overall level and differences among competence areas among university teachers. It is also consistent with Fernández-Morante et al. who found uneven competence profiles within a university context. The findings suggest that frequent use of digital platforms does not necessarily mean that teachers can integrate technology equally effectively into assessment, learner empowerment, and the development of students' digital competence.

The priority-needs analysis further showed that Assessment had the highest PNI modified value (0.473), followed by Facilitating Learners' Digital Competence (0.453) and Empowering Learners (0.403). Assessment ranked first, but the difficulty may not lie in administering online quizzes or assignments. Teachers must also make sense of the information collected, decide what feedback students need, and use the results when planning the next stage of instruction. The other two priority areas show that the need extends beyond assessment. Teachers also need to help students solve problems with technology, create digital content, and participate more actively in their own learning. Since both the current and expected levels came from the same self-assessment questionnaire, these gaps represent teachers' perceived development needs. They should not be treated as results from an external test of actual performance.

7.2. Discussion of Development Approaches and Implementation Directions

The findings for Research Objective 2 identified four interconnected approaches. Each approach responds to a priority found in the quantitative analysis. Digital Assessment Competence Development addresses the high priorities assigned to Analysing Evidence and Feedback and Planning. Students' Digital Competence Facilitation responds to the needs identified in Digital Problem Solving and Digital Content Creation. Learner-Centred Digital Teaching addresses Differentiation and Personalisation and supports students' self-regulated learning. Institutional Support for Sustainable Development connects these teaching priorities with training, technical assistance, infrastructure, leadership, and peer collaboration. Together, the four proposed approaches provide a coordinated basis for teachers' digital competence development at Nanjing Xiaozhuang University.

8. Recommendations

8.1. Recommendations for Implementation

Future implementation could begin with a pilot programme focusing on digital assessment, which was identified as the highest-ranked priority. The programme could support teachers in interpreting learning evidence, improving feedback, and using assessment results to inform instructional decisions. Additional professional development could focus on designing activities that enable students to evaluate digital information, create digital content, collaborate in digital environments, and solve authentic problems. Learner-centred digital teaching could also be supported through personalisation, differentiation, and self-regulated learning. At the institutional

level, targeted training, peer mentoring, technical assistance, appropriate infrastructure, and digital teaching communities are recommended. Regular needs assessments and evaluation should be used to examine the feasibility and effectiveness of these proposed approaches before their wider adoption.

8.2. Recommendations for Further Study

Future studies may include teachers from additional colleges or universities and use longitudinal designs to examine changes in competence and the long-term effectiveness of the proposed approaches. Further research may also compare disciplinary contexts while retaining the six-dimension DigCompEdu structure.

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