

# Digital Competence Formation in Teacher Education Programs: A Study from Northern Mountainous Vietnam

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Received: November 14, 2025

Accepted: December 10, 2025

Online Published: February 6, 2026

doi:10.5430/jct.v15n1p214

URL: <https://doi.org/10.5430/jct.v15n1p214>

## Abstract

In the context of the Fourth Industrial Revolution and digital transformation in education, developing digital competence among pre-service teachers has become essential to meet the requirements of modern teaching and the labor market. This study aims to assess the current status, identify influencing factors, and propose solutions for developing digital competence among students in teacher education institutions in the northern mountainous region of Vietnam. Using a mixed-methods approach that combined surveys and semi-structured interviews, data were collected from 600 students and 300 lecturers across four universities. The study assessed six key digital competence domains—information literacy, critical thinking and problem-solving with technology, digital communication and collaboration, digital content creation, digital ethics and safety, and the use of artificial intelligence. The findings show that students' digital competence levels are moderate, with mean scores ranging from 2.71 to 3.17. While students are proficient in basic technology use, their creative and pedagogical digital skills remain limited. Factors influencing digital competence development include institutional policies, lecturer competence, technological infrastructure, and the national digital transformation context. Survey results indicate that activities integrating digital competence into teaching, extracurricular programs, and Youth Union initiatives are being implemented but vary in effectiveness. The study recommends systematically embedding digital competence into teacher education curricula, enhancing lecturers' digital capacity, and improving digital infrastructure to foster a comprehensive digital learning ecosystem. These findings provide empirical evidence to support universities in developing strategies for strengthening digital competence among future teachers in the digital era.

**Keywords:** digital competence, pre-service teachers, higher education, digital transformation, the Northern mountainous region of Vietnam

## 1. Introduction

In the context of the Fourth Industrial Revolution, developing digital competence among university students is a key factor in meeting the demands of the modern labor market. Digital competence is not merely the ability to use technology but also encompasses creative thinking, information processing, and adaptability in a digital environment. According to the European Commission (2007, 2022) and UNESCO (2021), digital competence refers to the ability to use digital tools safely and creatively with critical thinking, forming the foundation that enables individuals to learn, work, and participate in the digital society actively and responsibly (Ilomäki, Paavola, Lakkala, & Kantosalo, 2016).

The identification of components that constitute university students' digital competence has received significant attention from both national and international scholars. Based on the digital competence frameworks of UNESCO (2018) and the Council of Australian University Librarians (CAUL, 2019), Trần Văn Hoà and Đỗ Văn Hùng (2021) proposed a digital competence framework for Vietnamese students comprising seven dimensions: (1) operation of devices and software; (2) information and data literacy; (3) digital communication and collaboration; (4) digital content creation; (5) cybersecurity and safety; (6) digital learning and skill development; and (7) profession-oriented digital competence.

Digital competence has been affirmed as a core capability that enables students to adapt to digital transformation and future career requirements (Đỗ et al., 2018; Châu Thị Hồng Nhu, 2024). Prior studies have emphasized the design of DIGITAL COMPETENCE training programs (Lloyd, 2014; Đỗ et al., 2018), the enhancement of lecturers' digital

capacity, and investment in technological infrastructure (Hà Văn Thắng, 2022). The development of digital competence is closely linked to the digital higher education environment, in which infrastructure, policies, lecturers' capacity, teaching methods, and digital academic culture play a critical role (Hà Thị Lan Hương, 2019; Trịnh Thị Thúy, 2022; Vũ Thị Mai Hương, 2024).

This study aims to assess the current status, challenges, and influencing factors in developing digital competence among pre-service teachers in the context of digital transformation, thereby proposing appropriate solutions for universities in the northern mountainous region of Vietnam (Shima & Jaupaj, 2025).

Research Questions:

1. What is the current level of digital competence among university students?
2. What solutions can universities implement to enhance students' digital competence?
3. What factors influence the development of students' digital competence?

## 2. Literature Review

### 2.1 Studies on University Students' Digital Competence

Numerous studies have proposed various digital competence frameworks that comprehensively describe the components of this competence. In China, Wang (2013) developed a framework comprising four dimensions: (1) tools and applications; (2) resources and management; (3) teaching and design; and (4) performance and development, with a total of ten specific competency items.

The International Computer and Information Literacy Study (ICILS, 2013; revised 2018) introduced a digital competence framework with eight dimensions organized into four strands: understanding computer use, gathering information, producing information, and digital communication. This framework emphasizes the ability to access, evaluate, create, share, and use information safely and responsibly (Fraillon et al., 2019).

According to UNESCO (2021), there are seven key domains of digital competence: (1) operating digital devices; (2) information and data literacy; (3) communication and collaboration; (4) digital content creation; (5) digital safety; (6) problem solving; and (7) job-related digital competence.

Similarly, the European Schools (Schola Europaea, 2020) framework identifies five major areas: (1) information and data literacy; (2) communication and collaboration; (3) digital content creation; (4) safety; and (5) problem solving.

All of these frameworks share a common perspective: digital competence is a combination of abilities related to the effective, creative, and responsible use of digital technologies in learning, work, and everyday life.

Studies on digital competence have employed multiple approaches and models. According to ICILS, digital competence is defined as "the ability to use computers to investigate, create, and communicate information effectively at home, at school, in the workplace, and in the community" (Trần Công Phong et al., 2019).

In Vietnam, Nguyễn Tân Đại and colleagues compared national and international digital competence models and proposed a "three-factor – eight-component" model consisting of: (1) information location (identifying the need and scope of information); (2) information acquisition (searching, evaluating, and managing information); and (3) information utilization (effectively using information, collaborating, and presenting ideas) (Đại & Marquet).

Drawing on international frameworks and the Vietnamese educational context, Trần Đức Hoà (2021) proposed a digital competence framework comprising seven main competence groups: operation of devices and software; information and data literacy; digital communication and collaboration; digital content creation; cybersecurity; digital learning and skill development; and profession-related digital competence.

In addition, Lê Anh Vinh et al. (2021), based on the UNESCO digital competence framework and the 2018 General Education Curriculum of Vietnam, constructed a digital competence framework for K-12 students consisting of seven competence domains: digital device operation; information and data processing; communication and collaboration; digital content creation; digital safety; problem solving; and career orientation.

Trần Đức Hoà and Đỗ Văn Hùng (2021, 2022), building on the UNESCO and CAUL frameworks, proposed a digital competence framework for Vietnamese university students with seven similar domains and identified ten essential sub-competencies for digital learning, including hardware literacy, internet skills, digital content creation, online collaboration, social media communication, basic programming, data analysis, copyright literacy, and digital empathy.

Nguyễn Xuân An (2024) proposed a digital competence framework for university students comprising five component

competences: selecting, searching, evaluating, managing, and organizing digital information.

Across the literature, scholars emphasize the essential role of digital competence in the context of digital transformation, viewing it as the foundation for learners and educators to perform effectively in digital environments. UNESCO also asserts that information and communication technology (ICT) will bring fundamental and comprehensive changes to education through its ICT Competency Framework for Teachers (ICT-CFT), which supports countries in developing policies and standards for teachers' digital competence training (Fallis, 2018; Phong & Lân, 2019).

Research on digital competence among pre-service teachers has developed along two main directions:

The first approach focuses on discipline-specific digital competence frameworks. For example, the proposed ICT skills for pre-service Biology teachers include: (1) the use of software tools and (2) the design of ICT-integrated lessons. Similarly, other studies have developed ICT competence frameworks for pre-service Chemistry teachers (six competencies, ten criteria, and four proficiency levels), Mathematics teachers (based on the UNESCO framework), and Informatics teachers (seven competencies, seventeen indicators, and three proficiency levels).

The second approach considers digital competence as a comprehensive technological competence within the overall structure of pre-service teachers' professional competencies. Hague & Payton (2010) proposed an eight-domain framework including basic technical skills, creativity, critical thinking, cultural and social awareness, collaboration, information retrieval, communication, and information security. Janssen et al. (2013) further incorporated dimensions such as legal awareness, ethics, privacy, and the social role of ICT.

Furthermore, Đinh (2022) proposed a framework for ICT application competence in educational research for pre-service teachers, comprising six competencies: literature review, data collection and analysis, academic writing and publication, and research collaboration - with 22 indicators classified into three proficiency levels, from basic to adaptive application.

## *2.2 Studies on the Development of Digital Competence among University Students*

Studies on the development of digital competence among pre-service teachers focus on identifying the key factors within the training process that influence the formation of professional competencies, particularly ICT skills.

Fabry, Higgs & Dee (1997) and Lea & Beggs (2000) asserted that the lack of formal training and self-directed learning constitutes a major barrier to ICT integration in education. Jones (2004) emphasized the importance of pedagogical approaches when integrating ICT into teaching. According to Collis & Jung and Hilary Perraton (2005), ICT training can follow four approaches: ICT as content, ICT as pedagogy, ICT as a tool, and ICT as a foundation for professional development.

Koehler & Mishra (2009) argued that teacher education programs should help pre-service teachers develop content knowledge, technological skills, and pedagogical competence simultaneously. Tondeur (2012) identified twelve factors influencing the effectiveness of ICT integration by pre-service teachers, grouped into two categories: content-pedagogical factors and implementation conditions. Studies by Barton & Haydn (2006) and Anne T. Ottenbreit-Leftwich (2010) also highlighted the importance of embedding technology throughout teacher education programs, contextualized within each subject area (Ofsted, 2002; Sue Harris, 1999).

From the perspective of developing digital competence among lecturers, Moore, Butcher & Hoosen (2016) proposed a strategy based on UNESCO's ICT Competency Framework for Teachers (ICT-CFT), encouraging both lecturers and students to be trained in leveraging technology for teaching and learning. Monash University implemented collaborative models connecting lecturers, pre-service teachers, and in-service teachers, thereby supporting students in effectively integrating ICT into real classroom contexts (Henderson & Cerovac, 2013).

Lloyd (2014) proposed ICT competency standards for Australian teachers, including: (1) designing ICT-enhanced lessons, (2) selecting appropriate digital resources, and (3) using ICT safely and ethically.

At the broader level of university students, Borisov et al. (2020) found that while students generally possess basic digital skills, significant disparities exist between rural and urban areas due to inequalities in infrastructure, internet access, and economic conditions. The study recommended establishing national and institutional platforms to foster students' digital competence development and support adaptation to digital environments.

In addition, Islam & Faisal Ali Khan (2023) emphasized the role of ICT in higher education quality management, while Mustopa et al. (2024) pointed out the challenges posed by artificial intelligence (AI) in teacher education and suggested increasing investment in AI-related infrastructure and professional training programs.

In Vietnam, several studies have focused on developing digital competence among pre-service teachers across various disciplines such as Mathematics, Chemistry, Geography, and Primary Education (Phạm Văn Bán & Nguyễn Phuong Thảo, 2018; Thái Hoài Minh, 2018). These studies mainly investigated the current status of ICT use, students' awareness of digital competence, institutional facilities, and the effectiveness of various approaches to developing digital competence among students and lecturers (Hà Thị Lan Hương, 2019; Lê Thị Kim Loan, 2020; Long, 2014).

Researchers have proposed multiple strategies to enhance pre-service teachers' digital competence, including: contextualizing digital competence frameworks in teaching practice; organizing digital competence -oriented learning activities; promoting self-directed learning and self-training; integrating ICT in pedagogical practice; modernizing technological infrastructure; and assessing students' digital competence levels (Hà Thị Lan Hương, 2019; Lê Thị Kim Loan, 2020; Long, 2014).

Đỗ Văn Hùng (2018) identified five key factors influencing digital competence development: institutional policy, stakeholders' awareness, teaching methods, learning approaches, and librarians' competence. He also developed an information literacy curriculum with seven modules, covering stages from information recognition and searching to evaluation, use, and academic presentation.

Phan Thị Tịnh (2021) proposed three measures to develop digital competence for primary education majors: (1) providing theoretical foundations on ICT in teaching, (2) creating modular self-study materials, and (3) integrating the TPACK model into pedagogical methodology courses.

Thái Hoài Minh (2016, 2018) developed an ICT competency framework for pre-service chemistry teachers comprising six components, ten criteria, and four proficiency levels, based on an analysis of teacher education programs across several universities.

Hà Văn Thắng (2022) conducted experimental interventions to improve ICT competence among geography education students, including knowledge provision, demonstration, technological integration in coursework, encouragement of self-learning, experiential activities, and infrastructure enhancement.

According to Trần Dương (2019), developing digital competence from the perspective of information literacy requires five solution groups: establishing standards and models for information literacy competence, designing training programs, innovating teaching methods, and reforming assessment practices.

Overall, the literature demonstrates that developing digital competence among pre-service teachers is an urgent requirement in the context of educational digital transformation. Research has primarily focused on constructing digital competence frameworks, assessing the current situation, and proposing solutions through innovations in curricula, teaching methods, teacher training, and technological infrastructure. Digital competence among pre-service teachers is not limited to ICT use in teaching but also encompasses creative thinking, information literacy, and professional digital skills—forming the foundation for a teaching workforce capable of meeting the demands of the digital era.

### 3. Methodology

The study employed a mixed-methods design combining a questionnaire survey and semi-structured interviews to collect data on university students' digital competence and the influencing factors from lecturers. Cluster sampling was employed, focusing on second- and third-year students enrolled in teacher education programs and foreign language majors at four selected universities. A minimum of 150 students per university were ensured to participate in the survey. The questionnaire was designed and administered via Google Forms, and data were collected from March to June 2025. The research sample comprised 620 second-year students and 300 lecturers from four universities in the northern mountainous region of Vietnam, selected to ensure representativeness of the regional higher education context.

Data were gathered through quantitative questionnaires and qualitative interviews. The interviews were conducted using semi-structured interview guides, with full audio recordings and detailed field notes, adhering to research ethics principles, including data coding and participant anonymity. The qualitative data were analyzed thematically to identify recurring patterns and salient factors that illustrate the current state of students' digital competence as well as the lecturers' influence on its development.

### 4. Results and Discussion

#### (i) Digital Competence of Pre-service Teachers at Universities in Northern Vietnam

Drawing on digital competence frameworks for university students proposed in previous studies (UNESCO, 2018,

2021; European Commission, 2022; Trần Đức Hoà, 2021) and guided by the Circular No. 02 (2025) of the Vietnamese Ministry of Education and Training (MOET) on learners' digital competence standards, this study assessed students' digital competence across six key domains: (1) ability to search for, evaluate, and process digital information; (2) critical thinking and problem-solving with digital technologies; (3) communication and collaboration in digital environments; (4) creation of academic digital content; (5) ensuring digital safety, ethics, and copyright compliance; and (6) use of artificial intelligence (AI).

A questionnaire was designed using a five-point Likert scale to measure items representing these six domains of students' digital competence. The collected data were analyzed based on mean scores, as presented in the following table.

**Table 1.** Current Status of Students' Digital Competence

No.	Content	Mean (Lecturer)	Mean (Student)
1	Ability to search for, evaluate, and process digital information	2.76	2.99
2	Critical thinking and problem-solving competence using digital technologies	2.74	2.89
3	Competence in digital communication and academic collaboration	2.92	3.06
4	Competence in creating academic digital content	2.83	2.99
5	Competence in ensuring digital safety, ethics, and copyright compliance	2.77	3.17
6	Application of Artificial Intelligence (AI)	2.71	3.04

Table 1 indicates that students' digital competence is at a moderate level, with mean scores ranging from 2.71 to 3.17 across six dimensions. Lecturers' assessments and students' self-assessments show largely consistent perceptions, although students tend to rate themselves slightly higher. Higher mean scores were observed for digital communication and academic collaboration and for digital safety, ethics, and copyright compliance. In contrast, lower scores were found for the application of Artificial Intelligence (AI) and for critical thinking and problem-solving using digital technologies, suggesting that these competencies are still developing. Overall, the alignment between lecturers' and students' evaluations reflects a shared understanding of students' current digital competence.

Findings from in-depth interviews and group discussions indicate that although most students are able to access and use basic digital platforms for learning purposes, there remain substantial disparities in access to digital devices and technological infrastructure, largely due to differences in family economic backgrounds. These constraints help explain the moderate level of students' digital competence, particularly in areas related to digital content creation, digital safety, legal awareness, and copyright compliance, as well as critical thinking and problem-solving using digital technologies.

In addition, while students are generally familiar with digital technologies and AI tools at a basic level, a subset of students exhibits passive learning behaviors and an over-reliance on AI, using such tools mechanically rather than critically. This tendency may hinder the development of higher-order thinking skills. Furthermore, challenges in implementing LMS-based learning—including limited internet bandwidth, outdated learning facilities, and a lack of technological synchronization—combined with students' reliance on personal devices under unequal learning conditions, have resulted in unequal opportunities to engage in digital learning environments.

Overall, university students' digital competence can be characterized as moderate to relatively high, yet it remains constrained by various individual and institutional barriers, highlighting the need for systematic institutional assessments and comprehensive interventions to reduce inequalities in learning conditions and promote more equitable development of digital competence among university students.

#### *(ii) Solutions for Developing Digital Competence among Pre-service Teachers*

According to UNESCO (2018), the development of digital competence for pre-service teachers should be aligned with teacher professional standards and the competence to organize teaching in technology-enhanced environments. The ICT Competency Framework for Teachers (ICT-CFT, 2018) emphasizes the importance of integrating technology into teacher education programs to enable students to effectively apply digital tools and resources in authentic classroom contexts.

Building upon previous studies on developing digital competence in higher education, key solutions have focused on: Utilizing digital learning environments (Imjai, Chansamran, Sungthong, Usman, & Aujirapongpan, 2025); Innovating

teaching methods and integrating digital competence development throughout the entire training process, rather than limiting it to a single course (Rentería Macías, 2024); Enhancing lecturers' digital competence and revising teacher education curricula to align with digital transformation goals (Rahimi, 2024; Hoaihongthong, Laorach, & Laonayor, 2024).

Based on this foundation, the present study focuses on examining the implementation of solutions for developing students' digital competence in two main directions: Integrating digital competence development within teaching and training activities, and Integrating digital competence development through the organization of co-curricular and extracurricular activities.

**Table 2.** Current Solutions for Developing Students' Digital Competence

No.	Item	Lecturers			Students		
		Mean (M)	SD	Rank	Mean (M)	SD	Rank
<b>I</b>	<b>Integrating digital competence development into training activities</b>	<b>3.44</b>			<b>3.26</b>		
1	Establishing digital competence learning outcomes within the training program	3.58	.912	2	3.36	.839	1
2	Including a course on digital competence development in the training program	3.44	.968	4	3.34	.830	2
3	Integrating digital competence development through teaching methods	3.41	.930	5	3.15	.799	7
4	Integrating digital competence development into courses on research methods and professional skill training	3.31	.984	6	3.17	.806	5
5	Requiring students to collaborate via digital platforms such as Google Docs, MS Teams, or Zoom, and to submit digital learning products such as videos, presentations, infographics, and e-portfolios	3.58	.938	3	3.27	.986	4
6	Organizing online and blended learning formats	3.61	.921	1	3.33	.938	3
7	Developing digital competence through experiential learning during professional internships	3.15	.926	7	3.17	1.013	5
<b>II</b>	<b>Integrating digital competence development through Youth Union and Student Association activities</b>	<b>3.49</b>			<b>3.30</b>		
8	Providing training and workshops for students on digital competence in designing and organizing professional or discipline-specific activities aligned with the characteristics of their faculty or university	3.56	.936	5	3.17	.897	8
9	Organizing competitions at the faculty or university level through Youth Union or Student Association initiatives on applying digital competence in learning or professional fields	3.52	.912	6	3.29	.894	5
10	Organizing student competitions for designing posters, infographics, and video clips using digital tools such as Canva, CapCut, and Genially	3.44	.992	8	3.28	.996	6

**Table 2.** Current Solutions for Developing Students' Digital Competence(continued)

No.	Item	Lecturers			Students		
		Mean (M)	SD	Rank	Mean (M)	SD	Rank
<b>Integrating digital competence development through Youth Union and Student Association activities</b>							
II	development through Youth Union and Student Association activities	3.49			3.30		
11	Implementing fanpage management and digital content creation, including post design and multimedia production on platforms such as Facebook, TikTok, and Instagram	3.58	.959	4	3.23	.820	9
12	Organizing online talks, livestreams, and seminars on current affairs, academic topics, and life skills via platforms such as Zoom and Google Meet	3.63	.940	3	3.28	.826	6
13	Using Google Forms, Google Sheets, and Notion to manage membership data, organize events, and track task progress	3.68	.938	2	3.34	.806	3
14	Organizing digital volunteer and community engagement activities such as creating websites or social media accounts to promote volunteer programs, fundraise, and support students through online learning initiatives	2.74	.774	9	3.35	.826	2
15	Organizing skill-sharing sessions on tools such as Canva, SPSS, and Google Workspace within student Technology Clubs and Media Clubs	3.49	.962	7	3.34	.826	3
16	Self-learning and self-development	3.77	1.001	1	3.44	.847	1

The results in Table 2 indicate that the current solutions for developing students' digital competence are evaluated at a moderate to high level, with overall mean scores ranging from 3.15 to 3.77. Within formal training activities, lecturers rated organizing online and blended learning formats as the most effective solution ( $M = 3.61$ , Rank 1), while students assigned the highest priority to establishing digital competence learning outcomes within the training program ( $M = 3.36$ , Rank 1). In contrast, solutions related to integrating digital competence through teaching methods (students:  $M = 3.15$ , Rank 7) and experiential learning during professional internships (lecturers:  $M = 3.15$ , Rank 7) received comparatively lower evaluations, suggesting that the pedagogical and practice-based integration of digital competence remains uneven across learning contexts.

Regarding extracurricular activities, solutions implemented through Youth Union and Student Association initiatives were also positively perceived, with mean scores of  $M = 3.49$  (lecturers) and  $M = 3.30$  (students). Notably, a discrepancy was observed in perceptions of digital volunteer and community engagement activities, which were rated lowest by lecturers ( $M = 2.74$ , Rank 9) but highly by students ( $M = 3.35$ , Rank 2). Across all solutions, self-learning and self-development emerged as the most influential strategy for both lecturers ( $M = 3.77$ , Rank 1) and students ( $M = 3.44$ , Rank 1), underscoring the crucial role of learner autonomy in the development of digital competence. These findings suggest that universities should complement institutional and curricular interventions with targeted support mechanisms that foster self-directed learning while addressing inequalities in students' access to digital resources.

Overall, the findings indicate that universities have implemented a relatively diverse set of measures to promote students' digital competence, which is consistent with the moderate to high mean scores reported across most solutions in Table 2. Both survey and interview data suggest that digital competence development has been increasingly emphasized through online and blended course design, innovation in assessment methods, and digital management of student learning. However, the effectiveness of these measures remains uneven, particularly in terms of pedagogical integration and experiential learning. Interview data reveal that the impact of teaching practices on students' digital

competence largely depends on individual lecturers' digital competence levels, which helps explain the lower ratings for solutions related to classroom-based integration and practicum-oriented activities.

Similarly, activities implemented through Youth Union and Student Association programs were perceived as moderately effective and contributed to diversifying opportunities for digital competence development. Nevertheless, qualitative findings indicate that these extracurricular initiatives are often fragmented and weakly connected to formal curricula, resulting in modest overall outcomes. The relatively lower evaluations of research methodology courses, professional skill-oriented subjects, and practicum placements further highlight existing gaps in practice-based digital competence development at the four universities in Northern of Vietnam. Together, these findings underscore the need for clearer institutional strategies and more systematic planning to better integrate formal training, teaching practices, and extracurricular activities into a coherent digital learning ecosystem aligned with the requirements of the digital transformation era.

*(iii) Factors Influencing the Development of Students' Digital Competence*

**Table 3.** Factors Influencing the Development of Digital Competence among Students (Lecturer Survey)

No.	Item	Level of Influence					Mean (M)	SD	Rank
		1	2	3	4	5			
1	Learning outcomes of the training program	12	10	65	147	66	3.82	.948	10
2	Digital transformation context in higher education institutions	9	8	64	156	63	3.85	.884	9
3	Training activities designed within the digital environment	9	14	62	160	55	3.79	.898	11
4	Work environment and employment positions after graduation requiring strong digital competence	10	4	62	164	60	3.87	.863	6
5	Each course (module) in the training program specifies explicit digital competence learning outcomes	7	16	66	160	51	3.77	.874	12
6	Completion of learning tasks assigned by lecturers requires students to possess a certain level of digital competence	4	11	62	167	56	3.87	.803	6
7	Internet connectivity and technological infrastructure in higher education institutions must be modernized	1	10	59	158	72	3.97	.775	1
8	Lecturers' digital competence	3	13	54	158	72	3.94	.826	3
9	Digital competence of technical staff, librarians, and laboratory assistants	3	15	48	167	67	3.93	.819	4
10	Conditions of the library and digital learning resource repositories	5	8	54	160	73	3.96	.825	2
11	Digital competence training and capacity-building programs organized by faculties, universities, and student or youth unions	5	10	51	171	63	3.92	.812	5
12	Annual seminars and discussions on students' digital competence in relation to their fields of study	10	10	52	168	60	3.86	.889	8
<b>Overall Mean (M)</b>		<b>3.88</b>							

The development of digital competence among university students is shaped by multiple interrelated factors that exert significant influence on their learning process. The factors that directly affect students' digital competence include psychological and digital awareness variables, environmental and infrastructural conditions, and demographic characteristics (Norhagen, Krumsvik, & Røkenes, 2024; Veloz Segura, Veloz Segura, Veloz Segura, & Núñez Michuy, 2024; Ru-Zhue et al., 2025). Within the higher education context, the factors influencing the process of digital competence development can be grouped into several dimensions: learning strategies, students' competence and skills,

teaching methods, learning resources and facilities, and lecturers' digital competence (Zheng & Kim, 2025; González Medina & Hernández Fernández, 2025; Rahimi, 2024). Based on the synthesis of previous studies on factors affecting digital competence development among university students, this study designed a survey instrument focusing on key influencing dimensions, including: components of the training program, aspects of program management and implementation, lecturers' competence, and technological infrastructure. These dimensions formed the basis for the development of the questionnaire items presented in Table 3.

Based on Table 3, lecturers' responses reveal that the overall level of influence of the examined factors is high ( $M = 3.88$ ), indicating that the digital competence of students is shaped by a combination of institutional, pedagogical, and technological elements.

Among all items, the most influential factor identified by lecturers is "Internet connectivity and technological infrastructure in higher education institutions" ( $M = 3.97$ ;  $SD = .775$ ), which ranks first. This highlights the crucial role of a modern and well-equipped digital infrastructure in supporting students' access to online learning resources, collaboration platforms, and digital assessment systems. Closely following are "Conditions of the library and digital learning resource repositories" ( $M = 3.96$ ) and "Lecturers' digital competence" ( $M = 3.94$ ), underscoring that institutional resources and teacher capacity are foundational conditions for fostering digital learning environments.

Factors related to institutional support and human resources, such as "Digital competence of technical staff, librarians, and laboratory assistants" ( $M = 3.93$ ) and "Digital competence training and capacity-building programs organized by faculties, universities, and student or youth unions" ( $M = 3.92$ ), also received high evaluations. These results suggest that the collaborative contribution of multiple stakeholders—academic, technical, and student organizations—is essential to sustain effective digital competence development across the university ecosystem.

Meanwhile, pedagogical and curricular elements, including "Learning outcomes of the training program" ( $M = 3.82$ ), "Training activities designed within the digital environment" ( $M = 3.79$ ), and "Each course specifying explicit digital competence learning outcomes" ( $M = 3.77$ ), were rated slightly lower. This indicates that, although policy-level and infrastructure-related factors are well recognized, the integration of digital competence into specific courses and learning activities still needs improvement.

Overall, the findings demonstrate that the advancement of students' digital competence is not solely dependent on individual motivation but relies heavily on a supportive institutional environment, robust digital infrastructure, and educators' digital proficiency. Strengthening these interconnected components can create a comprehensive and sustainable foundation for digital transformation in higher education.

The findings indicate that multiple factors influence the development of digital competence among students at universities in the northern mountainous region of Vietnam, including: (1) the national and local context of digital transformation; (2) policies of the Ministry of Education and Training (MOET); (3) the competence of the teaching staff; and (4) the availability of digital infrastructure and facilities.

Quantitative survey results show that all 12 factors listed in the questionnaire were rated by lecturers as having a moderate influence on the development of students' digital competence. The qualitative interview data further clarified the critical role of technological infrastructure. Lecturer 4, Lecturer 5, and a discussion group of five to seven lecturers emphasized that "facilities and technological infrastructure are decisive factors affecting the digital competence of both teachers and students." However, they also noted existing limitations related to internet speed, equipment, and learning tools.

From the students' perspective, groups Student 3 and Student 4 shared that "some students still lack personal devices such as smartphones and laptops, while network conditions and classrooms are inadequate for practicing digital skills." Several students also acknowledged that lecturers' awareness and expectations regarding digital competence positively influenced their motivation for self-learning and digital skill practice.

Additionally, Student 5 highlighted that "assignments requiring the use of digital technologies contribute to the development of discipline-specific digital skills; however, their effectiveness remains limited due to insufficient equipment, weak internet connections, and unsynchronized LMS systems." Lecturer 3 further noted that many students "are still unaware of legal regulations when engaging in online environments."

Analysis of lecturers' responses also revealed that curriculum design, teaching and learning activities, organizational conditions, and the overall context of digital transformation have direct yet varying impacts on individual students' digital competence development.

## 5. Limitations of the Current Study

This study has several limitations that should be acknowledged. First, the research was conducted in four universities in northern Vietnam, so the findings may not fully represent the national context. Second, the cross-sectional design captures only a single time point and does not reflect changes in digital competence over time. Third, the data were mainly self-reported, which may involve subjective bias. In addition, the qualitative component was limited in scope, and differences across disciplines were not examined. Future studies should expand the sample, apply longitudinal or experimental approaches, and include objective assessments to provide more comprehensive evidence.

## 6. Conclusion and Implications

The digital competence of pre-service teachers at universities in northern Vietnam has gained increasing attention and currently reaches a moderate to fairly good level. Most institutions integrate digital competence development into academic and extracurricular activities, yet implementation remains generic and uneven, depending largely on lecturers' capacity and technological infrastructure.

Students mostly possess basic digital skills, while their creative design and digital pedagogy abilities are still limited due to a lack of practical learning environments. digital competence development is shaped by institutional policy, infrastructure, and staff competence.

To improve outcomes, universities should embed digital competence systematically in teacher education curricula, enhance digital practicum experiences, and build a digital learning ecosystem. Continuous professional development for lecturers and pedagogical innovation are essential for sustaining progress.

This study provides empirical evidence to inform university policies on digital competence development. However, it does not compare differences across disciplines or academic years. Future research should focus on discipline-specific frameworks and policy effectiveness in advancing digital transformation in teacher education.

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## Acknowledgments

The authors sincerely appreciate the valuable contributions of all participants who took part in the survey and interviews for this study. The authors also acknowledge the Ministry of Education and Training for funding this research and all members of the research team for their time and efforts.

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Assoc. Prof. Ha Thi Kim Linh and Dr. Dam Thi Kim Thu: Conceptualization, study design, manuscript drafting, writing, revision, and final approval.

Assoc. Prof. Nguyen Thi Thanh Huyen: Supervision, editing, and final approval.

Dr. Duong Thi Nga and Dr. Dam Thi Kim Thu: Survey administration, data analysis, writing, and final approval.

All authors have read and approved the final manuscript. Any special agreements concerning authorship, including equal contributions, are stated in this section.

## Funding

This work was supported by Ministry of Education and Training, Vietnam [Project code: B2024-TNA-03].

## Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Informed consent

Obtained.

## Ethics approval

The Publication Ethics Committee of the Sciedu Press.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

## Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

## Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

## Data sharing statement

No additional data are available.

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