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Author for correspondence:
Trinh Thi Huong
thihuong@ctu.edu.vn
Can Tho University, Vietnam

Primary School Teacher Educators' Digital Competence: Perceived Confidence and Continuing Needs for 21st-Century Teaching

Trinh Thi Huong, Phan Ngoc Tuong Vy, Lu Hung Minh, Nguyen Thi Linh

Abstract

Background/purpose. As digital technologies transform education, primary school teacher educators (PSTEs) play a proactive role in preparing pre-service teachers. However, research on PSTEs' digital skills in the Vietnamese context is limited, with few studies providing a structured framework for digital competence. This study aims to explore PSTEs' perceived confidence in their digital skills and identify their continuing needs.

Materials/methods. The study adopted an explanatory mixed-methods design. Document analysis was initially conducted to develop a framework for digital competence. 129 PSTEs with over 10 years of teaching from three main regions in Vietnam were purposely selected to fill in a questionnaire assessing their perceived confidence in six competence domains. Twelve participants from different demographic backgrounds participated in semi-structured interviews to voice their needs for digital competence development.

Results. Findings indicate that PSTEs report fairly high levels of confidence across different areas of digital competence. PSTEs have highest confidence in digital communication and literacy, but lower confidence in solving technical issues and applying AI. They expressed concerns about maintaining professional image, ensuring digital safety and credibility, and achieving equity in technology use, influenced by regional features, gendered assumptions, and generational gaps.

Conclusion. The study concludes that PSTEs in Vietnam need context-sensitive training to develop and appropriately apply specific digital skills. Integrating self-efficacy-based strategies like peer collaboration, hands-on learning, emotional support, societal backing, and addressing technology misconceptions can enhance their confidence and competence in preparing future educators for the digital era.

1. Introduction

The rapid transformation of digital technologies in the 21st century has reshaped worldwide education, driven by technological innovation, environmental sustainability, the COVID-19 pandemic, and natural disasters, all of which have intensified the need for digital competence worldwide. In this interconnected, technology-driven era, digital literacy is essential for both learners and educators, ensuring that they can navigate the digital landscape effectively. As the world adapts to the challenges and opportunities posed by digital technologies, it has become clear that preparing educators for this new reality is crucial to fostering a generation that is digitally competent and ready for the future.

Despite such global emphasis, there are few empirical studies in Vietnamese contexts regarding primary school teacher educators (PSTEs). To fill this gap, this study adopted an explanatory mixed-methods design, commencing with document analysis to develop a digital competence framework, followed by a questionnaire and semi-structured interviews to assess PSTEs' perceived confidence and their professional development needs. The results indicate that while PSTEs express relatively high confidence in certain areas of digital communication and safety, concerns were identified with digital problem solvings of technical issues and adopting emerging trends, particularly artificial intelligence (AI). The findings and discussion imply the expectations for tailored continuing professional development (CPD) programs to address these challenges and enhance PSTEs' digital competence. By incorporating strategies based on self-efficacy theory, these programs can improve PSTEs' confidence and prepare them to guide future educators in an ever-changing world.

2. Literature Review

2.1. Teachers' digital competence

As technology continues to progress at a rapid pace, digital competence has become an indubitably vital skill set, chiefly in human resources training and education. Defined broadly as the confident and critical utilization of digital technologies for virtually communicating, cooperating, content creating, and solving problems, digital competence has been recognized as an essential component of 21st-century skills (Laar et al., 2017). Frameworks proposed by the European Commission's DigComp and UNESCO's Information and Communication Technology (ICT) Competency Framework for teachers offer several structured definitions, outlining digital competence as a multidimensional construct that extends beyond basic technical skills (Christine, 2017; Mattar et al., 2020). These frameworks associate technology with ethical, pedagogical, and safety considerations, figuring out the need for educators and related stakeholders in the field to individually and collaboratively navigate digital environments in a responsible manner.

Within the educational context, digital competence takes on a more dynamic role, surpassing mere technological proficiency to encompass the ability to integrate digital tools into meaningful pedagogical practices (Amhag, Hellström, & Stigmar, 2019). Digital competence is a multifaceted requirement for all stakeholders in education, with each group's distinct role in shaping and implementing digital practices aligned to their responsibilities. Students, as the primary beneficiaries of digital integration, require certain skills for basic technological use. Digital competence for students includes information literacy, critical thinking in online environments, responsible digital citizenship, and the ability to self-study with digital tools for learning and collaboration (Zhao, Llorente, & Gómez, 2021). Regarding classroom management, teachers must develop instructional strategies for digital learning, ensuring student engagement while addressing issues such as screen time balance, online safety, and equitable access to resources (Abimbola et al., 2024). School leaders play a critical role in shaping educational institutions' digital infrastructure and culture. Their digital competence involves strategic decision-making related to technology procurement, digital resource allocation, and the implementation of professional development programs for teachers (Karakose,

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Polat, & Papadakis, 2021). Administrators also oversee data security policies, ensuring compliance with ethical and legal standards for student and staff data protection (Hina, Dhanapal, & Dominic, 2020). Policymakers further influence the broader digital education landscape through curriculum reforms, funding initiatives, and regulatory frameworks. Their digital competence is centered on understanding global and local technological trends, setting benchmarks for digital literacy, and addressing digital divides across different regions (Hsu, Irie, & Ching, 2019; Llorent-Vaquero, De Pablos-Pons, & Velez, 2023). Lastly, with a proactive stance, teacher educators should not only possess expertise in digital tools but also critically assess their pedagogical impact, equipping future teachers to anticipate challenges and demonstrate agency in the evolving digital education sphere (Choi-Lundberg et al., 2023; Rahimi & Tafazoli, 2022).

2.2. Primary school teachers in digital era

In the digital era, primary school teachers worldwide have increasingly integrated technology into their teaching practices, reflecting a global shift toward digitized education. Empirical studies prove digital competence's benefits in improving instructional effectiveness, fostering student engagement, and enhancing overall learning outcomes (Falloon, 2020; Rawal, 2024). Teachers with advanced digital proficiency are more inclined to implement technology-enhanced teaching strategies, including hybrid learning, personalized learning platforms, game-based instruction, and dynamic multimedia tools (Kasperski, Blau, & Ben-Yehudah, 2022; Yondler & Blau, 2021). Despite the recognized advantages, the extent and success of digital integration in primary education vary significantly across countries and educational contexts. Research from developed nations accentuates the importance of institutional support, well-structured professional development programs, and strong policy frameworks in ensuring effective technology use in classrooms (Hubers, D.Endedijk, & Van Veen, 2020). Nevertheless, studies from developing nations attribute the sluggish or inefficient integration of technology to restricted access to digital facilities, inadequate educator preparation, and inequalities in technological provisions between metropolitan and remote schools (Dolo & Flomo, 2024; Ofosu-Asare, 2024). Besides, threats that directly related to digital tools are classroom management, screen time regulation, data privacy concerns, and the pedagogical alignment of digital tools have been widely debated, illustrating the complexities of digital transformation in primary education (Genlott et al., 2021; Quaicoe, Ogunyemi, & Bauters, 2023).

Aforementioned were more of the advantages and challenges that primary school teachers share with other teachers and practitioners. Nonetheless, embedding digital tools for young learners presents unique challenges, as they are still developing cognitive, social, and motor skills, necessitating complex approaches to digital integration (Trinh, Phan, & Phan, 2025). Edwards et al. (2018) and Ongoro and Fanjiang (2024) discussed that while interactive storytelling and gamified learning can enhance literacy and numeracy, teachers worry about excessive screen time, passive content consumption, and reduced face-to-face interactions. Digital scaffolding is also essential, as younger students struggle with independent technology use and require structured teacher guidance (Puntambekar, 2021; Sharma & Hannafin, 2007). Sun et al. (2021) suggest blending digital tools with hands-on activities could foster outcomes for primary school learners. Teacher digital readiness further shapes integration success, requiring not just technical skills but also adaptive teaching strategies to design digital lessons with balanced engagement pedagogy (Nikolopoulou et al., 2020). Lastly, digital citizenship education is particularly crucial in primary education, as teachers gradually introduce young learners to online safety, responsible communication, and critical media literacy, laying the foundation for lifelong responsible technology use (Lauricella, Herdzina, & Robb, 2020; Opria & Momanu, 2023).

In Vietnam, digital competence has become an area of increasing focus, particularly within national efforts to modernize the education system (Tran et al., 2020). However, mostly aligning with international studies from developing countries, implementation remains uneven across regions,

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with urban schools benefiting from better access to technology and training opportunities, while rural schools continue to face resource limitations. Vietnam's Ministry of Education and Training (MoET) has insisted on teachers' development of strong digital skills, yet outdated equipment, limited institutional support, and a lack of targeted professional development programs still persist (Nguyen et al., 2024). The dominance of conventional exam-oriented teaching approaches sometimes clashes with the interactive, student-centered approaches facilitated by digital tools, leading to inconsistencies in how digital competence is perceived and applied in practice. Although considerable research has explored digital education trends, studies focusing on primary school teacher educators remain scarce. As influential figures in preparing pre-service teachers, teacher educators' digital competence will partially or almost completely shape the next generation of digitally competent educators (Hoang et al., 2022). However, their professional development needs and perceptions of digital competence have not been sufficiently addressed in the literature. Since digital competence remains an ambiguous construct for many teacher educators, there is a need to classify its components from foundational to advanced levels. This study aims to synthesize existing literature and national policies to create a digital competence framework and then apply this framework to explore Vietnamese pre-service teacher educators' confidence in their digital skills and their professional development needs for effective technology integration in education.

2.3. Conceptual and theoretical framework guiding the study

Figure 1 presents specific digital competence skills extracted from Thông tư số 02/2025/TT-BGDĐT: Quy định Khung năng lực số trong giáo dục (Circular No. 02/2025/TT-BGDĐT: Regulations on the Digital Competence Framework for Education). While the main domains follow the original structure of the framework, the specific skills have been rearranged according to Bloom’s Taxonomy, ranging from lower-order to higher-order skills for better comprehension. This framework applies to relevant stakeholders, encompassing teachers, practitioners, and students, who represent the final recipients of education across various contexts in Vietnam. Thus, it demands contextualization when assessing specific cases to ensure its applicability and effectiveness in different educational settings.

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Data and information literacy	➢ Search for accurate and relevant information ➢ Organize and manage digital resources ➢ Identify suitable academic sources for lesson planning ➢ Evaluate the credibility of online educational content ➢ Adjust content to align with cultural and contextual values.
Communication and collaboration	➢ Use digital platforms for communication ➢ Collaborate with educators and students online ➢ Communicate inclusively across diverse backgrounds ➢ Engage in digital education communities ➢ Manage and model professional digital image
Digital content creation	➢ Create interactive digital materials ➢ Edit multimedia resources to fit educational goals ➢ Apply copyright and licensing rules ➢ Integrate multiple sources into educational content ➢ Use coding or design tools for interactive materials.
Digital safety	➢ Protect personal data and model safe practices ➢ Teach strategies against digital security threats ➢ Promote digital well-being and responsible tech use ➢ Advocate for eco-friendly digital practices ➢ Address online risks like cyberbullying and misinformation
Digital problem solving	➢ Troubleshoot technical issues in teaching ➢ Explore new educational technologies ➢ Adapt to evolving digital platforms ➢ Use digital tools to solve classroom challenges ➢ Reflect and seek professional development in edtech
AI application	➢ Understand basic AI functions in education ➢ Use AI tools to support academic work ➢ Assess the accuracy of AI-generated content ➢ Discuss AI ethical considerations ➢ Guide responsible AI use in classrooms.

Figure 1. The adopted digital competence framework in the study

This study is grounded in Bandura's (1997) Self-Efficacy Theory to examine teacher educators' digital competence and their perceived confidence in adopting technology for teacher preparation programs. When mentioning self-efficacy, it refers to an individual's belief in their ability to successfully perform specific tasks, playing a crucial role in professional learning, instructional decisions, and overall teaching effectiveness (Zonoubi, Rasekh, & Tavakoli, 2017). Self-efficacy comprises four core sources that shape and enhance self-efficacy: Performance Experiences, Vicarious Experiences, Social Persuasion, and Physiological Feedback (Bandura & Wessels, 1997). First, Performance Experiences, or direct involvement plays an indispensable role, as hands-on engagement with educational technologies strengthens their self-perceived competence. Second, Vicarious Experiences, or observing peers or experts successfully integrating digital tools, reinforce beliefs in their own ability to do the same. Third, Social Persuasion, including institutional support, peer collaboration, and mentorship, boosts confidence in digital teaching practices. Lastly, Physiological Feedback, such as anxiety, excitement, stemming workload pressures and emotional management strategies, influence self-efficacy to varying extent. As the main focus of this study is digital competence, Figure 2 provides an illustrative representation of self-efficacy principles related to technological proficiency.

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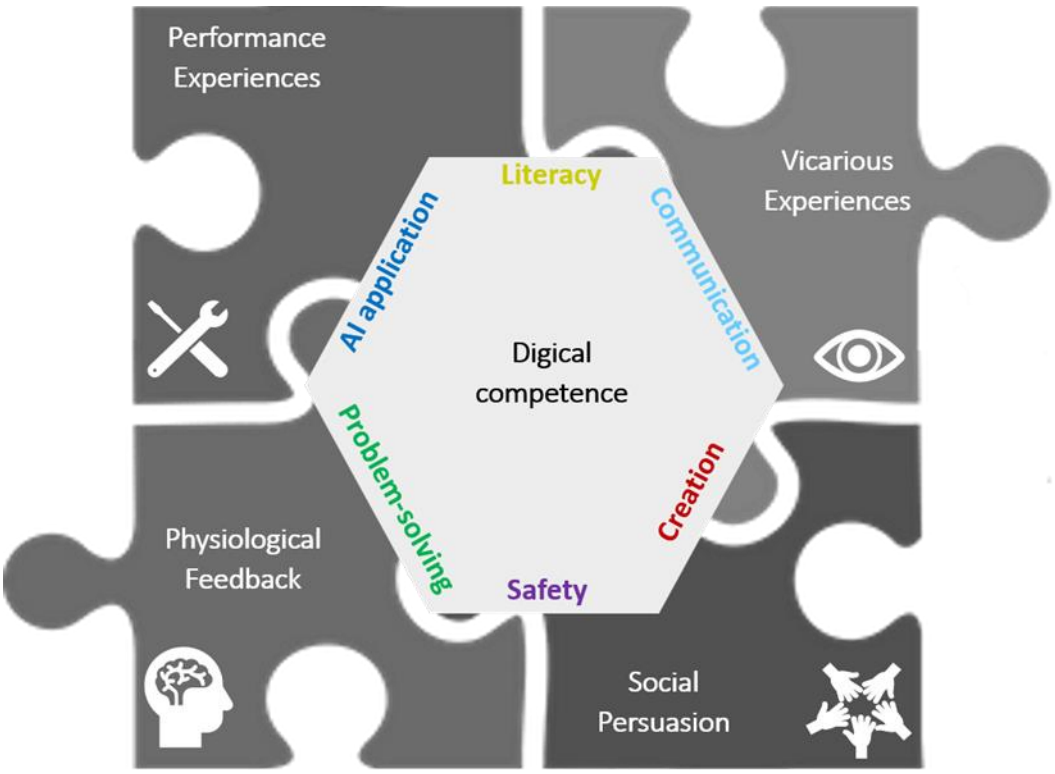

Figure 2. The emerging blueprint guiding the study

Guided by these principles, two research questions were formed in this study:

1. What is primary school teacher educators' perceived confidence in digital competence, and which domains are their strongest and weakest?

2. What are primary school teacher educators' concerns and needs for developing digital competence?

3. Methodology

3.1. Research design

This study adopted a divergent mixed-methods design, utilizing an explanatory sequential approach, where the quantitative phase preceded the qualitative phase (Subedi, 2016; Tashakkori, Johnson, & Teddlie, 2020). Questions were established through identified gaps and theoretical frameworks to investigate the perceived confidence and concerns of PSTEs in Vietnam regarding their digital competence for 21st-century teaching. Due to the regulatory framework established by the MoET, only public universities situated in municipalities or provincial centers were authorized to offer Primary School Teacher Education programs. Thus, this study targeted 20 eligible universities, selected through a professional network of teacher educators spanning three regions of Vietnam. These regions encompass diverse geographical contexts, from mountainous areas Northwestern Vietnam and the Central Highlands, coastal provinces, to the southern deltas. All participating teacher educators were regarded as experienced professionals, having a minimum of ten years of preparing pre-service primary school teachers. Their extensive professional backgrounds encompassed multiple policy shifts and educational initiatives, positioning them as key informants in examining the integration of digital competence into teacher education.

3.2. Research participants

The study utilized a purposive sampling technique to recruit participants who met specific criteria for meaningful insights relevant to the study's objectives (Robinson, 2024). The selected participants were full-time PSTEs with a minimum of 10 years of experience and working in different regions of

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Vietnam (see Table 1). Given that digital competence is the most critical skill for the 21st century and has gained even greater significance following the COVID-19 pandemic, veteran teacher educators in Vietnam's workforce were intentionally chosen. With their age and years of teaching experience, it can be traced back that they were trained in a time when digital tools were either very limited or completely absent. Their perspectives, therefore, offer inclusive insights into their perceived confidence for integrating digital competence into teacher education, particularly in preparing themselves and pre-service teachers to meet the demands of a technology-driven era. Ethical guidelines ensured participants' rights and confidentiality. Informed consent was obtained, with voluntary participation and the right to withdraw. Pseudonyms protected anonymity, and data were securely stored. Interviews were anonymized for confirmability, adhering to ethical standards.

Table 1. Summary of the questionnaire participants

Demographic variable		N = 129
Gender	Female	34 (26.36%)
	Male	95 (73.64%)
Years as full-time PSTEs	10-15 years	53 (41.09%)
	More than 16 years	76 (58.91%)
Regions	Northern Vietnam	39 (30.23%)
	Central Vietnam	33 (25.58%)
	Southern Vietnam	57 (44.18%)

As this study follows an explanatory sequential design, interview participants were selected based on the criteria from the quantitative phase. The selection aimed to ensure diverse representation in terms of gender, teaching experience, and regional background, allowing for a deeper exploration of possibly diverse patterns identified through the questionnaire (see Table 2).

Table 2. Summary of the interview participants

PSTE ID	Gender	Teaching experience	
P1	Male	10 years	Northern region
P2	Male	11 years	
P3	Female	12 years	
P4	Female	16 years	
P5	Male	12 years	Central Region
P6	Male	12 years	
P7	Female	16 years	
P8	Female	18 years	
P9	Male	10 years	Southern region
P10	Male	18 years	
P11	Female	19 years	
P12	Female	21 years	

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3.3. Research instruments

Two main instruments were used for data collection in this study. At first, a questionnaire was administered to investigate PSTEs' perceived confidence about digital competence in around one month. The process continued with semi-structured interviews conducted with selected participants to explore their concerns and needs for digital competence in greater depth (see Table 3).

Table 3. Research instruments and their aims

Instruments	Aims
Questionnaire	Examine PSTEs' perceived confidence about digital competence.
Semi-structured interviews	Explore PSTEs' needs for developing digital competence.

The questionnaire served as an economical and efficient tool for collecting data on a large scale within a limited timeframe and geographical distance (Belisario et al., 2015). In the demographic section, participants' gender, years of experience, and work region were captured. In the survey section assessing self-reported confidence about digital competence, a total of 30 questionnaire items were put into six clusters based on the MoET's six domains. The items were listed following the MoET's original descriptions without being reordered or ranked by skill level to avoid influencing respondents' perceptions. Each item was adapted to link with PSTEs' responsibilities in preparing pre-service teachers. Responses were measured by 5-point Likert scale from 1 (Very Unconfident), 2 (Unconfident), 3 (Neutral), 4 (Confident), to 5 (Very Confident) (see Table 4).

Table 4. Summary of the questionnaire

Questionnaire section		Item
Demographic section	Gender, teacher experience, work region	I, II, III
Cluster section	A. Data information and literacy	1, 2, 3, 4, 5
	B. Digital communication and collaboration	6, 7, 8, 9, 10
	C. Digital content creation	11, 12, 13, 14, 15
	D. Digital safety	16, 17, 18, 19, 20
	E. Digital problem solving	21, 22, 23, 24, 25
	F. AI application	26, 27, 28, 29, 30

Following the questionnaire phase, selected participants took part in semi-structured interviews to further elaborate on their responses regarding the six domains of digital competence. Lasting approximately 30 to 40 minutes, these interviews aimed to explore participants' experiences with digital competence, deducing from their concerns to their continuing needs. As the interviewees were actively working across three regions of the country, P11 and P12 took part in offline interviews, while ten teachers from P1 to P10 participated in online interviews. All interviews were carried out in Vietnamese and recorded with participants' agreement.

3.4. Data analysis

SPSS version 27.0 was employed to analyze the questionnaire data for the quantitative phase, with reliability testing yielding a Cronbach's alpha of 0.986, indicating high internal consistency (Vaske, Beaman, & Sponarski, 2017). Means and standard deviations were calculated as descriptive statistics to demonstrate PSTEs' perceived confidence levels in digital competence. Inferential statistical analyses, including two independent samples t-tests and a one-way ANOVA, were

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conducted to examine differences in confidence levels based on demographic factors such as gender, teaching experience, and work region.

A thematic approach was used to examine the transcribed interview data for the qualitative analysis. Through an inductive coding process, umbrella themes of PSTEs' challenges and support needs in developing digital competence emerged. The analysis adhered to the guideline from Padilla (1996), which involved becoming familiar with the data, generating initial codes, identifying patterns, refining themes, defining and labeling themes, and compiling the final report (Goldsmith, 2021). To uphold trustworthiness, member checking, peer debriefing, and maintaining an audit trail were employed to strengthen the credibility and confirmability of the findings (Creswell & Poth, 2016).

4. Results

4.1. PSTEs' perceived confidence of their digital competence

Descriptive statistics were run to show an overall picture of perceived confidence across digital competence domains, with an overall mean of M=3.65 (Figure 3). Based on classification of Oxford (2001), this falls within the high-confidence range (3.6–4.19), though still on the lower end.

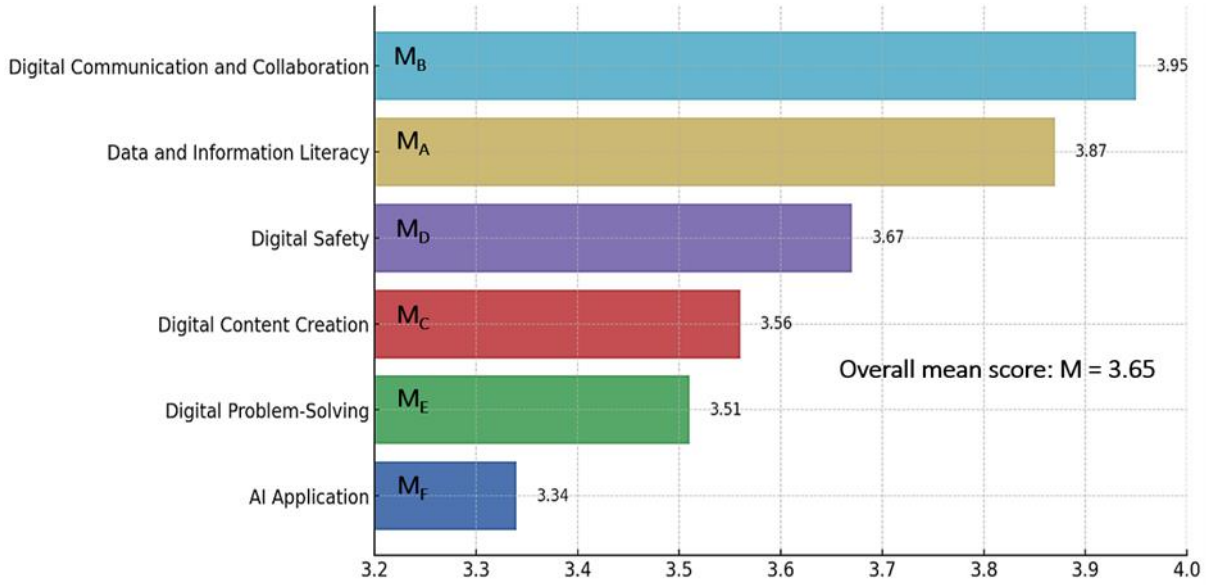

Figure 3. Perceived confidence across digital competence domains

The highest perceived confidence was in digital communication and collaboration (MB = 3.95), firmly within the high range, with strong confidence in communication and inclusive interactions. Data and information literacy (MA = 3.87) also reflected high confidence, particularly in identifying academic sources, though participants were slightly less confident in evaluating and organizing digital materials. Digital safety (MD = 3.67) remained in the high range, with stronger confidence in promoting responsible use but slightly lower confidence in cybersecurity awareness. Digital content creation (MC = 3.56) and digital problem-solving (ME = 3.51) both fell into the moderate range (2.6 – 3.59) with lower levels of perceived confidence. The lowest-rated domain was AI application (MF = 3.34), also in the moderate range, posing needs for further support in AI-related competence to timely support pre-service teachers.

4.1.1. Digital Communication and Collaboration

This domain has the highest overall mean (MB=3.95), reflecting strong perceived confidence among PSTEs in using digital tools for communication and collaboration (see Table 5).

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Table 5. Descriptive statistics of Cluster B (N=129)

Item	Mean	SD
Cluster B: Digital communication and collaboration for fostering online collaborative learning and professional networking	M_B=3.95	.583
6. I can use digital platforms (e.g., email, learning management systems) to communicate with pre-service teachers and colleagues.	4.09	.723
7. I can collaborate with pre-service teachers and fellow educators using online tools (e.g., Google Classroom, MS Teams).	3.99	.690
8. I can manage my online professional image as a teacher educator and model best practices for pre-service teachers.	3.83	.686
9. I can communicate respectfully and inclusively with students and educators from diverse cultural and generational backgrounds.	4.01	.643
10. I can participate in digital education communities and networks to enhance teacher education programs.	3.84	.716

The highest-rated ability is using digital platforms to communicate with pre-service teachers and colleagues (M6=4.09), followed by communicating respectfully and inclusively across diverse cultural and generational backgrounds (M9=4.01). Educators also report confidence in collaborating through online tools (3.99) and participating in digital education communities (3.84). The lowest-rated item, managing an online professional image (3.83), suggests that educators may need further support in modeling best digital practices for pre-service teachers.

4.1.2. Data and Information Literacy

The overall mean for this cluster is MA=3.87, indicating that PSTEs perceive themselves as highly confident in handling digital information (see Table 6)

Table 6. Descriptive statistics of Cluster A (N=129)

Item	Mean	SD
Cluster A: Data and information literacy for guiding pre-service teachers in technology-based practice	M_A=3.87	.660
1. I can use digital tools to search for accurate and curriculum-relevant information.	3.95	.623
2. I can verify the reliability and credibility of online educational resources for primary education.	3.75	.662
3. I can organize and manage digital files, data, and teaching materials effectively.	3.74	.773
4. I can identify academic sources that align with learners' proficiency to support pre-service teachers' lesson planning and research.	4.05	.623
5. I can evaluate the relatedness of educational content to contextual and cultural values before using or recommending it for primary classrooms.	3.88	.620

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The highest-rated item is the ability to identify academic sources that align with learners' proficiency (M4=4.05), suggesting that educators feel competent in selecting relevant references for pre-service teachers. Following closely is the ability to search for accurate and curriculum-relevant information (M1=3.95) and assess the relatedness of educational content to contextual and cultural values (M5=3.88). The lowest-rated items are checking the reliability of online educational resources (M2=3.75) and organizing and managing digital files (M3=3.74), revealing that extra training could be beneficial for developing higher-order skills of information verification and administration.

4.1.3. Digital Safety

The mean score for this cluster is MD=3.58, implying that PSTEs show an average level of confidence in ensuring digital safety in teacher education (see Table 7).

Table 7. Descriptive statistics of Cluster D (N=129)

Item	Mean	SD
Cluster D: Digital safety for ensuring safe and responsible technology use	M_D=3.58	.732
16. I can protect my personal data and model safe online practices for pre-service teachers.	3.67	.743
17. I can recognize and teach strategies to avoid common digital security threats (e.g., phishing, malware) in educational contexts.	3.46	.791
18. I can manage my digital well-being and promote healthy technology use among pre-service teachers.	3.62	.675
19. I can adopt and advocate for environmentally responsible practices when using digital devices in education.	3.65	.681
20. I can help pre-service teachers identify and address online risks of cyberbullying and misinformation.	3.50	.772

The highest-rated skill is protecting personal data and modeling safe online practices (M16=3.67), closely followed by advocating for environmentally responsible digital practices (M19=3.65). Managing digital well-being and promoting healthy technology use (M18=3.62) also received a relatively high rating. However, perceived confidence is lower in helping pre-service teachers identify and address online risks such as cyberbullying and misinformation (M20=3.50), identifying and teaching strategies to avoid digital security threats (M17=3.46), indicating areas that might benefit from more targeted and specialized metacognition training.

4.1.4. Digital Content Creation

With an overall mean of MC=3.56, this cluster indicates a moderate level of perceived confidence in designing digital materials for teacher education (see Table 8).

Table 8. Descriptive statistics of Cluster C (N=129)

Item	Mean	SD
Cluster C: Digital content creation for designing engaging and pedagogically sound materials	M_C=3.56	.762
11. I can create digital content (e.g., interactive presentations, educational videos) for use in primary teacher education.	3.52	.730

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12. I can edit and improve multimedia teaching resources to align with educational goals.	3.69	.694
13. I can apply copyright and licensing rules when creating or sharing teaching materials.	3.50	.802
14. I can integrate information from various sources to develop comprehensive educational resources.	3.76	.705
15. I can use basic programming, educational software, or web design tools to create interactive learning materials for pre-service teachers.	3.35	.881

Combining information from diverse sources to develop teaching resources was rated as a highly confident skill (M14=3.76), followed by adapting multimedia teaching resources to align with standard educational goals (M12=3.69). Creating digital content such as interactive presentations and educational videos (M11=3.52) and applying copyright and licensing rules (M13=3.50) were perceived with moderate confidence. The lowest-rated item, using basic programming, educational software, or web design tools for interactive learning materials (M15=3.35), reinforces a potential gap in more advanced digital content creation skills.

4.1.5. Digital Problem-Solving

With an overall mean of ME=3.51, this cluster reveals a median level of confidence in troubleshooting when working within the educational digital environment (see Table 9).

Table 9. Descriptive statistics of Cluster E (N=129)

Item	Mean	SD
Cluster E: Digital problem solving for adapting to evolving educational technologies	M_E=3.51	.708
21. I can solve technical issues that arise when using digital tools in teaching and learning.	3.32	.760
22. I can explore new educational technologies to improve pre-service teacher engagement and learning outcomes.	3.55	.684
23. I can adapt to new digital platforms and integrate them into teacher education programs.	3.59	.714
24. I can use digital tools to innovate and address solutions for classroom challenges in primary education.	3.56	.684
25. I can reflect on my own digital skills and seek professional development opportunities to stay current with educational technology.	3.55	.696

The highest-rated items are the adaptability to new digital platforms and deploying them for teacher education (M23=3.59) and using digital tools to innovate and tackle classroom solutions (M24=3.56). Educators also report moderate confidence in exploring new educational technologies and engaging in professional development to enhance digital skills (M22=M25=3.55). However, perceived confidence in solving technical issues that arise in teaching and learning was relatively low (M21=3.32), inferring that while PSTEs feel confident using technological tools to solve classroom problems when the tools function well, technical troubleshooting still remains a challenge.

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4.1.6. AI Application

This cluster has an overall mean MF=3.34, showing an average level of perceived confidence among PSTEs regarding one of the latest technological advancements in education (see Table 10).

Table 10. Descriptive statistics of Cluster F (N=129)

Item	Mean	SD
Cluster F: AI application for preparing future teachers to use AI in primary education	M_F=3.34	.749
26. I understand the basic functions and educational uses of AI tools	3.36	.695
27. I can use AI applications (Generative AI, adaptive learning platforms) to support pre-service teachers' academic work.	3.28	.729
28. I can evaluate the accuracy and appropriateness of AI-generated educational content.	3.33	.772
29. I can understand the educational ethical considerations of AI use and can discuss them with pre-service teachers.	3.44	.749
30. I can guide pre-service teachers in using AI tools responsibly and effectively in primary classrooms.	3.29	.804

The highest-rated ability is understanding ethical considerations of AI in education (M29=3.44), suggesting that educators are more aware of AI-related ethical issues than its practical applications. Confidence is slightly lower in understanding basic AI functions and educational uses (M26=3.36) and evaluating AI-generated educational content (M28=3.33). The lowest-rated items include guiding pre-service teachers in responsible AI use (M30=3.29) and using AI applications to support pre-service teachers' academic work (M27=3.28), emphasizing several limited skills when making use of AI tools in teacher education.

The Pearson correlation test was run and the result revealed significant positive correlations ($p < 0.01$) among all six digital competence domains.

Table 11. Pearson correlation results for digital competence domains

Var	M_A	M_B	M_C	M_D	M_E	M_F
M_A	1	.648** (p = .000)	.617** (p = .000)	.550** (p = .000)	.626** (p = .000)	.508** (p = .000)
M_B	.648** (p = .000)	1	.659** (p = .000)	.571** (p = .000)	.615** (p = .000)	.446** (p = .000)
M_C	.617** (p = .000)	.659** (p = .000)	1	.754** (p = .000)	.760** (p = .000)	.676** (p = .000)
M_D	.550** (p = .000)	.571** (p = .000)	.754** (p = .000)	1	.766** (p = .000)	.583** (p = .000)
M_E	.626** (p = .000)	.615** (p = .000)	.760** (p = .000)	.766** (p = .000)	1	.721** (p = .000)
M_F	.508** (p = .000)	.446** (p = .000)	.676** (p = .000)	.583** (p = .000)	.721** (p = .000)	1

Note: p < .01 (2-tailed), N = 129

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The strongest correlation was observed between ME (Digital problem solving) and MD (Digital safety) ($r = 0.766$, $p < 0.01$), indicating a strong association between these two aspects of digital competence. Similarly, MC (Digital content creation) was strongly correlated with ME ($r = 0.760$, $p < 0.01$) and MD ($r = .754$, $p < 0.01$), suggesting that content creation skills are closely linked to problem-solving and digital safety awareness. Moderate to strong correlations were also found between MA (Data literacy) and MB (Digital communication) ($r = 0.648$, $p < 0.01$), as well as MA and ME ($r = 0.626$, $p < 0.01$). The lowest correlation was between MF (AI application) and MB ($r = 0.446$, $p < 0.01$), indicating a relatively weaker association between AI application and digital communication skills compared to other pairs. These findings show that while all digital competence domains are interrelated, certain aspects of problem-solving, safety, and content creation, tend to intersect more strongly than others.

Two independent t-tests were run to compare means between two groups of gender and years of as full-time PSTEs. A one-way ANOVA was run to compare responses from three different work regions. The results indicate that years of full-time PSTEs and work regions show no statistically significant differences in perceived confidence across digital competency domains. However, gender significantly influences several reported domains (see Table 12).

Table 12. Results of independent T-test on PSTEs' responses between gender

Var		N	Mean	F	Sig.	Sig. (2-tailed)	Interpretation
M_A	Male	34	4.0824	0.001	.981	**.010**	Males' perceived confidence is higher in data information and literacy.
	Female	95	3.8021			**< 0.05**	
M_B	Male	34	4.1294	0.211	.647	**.042**	Males' perceived confidence is higher in digital communication and collaboration.
	Female	95	3.8884			**< 0.05**	
M_C	Male	34	3.7588	1.008	.317	**.043**	Males' perceived confidence is higher in digital content creation.
	Female	95	3.4926			**< 0.05**	
M_D	Male	34	3.8765	2.649	.106	**.002**	Males' perceived confidence is higher in digital safety.
	Female	95	3.4737			**< 0.05**	
M_E	Male	34	3.7529	0.155	.695	**.008**	Males' perceived confidence is higher in digital problem-solving.
	Female	95	3.4274			**< 0.05**	
M_F	Male	34	3.5118	2.702	.103	.082	No significant difference in perceived confidence in AI application.
	Female	95	3.2800			≥ 0.5	

Note: All F-values have Sig. > 0.05 → equal variances assumed; Significant values (p < .05) are in bold.

The independent samples t-test examined gender differences across six domains of digital competence. For domains A–E, The findings reveal statistically significant differences ($p < 0.05$) between male and female responders, suggesting that male respondents reported higher perceived competence in these areas. Specifically, the largest mean difference was observed in Digital safety (D) (Male: 3.88, Female: 3.47, $p = 0.002$), followed by Data information and literacy (A) (Male: 4.08, Female: 3.80, $p = 0.010$). These findings imply that males generally feel more confident in handling digital data, online communication, content creation, virtual safety, and problem-solving. Moving to AI application (F), however, no significant difference was observed ($p = 0.082$), suggesting that male and female participants share similar levels of confidence in integrating AI into their teaching.

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4.2. PSTEs' concerns and needs for developing their digital competence

The survey findings reveal varying levels of confidence among PSTEs throughout different domains of digital competence. Through qualitative insights, PSTEs articulate their concerns and challenges, then come to potential solutions for enhancing their digital preparedness in teacher education.

4.2.1. Enhancing professional image in educational digital environment

PSTEs generally perceived professional image in the digital environment as a combination of their online presence, interactions, and the way they model ethical and professional behavior for pre-service teachers. For many, it is about using digital platforms effectively and maintaining credibility, engaging in meaningful professional discourse, and adhering to societal ethical standards in online spaces. A female teacher from one of the crowdest and modern cities in Northern Vietnam shared:

> "It's not just creating a profile on a teaching platform. It's about how we present ourselves, how we interact, and how others, especially our students, interact with us as professionals." (P4, excerpt 4)

This could be understood that professional image is tied to both self-representation and external perception. Similarly, a 10-year-in-service male educator emphasized the role of professionalism in digital spaces:

> "What we post, how we respond in discussions, and even the way we format emails all contribute to how we're perceived as educators. And pre-service teachers pick up on that. I'm pretty sure they will either learn from us or 'critique' us and treat their future students alike." (P9, excerpt 9)

However, there is some uncertainty about best practices for maintaining a professional online image. Some PSTEs are unsure how to balance approachability with authority in digital interactions. While they are confident in their ability to communicate professionally in face-to-face settings, translating these skills into the digital space presents a new challenge.

A major concern is how to adapt their communication style to be both professional and relatable to today's digital-native pre-service teachers. Unlike traditional professional communication, which follows clear protocols, online interactions require a balance of humor, trend awareness, and educational value while maintaining safety and respect. This challenge is heightened by the fact that some pre-service teachers are still too young to fully grasp the importance of professional image in digital spaces.

> "Young teachers expect a more casual, interactive style, but at the same time, we have to set boundaries and model professionalism. Sometimes, my students are quite too young to realize what professionalism online really means. They post and comment without thinking about long-term consequences." (P10, excerpt 10)

This makes it even more crucial for PSTEs to model and explicitly teach digital professionalism, not just as a concept but as a daily practice. As the digital space amplifies the risks of miscommunication or unintended consequences.

> "The 'butterfly effect' of online content, where a small comment or post can be captured, shared, and misinterpreted far beyond its original context, adds another layer of complexity. Once something is out there, we lose control over how it spreads. Digital professionalism is so tricky." (P11, excerpt 11)

To navigate this, PSTEs called for guidance on integrating their existing communication skills with the evolving norms of digital interaction. Almost 80% of PSTEs as interviewees acknowledged that effective online communication is not just about presence but also about choosing the right platform for the right purpose. Some situations demand real-time interaction, such as live discussions or urgent announcements, where video conferencing tools or instant messaging apps may be most effective. Meanwhile, more formal or reflective discussions might be better suited for email,

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discussion forums, or learning management systems. Understanding the appropriate use of each tool strengthens the effectiveness of communication, as each platform offers unique benefits.

4.2.2. Upgrading digital literacy of verifying information and ensuring online safety

Despite PSTEs' overall confidence in handling digital information, challenges persist in verifying the credibility of online educational resources. While finding information is easy, assessing its reliability and relevance for primary education remains complicated. The lack of exposure to source evaluation methods makes it difficult to equip pre-service primary school teachers with critical thinking in digital literacy. P6, P7, and P12 expressed concerns about downloading, archiving, and managing digital materials efficiently while ensuring compliance with copyright regulations. They subsequently emphasized the need for more CPD sessions focused on curating reliable resources and organizing digital repositories to support ethical and efficient digital resource management.

Ensuring digital safety is another area where PSTEs express moderate confidence, with particular difficulties in addressing cyber threats and misinformation.

> "It's so hilarious yet alarming how common scammers in Vietnam often 'disguised' as primary school teachers, deceitfully calling kids' parents with fake emergencies or sending virus-infected links to steal information and money. Since primary school teachers and young children are easy targets, stakeholders in primary education keep warning about these scams and working to prevent them."

Given the rapid evolution of digital threats, there is a pressing need for structured PD that integrates real-life case studies, cybersecurity awareness, and digital well-being into teacher education. Beside, the rise of AI presents new challenges in digital literacy. While PSTEs recognize AI's growing role in education, they still feel unfamiliar to guide pre-service teachers in its responsible use. Many acknowledge that AI-generated content lacks the ability to handle cultural sensitivity and contextualize data appropriately. This can lead to overgeneralization, which is particularly problematic in teacher education, where cultural and linguistic nuances shape effective pedagogy. As P5, a veteran teacher educator training pre-service teachers in the culturally and religiously diverse Central Highlands of Vietnam, shared:

> "I know AI has potential, but I lack the training to use it sensibly in primary education. I always remind my learners that kids are like blank paper, if we draw the wrong lines, those marks stay with them for life, shaping their core beliefs in ways we might not intend." (T5, excerpt 5)

Since PSTEs are preparing Vietnamese pre-service teachers to teach Vietnamese children, ensuring that AI tools align with local educational and cultural contexts is crucial. Without proper guidance, overreliance on AI may result in a disconnect between classroom realities and AI-generated recommendations. Given these concerns, PSTEs emphasize the need for targeted PD on AI literacy. They call for training that helps them understand AI's limitations, particularly its inability to recognize localized teaching approaches and cultural nuances. Strengthening digital literacy in AI use, alongside information verification and online safety, is essential to ensure that technology enhances rather than undermines primary education.

4.2.3. Overcoming misconceptions about digital and technological use in education

Informed by the comparison in statistics tests, the interviewees elaborate on the misconceptions and stereotypes surrounding technology use in teacher education. Gendered assumptions about technology competence remain a concern among PSTEs. Some female teacher educators recognize that deeply ingrained beliefs about gender and technology influence teachers across generations.

> "It's not just about us, it's what we model for future teachers. If we keep relying on male colleagues for tech issues, pre-service teachers will carry that mindset into their own classrooms." (P4, excerpt 4)

> "Sometimes, we, the females, feel that technology is not our main responsibility. It's always been the domain of male teachers. We barely see it as part of our role in the classroom." (P7, excerpt 7)

Addressing this requires targeted PD initiatives that empower all educators, regardless of gender, to develop digital problem-solving skills and confidence in independent technology use. According to 11 over 12 PSTEs, the consequence of this misconception is the overreliance on fully functional technology, leaving educators uncertain when digital tools fail.

> "Many of us are confident when everything works perfectly, but the moment a tool malfunctions, we almost freeze. It's like we forget we're the ones in control, not the technology." (P11, excerpt 11)

This lack of troubleshooting skills reinforces dependence on external support, further entrenching gendered divides in digital competence. PSTEs stress the need to cultivate adaptability, guaranteeing that pre-service teachers have dual skills of using digital tools and handling unexpected disruptions on their own.

Another common misconception is the belief that all tasks and activities must be enhanced with technology. While digital tools can be powerful, maintaining an equilibrium between conventional and digital instructional methods is essential. Certain educational interactions of facilitating deep discussions, handling sensitive topics or defending authorships, may be more impactful in face-to-face environments. As P6 wisely notes:

> "It also depends on which subject you are teaching, right? For primary education subjects, certain activities need to be tech-enhanced to illustrate or conceptualize abstract ideas, like using videos or interactive tools in science or math. But for language or social studies, sometimes Powerpoint slides could be absent, as the real presence and emotions that come from face-to-face discussions are way more important." (P6, excerpt 6)

Recognizing the appropriate context for using digital platforms is important for strengthening communication and maximizing pedagogical impact. By addressing these challenges through expert professional development programs, educators could be better equipped to guide pre-service teachers in utilizing technology responsibly, effectively, and equitably.

5. Discussion and Implications

The findings show that all components of digital competence are interrelated, which concurs with Rawal (2024) on the emerging framework, and with Fernández-Batanero et al. (2020) and Rahimi and Tafazoli (2022) on higher education lecturers' perceptions and experiences. In particular, PSTEs' perceived digital competences ranked similarly in some areas and differently in others compared to Hoang et al. (2022), primarily due to the different categorization of skills. However, both studies align in emphasizing digital communication and literacy as the most critical aspects of digital competence. In the current study, perceived confidence in digital communication ranked the highest, which can be understood by recognizing that as Vietnamese teacher educators are typically well-trained in interpersonal skills, they simply need to adapt and apply these skills to digital contexts (Trinh, Phan, & Phan, 2025). Reported confidence in digital literacy ranked second, as PSTEs in the study have been in the field for a long time and have extensive exposure to technology, from early stages to the recent complex landscape. However, critical evaluation and being well-judged and wisely conscious in today's battle against misinformation, need support, as the veteran P12 said, "20 years ago we read to learn, now we carefully learn to read, specifically reading online."

Digital safety confidence ranked third, showing that when teachers have digital literacy, their awareness of safety also follows. All they need to enhance pivots around selecting effective ways to transfer this knowledge to pre-service teachers. Perceived confidence in digital creation ranked fourth because the first three competencies are foundational, whereas creating something new demands greater effort. Problem-solving ranked fifth in confidence level and was tightly linked to pure technological skills, which might be underrepresented in teacher education, as this is often more emphasized in other natural science disciplines. Interestingly, across all five domains, male teachers reported higher confidence than female teachers, even though there are fewer male teachers in both

the study sample and the overall Vietnamese teaching workforce. This could be linked to the stereotype rooted in Vietnamese society for many centuries, reinforced by the belief that men are naturally more adept at technology, which can significantly hinder women's motivation and professional growth. The belief that women nurturing humans while men handle machinery and brain-intensive tasks perpetuates gender inequality in the workplace and education. Finally, the ability to execute AI tools was the domain where both genders felt the lowest confidence without significant differences, likely due to its novelty and the lack of exposure to it.

The qualitative findings bring up three major needs in improving online professional image, digital safety concerning AI-generated information assessment, and equity in CPD for educational technology. First, PSTEs stress the significance of shaping a professional image in the digital world, focusing on balancing how they present themselves, their interactions, and maintaining ethical standards online, reinforcing findings from Engeness (2020) and An et al. (2023). To address the concern of professional image in digital spaces, Social Persuasion can be leveraged to encourage PSTEs to observe their peers and more experienced educators who demonstrate exemplary professional behavior online. This principle suggests that positive feedback and encouragement from others can help build confidence. Vicarious Experiences could be an option for learning, and they are not limited to observing peers or older educators but by looking at the younger generations of Gen Z and Gen Alpha as well. These younger generations, who are digital natives, often set trends in digital communication, social media interaction, and online behavior. As such, PSTEs can benefit from adapting their professional image to resonate with these trends. By learning from both older role models and younger peers, PSTEs tend to develop a clearer understanding of how to manage their digital image and represent themselves professionally in the online space while staying relevant to current technological trends. CPD initiatives should create opportunities for PSTEs to exchange and reflect on their sophisticated experiences with digital professionalism. These collaborative endeavors could enhance their confidence in navigating digital environments, as sharing challenges within a supportive community reassures them that they are not alone.

In the area of digital safety and AI assessment, Performance Experiences appear to be critical interventions. Providing PSTEs chances to use AI tools allows them to gain firsthand knowledge in assessing the effectiveness of AI-generated content and managing the risks associated with it. Engaging with these tools in a controlled yet supportive environment will enable PSTEs to build competence and confidence in their ability to apply safeguards effectively (Ahn, 2024). Regarding affect, Physiological Feedback, which refers to managing stress or anxiety related to new technologies, can be supported by creating a safe, low-pressure working environment. CPD programs should include focused workshops and simulations to allow PSTEs to practice verifying information, evaluating AI-generated content, and addressing online safety concerns through real-life instances. About the third issue, equity in CPD and awareness-raising, is especially critical for PSTEs in regions with limited access to digital resources, echoing international findings from Kim et al. (2021) and (Weisberg & Dawson, 2023). All four principles of Self-efficacy are vital in overcoming long-standing barriers. Observing others provides valuable examples of success and can inspire confidence even before one feels ready. Following this, engaging in direct hands-on practices to tackle technical issues allows PSTEs to develop practical skills and boosts their confidence when successful. Managing emotions, particularly apprehension or anxiety around new technologies, is essential for building resilience. As suggested by Belinda and Wei (2024), CPD programs should incorporate strategies to alleviate this stress by considering the diverse backgrounds of PSTEs, ensuring that strategies are suitable and contextually relevant to their regional settings. From the outer circle, societal support from institutions and policymakers is essential in providing the resources and encouragement needed for PSTEs to excel in digital environments.

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6. Conclusion and Recommendation

The study achieved its aims by addressing two primary questions regarding the perceived confidence and needs of PSTEs across Vietnam. Regarding perceived confidence, the findings revealed that the highest levels of self-assurance were reported in communication, digital literacy, and online safety, while areas like problem-solving and AI integration showed lower levels of confidence. When it comes to needs, the study identified issues related to enhancing online professional image, safety, credibility, and equity in educational education. These concerns were shaped by multifaceted factors of gender, geographic regions, subject matter, and generational gaps. The discussion suggests applying self-efficacy enhancement strategies to boost confidence and develop digital competence among PSTEs, empowering them to navigate the evolving technological landscape effectively. As P3 humorously put it, "We, teacher educators, are like the non-biological grandparents. We rarely teach the kids, but we teach their parents how to teach them." This metaphor amplifies the prominent characteristic of PSTEs, who, despite not immediately interacting with young students, play a crucial role in shaping the teaching methods that will ultimately impact the learners. Given their indirect yet significant influence, PSTEs should receive sustainable and context-sensitive training for digital competence expansion to prepare many more future educators.

Together with contributions to existing literature of primary education contexts, the study possesses limitations due to its cross-sectional design, which restricts the ability to observe changes over time or establish causal relationships. As data was collected at a single point, it does not capture the fluctuating nature of digital competence development or the evolution of PSTEs' perceptions and needs in relation to their professional growth. About triangulation, the study primarily relied on self-reported data, which may have introduced bias, as participants might have exaggerated their confidence or minimized difficulties. The absence of other objective measures, such as standardized digital competence assessments or behavioral observations, compromise the ability to validate the accuracy of self-reports and evaluate actual competence beyond perceived levels.

For future research, to supplement this informative study, longitudinal studies would be valuable to track the progression of PSTEs' digital competence and to better understand how their confidence and skills evolve over time. To enhance reliability, integrating objective instruments such as digital literacy tests or observational assessments could provide a thorough understanding of PSTEs' skills and offer a more precise measure of their development. Future research could also examine the effects of specific CPD interventions on digital competence across different regional contexts to identify best practices for strengthening PSTEs' readiness for the digital demands of teaching.

Declarations

Author Contributions. 1st Author: supervision, conceptualization, overall quality assurance; 2nd Author: literature review, data collection and interpretation, dissertation writing; 3rd and 4th Authors: guidance on data analysis, final manuscript review.
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Ethical Approval. The project objectives and data collection procedure with surveys and interviews were evaluated for compliance with ethical standards. Follows are information related to this ethical approval; Ethical approval number: 20231220.
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About the Contributor(s)

Trinh Thi Huong is a teacher educator at Faculty of Preschool and Primary Education, School of Education, Can Tho University. Her research interests include teacher training, emotional education, and early childhood development.
Email: thihuong@ctu.edu.vn
ORCID: https://orcid.org/0000-0003-0315-5115

Phan Ngoc Tuong Vy is a TEFL Master's student at School of Foreign Languages, Can Tho University. Her research interests include professional development in higher education, active learning, and educational innovation.
Email: vym1623063@gstudent.ctu.edu.vn
ORCID: https://orcid.org/0009-0004-1058-0069

Lu Hung Minh is a lecturer at Faculty of Preschool and Primary Education, School of Education, Can Tho University. His research interests include teaching methodoly i primary education.
Email: hungminh@ctu.edu.vn
ORCID: https://orcid.org/0000-0002-8419-525X

Nguyen Thi Linh is a lecturer at Faculty of Preschool and Primary Education, School of Education, Can Tho University. Her research interests include teaching methodology in primary education.
Email: ntlinh@ctu.edu.vn
ORCID: https://orcid.org/0009-0002-6534-5336