Developing Future Teachers' Self-Efficacy in Digital Learning Environments: The Case of Kazakhstan

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Abstract: This study examines how prospective teachers in Kazakhstan develop self-efficacy for teaching in digital learning environments and identifies the individual, organizational, and systemic mechanisms that facilitate or impede this process. It integrates international research on teacher self-efficacy, established digital competence frameworks such as TPACK and DigCompEdu, and current developments in Kazakhstan's educational policies and technological infrastructure. The paper explores how personal beliefs about teaching capabilities, prior pedagogical experiences, and institutional contexts shape prospective teachers' confidence in integrating technology into instruction. It further analyses the factors that strengthen digital self-efficacy, highlights the critical role of institutional support in cultivating sustained competence, and addresses the implications of the urban–rural digital divide for equity in teacher preparation. The study concludes with recommendations for teacher education programs to establish a sustainable model for developing digital self-efficacy among future teachers in Kazakhstan.

Keywords: teacher self-efficacy, future teacher, digital competence

Introduction

Digital transformation and technological progress have significantly reshaped the modern educational landscape (Zou et al., 2025). The swift shift from traditional face-to-face teaching to digital and blended learning methods, sped up by the COVID-19 pandemic, has further transformed education (El-Soussi, 2022). As a result, digital competence has become an essential requirement for teaching professionals at all educational levels. In this context, researchers are increasingly focused on how future teachers build confidence and skills to use digital tools and pedagogies - known as teacher self-efficacy in digital environments - recognizing this as a key priority for teacher education programs worldwide (Caena & Redecker, 2019).

In the context of digital transformation in education, Kazakhstan, as a developing country transitioning to a knowledge-based economy, has recognized the need for digital transformation. To achieve this, the Kazakhstani government has launched large-scale modernization programs, including strategic partnerships with international companies such as Coursera, to enhance digital skills development in higher education institutions (Prime Minister of Kazakhstan, 2024). Moreover, in recent years, Kazakhstan has developed its first national framework for integrating AI into education, establishing standards for digital literacy for both learners and educators through 2029 (Ministry of Education of Kazakhstan, 2025). Despite these important policy initiatives, numerous obstacles persist in hindering the implementation of digital transformation in Kazakhstani education, including the rural-urban digital divide in infrastructure and unequal access to quality digital resources (Amirova et al., 2023; Academy of Pedagogy and Psychology of Kazakhstan, 2017). Therefore, understanding how prospective teachers in Kazakhstan develop strong self-efficacy beliefs in digital learning environments, while accounting for structural barriers, is crucial.

Self-efficacy for Teaching, rooted in Albert Bandura's Social Cognitive Theory, is defined as the confidence an individual has in their ability to organize and perform the actions necessary to achieve specific teaching goals (Bandura, 1997). Bandura highlighted that self-efficacy is not just confidence in one's abilities but rather a belief in one's ability to succeed in a particular situation, especially when facing challenges. Teacher self-efficacy includes confidence in implementing instructional strategies effectively, maintaining classroom management, and engaging students in meaningful learning experiences (Tschannen-Moran & Woolfolk Hoy, 2001). The effects of teacher self-efficacy go well beyond personal satisfaction. Numerous studies have shown strong links between teacher self-efficacy and positive outcomes, including student achievement, engagement, teacher quality, retention, and lower occupational stress (Jerrim, 2023; Emiru et al., 2024). Specifically, teachers with higher self-efficacy are more likely to design engaging activities, persist with struggling learners, and use diverse instructional methods, all of which contribute to better student outcomes (Turner et al., 2014).

When examining the relationship between teacher self-efficacy and digital learning environments, the importance of this construct becomes even clearer. Studies indicate that a teacher's confidence in their technological abilities directly affects their willingness to incorporate technology into instruction and the quality of the technology-enhanced pedagogical practices they employ (Paetsch et al., 2023). Teachers exhibiting high self-efficacy in using digital technologies, while demonstrating greater facility in applying digital tools, also conceptualize technology as pedagogically enabling rather than supplementary to "real" teaching. Consequently, teachers characterized by high self-efficacy in technology integration create engaging learning environments that leverage technology's cognitive benefits to support collaborative learning and personalize educational pathways (Zimu, 2024).

As rapidly evolving technological innovations in education and heightened expectations for newly qualified teachers to integrate digital tools and pedagogies have increased, developing self-efficacy in digital environments among future teachers has become particularly important. However, teacher education programs face significant challenges in fostering self-efficacy development. Many teacher candidates enter preparation programs with diverse levels of digital competency, ranging from sophisticated personal technology use to minimal experience or negative views of technology's educational role (Saine & West, 2017). Moreover, the transition from traditional field-based practicums to virtual teaching environments, initiated during the pandemic but increasingly normalized, requires teacher education programs to reconsider how they provide authentic digital learning opportunities (Bobley, 2021).

This paper explores how prospective teachers in Kazakhstan develop self-efficacy in digital learning environments and identifies which institutional and pedagogical processes most effectively support this growth. It synthesizes existing

research on teacher self-efficacy, digital competency frameworks, and specific variables relevant to Kazakhstan's national education system to provide evidence-based insights for enhancing teacher preparation programs.

Three central questions guide the synthesis:

1. What are the theoretical and empirical understandings of how self-efficacy develops in teachers, especially in digital settings?

2. What are the global trends and institutional frameworks for defining the digital preparation of teachers?

3. What are the key challenges and opportunities presented by Kazakhstan's context, and how could they influence interventions promoting self-efficacy development?

By addressing these questions, the paper establishes the foundation for evidence-informed recommendations for teacher education policy and practice in Kazakhstan and other countries facing similar digital transformation requirements.

1. Methodology

Document analysis, a systematic examination of documentary evidence that produces deeper understanding and empirically-based knowledge (Bowen, 2009), was employed. This methodology is suitable for conceptual and theoretical papers that synthesize the literature, identify patterns within it, and develop analytical frameworks grounded in previous scholarly work.

The literature review involved a systematic search across several academic databases: Scopus, Web of Science, ERIC, and Google Scholar. Keyword combinations included: "Teacher Self-Efficacy", "Digital Learning Environments", "Digital Competence", TPACK, DigCompEdu, "Teacher Education", "Preservice Teachers", "Technology Integration", "Education in Kazakhstan", and "Digital Divide in Education". The search was limited to publications from 1977 through 2025, capturing both foundational theoretical literature on self-efficacy and current empirical studies on digital pedagogy and teacher preparation. Inclusion criteria were: (a) sources addressing theoretical foundations and empirical evidence regarding teacher self-efficacy; (b) digital competence frameworks for educators; (c) pedagogical and institutional mechanisms enhancing self-efficacy in digital learning environments; or (d) Kazakhstan's educational environment, including digitalization policies and infrastructure challenges.

The document analysis identified and synthesized 47 sources: 34 peer-reviewed journal articles, 1 doctoral dissertation, 1 conference paper, 3 books or chapters, and 8 reports from Kazakhstan and international organizations, including governmental decrees, ministerial frameworks, EDUCAUSE, and OECD. Thematic content analysis was performed on all documents. Recurring themes, theoretical constructs, and empirical findings were identified, coded, and synthesized to answer the research questions. This analytical approach allowed for the integration of diverse perspectives from international scholarship, policy discourse, and Kazakhstan-specific research, creating a comprehensive evidence base that supports the conceptual model and recommendations.

2. Literature Review

Teacher Self-Efficacy: Key Concepts, Foundations, and Importance in Teacher Education

Teacher self-efficacy, derived from Bandura's (1977, 1997) broader self-efficacy definition, is the belief that teachers possess in their ability to teach and positively influence student learning, regardless of student motivation levels (Tschannen-Moran & Woolfolk Hoy, 2001). Significantly, self-efficacy differs from competence. A teacher may possess the highest level of pedagogical knowledge possible but still question their ability to apply that knowledge effectively in the classroom (Pfitzner-Eden, 2016).

Bandura (1997) identified four sources of self-efficacy. The first is mastery experienced, direct successes or failures in teaching, which is generally considered the strongest source, though its strength depends on how individuals interpret success or failure (Bandura, 1977). The second is vicarious experience, defined as observing similar others perform successfully, which is more effective when observers identify with the model (Bandura, 1977). The third is verbal

persuasion, less effective than the first two but capable of supporting efficacy development when provided by credible sources alongside other experiences (Pfitzner-Eden, 2016). The fourth is physiological/affective state, which includes anxiety and stress that lower efficacy and positive emotional states that increase it (Bandura, 1997). The importance of teacher self-efficacy in teacher education is evident through its relationship to many aspects of teacher effectiveness and professional development. Over three decades of research demonstrate that teacher self-efficacy correlates positively with student achievement, engagement, classroom management, and adoption of new instructional practices (Tschannen-Moran et al., 1998; Jerrim, 2023; Emiru et al., 2024). Furthermore, self-efficacy is positively associated with job satisfaction, professional commitment, professional well-being, and reduced stress (Schwarzer & Hallum, 2008). Teacher self-efficacy is particularly important because teacher turnover and burnout remain major problems in schools, especially for beginning teachers, who are at the most significant risk of decreased efficacy (Klassen et al., 2011). Additionally, teacher self-efficacy predicts teachers' receptivity to professional learning and willingness to use new instructional methods (Donohoo & Katz, 2019). Teachers with high self-efficacy are more motivated to participate in professional development opportunities and more likely to translate learning into classroom practice changes.

Given this significance, teacher education programs should intentionally design and deliver experiences supporting self-efficacy development. Both theoretically and practically, supporting this development is an essential program goal. Research shows that preservice teachers' self-efficacy beliefs established during preparation predict their classroom behaviours and effectiveness as early career teachers (Woolfolk Hoy & Burke Spero, 2005). Similarly, preservice teachers in well-designed, supportive programs that offer authentic teaching experiences, timely and constructive feedback, and opportunities for collaboration develop stronger self-efficacy than those in less structured programs (Mather & Visone, 2024; Pfitzner-Eden, 2016). These findings indicate that teacher education programs are accountable for designing and implementing intentional, systematic strategies to cultivate self-efficacy during initial preparation, recognizing that beliefs developed at this stage establish trajectories that extend throughout teachers' careers.

Tschannen-Moran and Woolfolk Hoy (2001) defined self-efficacy as multidimensional across three correlated but distinct areas. The first is instructional strategy efficacy, confidence in using diverse instructional approaches, in designing appropriate learning experiences, in responding effectively to inquiries, and in assessing learning. The second is classroom management efficacy – confidence in establishing and maintaining order, implementing high behavioural standards, managing classroom emotional dynamics, and creating equitable environments. The third is student engagement efficacy, confidence in inspiring and motivating students, encouraging internal motivation, engaging families, and helping students build confidence. Understanding this multidimensionality acknowledges that teachers have varying levels of confidence across domains. The Teachers' Sense of Efficacy Scale (TSES), developed by Tschannen-Moran and Woolfolk Hoy (2001), remains the most widely used measurement tool and demonstrates excellent reliability and validity across multiple international settings and population samples (Gálvez-Nieto et al., 2023).

Digital Teacher Preparation: Trends, Frameworks, and Self-Efficacy

Global education has increasingly applied digital technologies to support learning and teaching, driven by technological advancements, digital citizenship policy initiatives, and the need for alternative delivery methods during COVID-19 (Zou et al., 2025). While many digital learning models exist featuring various technology applications, digital learning itself includes pedagogies that leverage technology's affordances for personalized learning, real-time adaptive instruction, collaborative knowledge construction, and access to diverse information sources and global learning communities (Zawacki-Richter et al., 2019).

Current and emerging trends in global digital education are significant. Artificial Intelligence represents a major emerging force, enabling intelligent tutoring systems that learn individual student needs, automate assessment and feedback, and create customized real-time learning pathways (Zou et al., 2025). Virtual and Augmented Reality enable educators to create highly engaging, interactive learning environments ideal for complex and abstract concepts (Hursen & Beyoğlu, 2020). Learning analytics, combined with data-driven decision-making, supports instructors in identifying struggling students early, creating personalized interventions, and tracking the success of pedagogical approaches (EDUCAUSE Analytics Landscape Study, 2024). Hybrid and flexible learning models provide opportunities

for synchronous and asynchronous, online and face-to-face, and self-paced and instructor-facilitated experiences supporting diverse student needs (Digital Learning Institute, 2025).

The rapid expansion of digital technologies and pedagogies creates significant implications for teacher preparation, requiring competency development beyond pedagogical knowledge. Two prominent frameworks define required digital competencies. The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006), extends Shulman's pedagogical content knowledge by integrating technological knowledge. TPACK defines effective technology use as requiring simultaneous consideration of content knowledge, pedagogical knowledge, and technological knowledge. Critically, the intersection of these knowledge domains creates synergistic knowledge exceeding their individual sum (Mishra & Koehler, 2006). TPACK emphasizes the situated, context-dependent nature of technology integration.

The European Framework for the Digital Competence of Educators (DigCompEdu), created by the European Commission's Joint Research Centre, describes 22 educator-specific digital competences organized into six areas: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence (Caena & Redecker, 2019; Joint Research Centre, 2022). DigCompEdu's focus extends beyond technical skills to how digital technologies enhance educational practice across all professional roles. It differentiates proficiency levels – A (foundational), B (integration), and C (leadership and innovation) – acknowledging that teachers' competence evolves and that digital leaders support peers, promote innovation, and adapt materials to contextual needs (Redecker & Punie, 2017). DigCompEdu has gained international adoption as a resource for designing teacher education programs (Cabero-Almenara et al., 2023).

Teacher self-efficacy is the most critical mediator in classroom technology integration. A study of 298 prospective teachers found that "technology self-efficacy was a major predictor of TPACK, and had statistically significant positive correlations between university support, perceived competence, and self-efficacy" (Wang & Zhao, 2021). Without confidence in their ability, prospective teachers rarely apply technical knowledge. Research shows self-efficacy predicts technology implementation far better than technical knowledge or skill (Teo & van Schaik, 2012). Consequently, providing technology training, while important, is insufficient; programs must deliberately build confidence through structured experiences, developing both confidence and competence.

The COVID-19 pandemic drew worldwide attention to preparing teachers for digital instruction, with many countries requiring or recommending the development of explicit online/blended teaching competencies (Bobley, 2021). Research on pedagogical approaches in digital environments reveals effective strategies. Virtual field experiences offering structured guidance, feedback, and examples increase candidate confidence and self-efficacy (Keefe, 2020). Online coaching providing immediate feedback on demonstrations enhances confidence and technological skills (Wake et al., 2017). Candidates participating as learners in high-quality online or blended courses develop favourable teaching perceptions and greater confidence (He, 2014), consistent with research showing authentic experiences in similar-to-eventual-practice environments enhance self-efficacy through mastery experiences.

3. Kazakhstan Context: Teacher Education System, ICT Integration Initiatives, and Digital Infrastructure Challenges

Over the past twenty years, Kazakhstan has undertaken significant educational reforms, pursuing a transition from a commodity-based to a knowledge-based economy and becoming globally competitive (Prime Minister of Kazakhstan, 2024). Teacher education occurs under Ministry of Education oversight through national standards and quality assurance structures, with preparation conducted by pedagogical universities and general university education departments. Historically focused on subject knowledge and general pedagogy, digitalization has recently become an explicit policy priority (Nurbekova, 2023).

Kazakhstan has undertaken numerous digital transformation efforts. The State Program "Digital Kazakhstan", approved in 2017, identified digitalization as a foundational educational modernization by promoting technology for administrative automation, expanding distance learning, and improving access to resources (Nurbekova, 2023). A significant initiative involved a large-scale Coursera partnership that integrated professional certifications and technology courses into teacher and higher education curricula (Prime Minister of Kazakhstan, 2024). This rapidly scaled from 25 initial universities to 93 within one year, with 853 Coursera courses replacing 116 university disciplines and 3,244 courses incorporated into 1,631 disciplines by 2023 (Prime Minister of Kazakhstan, 2024). Additionally,

Kazakhstan initiated national AI integration standards, with a three-tiered teacher professional development program beginning the 2025-2026 academic year (Ministry of Education of Kazakhstan, 2025).

Digitalization implementation spans multiple stages dating to the late 1990s. Systematic educational system automation began in 1997; by the mid-2010s, universities, including Al-Farabi Kazakh National University, had established MOOC and distance education infrastructure (Nurbekova, 2023). During COVID-19, more than 700 teachers received advanced training through the Erasmus+ HIEDTEC project, illustrating international collaboration. Institutions like Toraigyrov University (Pavlodar) have established comprehensive digital ecosystems, including automated management systems, distance-learning support, and integrated resource repositories (Nurbekova, 2023).

Despite ambitious initiatives, critical challenges persist. The most significant is the pronounced rural-urban digital divide. Urban internet and ICT access were 81.3% in 2016, compared with 70.9% in rural areas (Amirova et al., 2023). High-speed internet distribution is uneven. This infrastructure gap directly impacts educational equity and opportunity. Rural students and teachers lack consistent, reliable internet access for real-time instruction, multimedia resources, or emerging technologies (Amirova et al., 2023; Academy of Pedagogy and Psychology of Kazakhstan, 2017). Research on the impact of the digital divide in Kazakhstan's Turkestan Region found that rural students experienced slower internet, fewer devices, and limited access to career guidance platforms (Academia.edu, 2025).

Beyond infrastructure, significant gaps exist in teacher training for digital pedagogy. While policy requirements and initiatives exist, many institutions lack systematic programs for developing teacher competencies; content quality control varies widely (Nurbekova, 2023). Research identifies continuing challenges, including "uneven access, teacher training, quality control of educational content, and the sufficiency of quality control mechanisms" (Nurbekova, 2023, p. 5). These gaps particularly disadvantage candidates who complete preparation without adequate exposure to digital pedagogy or to the development of self-confidence.

In this regard, the Ministry of Education's AI implementation policy (2025-2029) acknowledges challenges, listing "school infrastructure preparedness especially in rural settings", "large-scale teacher training requirements", "student privacy protection necessity", and "digital inequity among regions" as specific risks and obstacles (El.kz, 2025). This reflects governmental awareness that equitable technology implementation requires intentional capacity building and infrastructure investment.

4. Building Teacher Self-Efficacy in Digital Learning Environments: Institutional and Pedagogical Mechanisms

Researchers have identified institutional and pedagogical mechanisms to foster and develop prospective teachers' self-efficacy in digital environments, grounded in Bandura's theoretical model and the professional development literature.

A primary mechanism is structured, authentic experiences that enable meaningful mastery experiences. Research consistently shows that candidates who experience actual teaching practice with supportive guidance and constructive feedback demonstrate significantly higher self-efficacy than those who only observe or learn theoretically (Keefe, 2020; Pfitzner-Eden, 2016). Experience authenticity matters; authentic experiences teach candidates that virtual teaching requires managing technology systems, adapting to reduced social cues, and developing digital engagement methods. Successful adaptation builds absolute confidence (Mather & Visone, 2024). Additionally, experience number significantly matters. Bandura (1997) indicates that self-efficacy grows through successive mastery experiences. Multiple experiences are preferable to singular ones because each builds on prior successes, allowing candidates to observe their development.

Vicarious experiences observing effective peer and mentor teaching represent additional sources of development. Research shows that candidates who observe and reflect on their peers' and mentors' practices report increased confidence. When candidates observe peers' effective strategies for addressing challenges such as management, disengagement, or technical difficulties, they gain confidence in employing similar approaches (Mather & Visone, 2024). Research emphasizes reflective discussions and debriefings following observations, facilitating identification and application of essential teaching elements (Johnson, 2022). The effectiveness of verbal persuasion depends on the presentation method. When verbal persuasion includes constructive feedback, identifying strengths and weaknesses, providing specific improvement strategies, and reassuring candidates that development is developmental, it becomes powerful (Mather & Visone, 2024). Credible sources carry more weight than generic praise (Bandura, 1997).

Mentorship relationships, coaching, and supervisor feedback represent valuable avenues within teacher education contexts.

Attention to physiological and affective responses is critical. Anxiety, stress, and negative emotions negatively impact efficacy unless addressed (Bandura, 1997). Anxiety partially mediates the relationship between self-efficacy and online teaching participation. While high self-efficacy buffers against anxiety, continued anxiety prevents engagement and erodes confidence (Manning, 2022). Programs should assist candidates in managing anxiety through opportunities to familiarize themselves with tools, low-pressure practice environments, problem-solving development, and mindfulness practices associated with technology use and positive emotions (Shi, 2025).

Beyond these four efficacy sources, researchers identify additional variables enhancing development. Collaborative learning communities enable shared technology experiences, collaborative problem-solving, and group reflection (Ohle-Peters et al., 2024). These environments provide vicarious learning, peer persuasion, and opportunities for mastery. Studies show that shared goals, communication, and iterative improvement significantly predict willingness to adopt digital strategy (RSIS International, 2025).

Mentorship and coaching structures effectively foster digital self-efficacy. Novice candidates paired with experienced digital experts are more successful in developing efficacy (Amemasor et al., 2025; Ohle-Peters et al., 2024). Mentors provide ongoing personalized guidance, expert viewing opportunities, constructive feedback, and emotional support. Effective mentoring requires mentors who possess high self-efficacy and technology integration competence, positioning them as role models and persuasive sources (Guidetti et al., 2018).

Curriculum integration, systematically including digital pedagogy across all components, enhances competence development and transfer to practice (Archambault & Crippen, 2009; Ohle-Peters et al., 2024). Subject-specific courses that integrate technologies and consider digital teaching approaches build richer pedagogical understanding and confidence.

Blended or hybrid professional development that combines online and face-to-face learning, hands-on practice, ongoing mentorship, and follow-up support is more effective than one-time workshops (Amemasor et al., 2025). Effective programs clearly define relevant objectives, offer active practice opportunities, reflection opportunities, and continuous feedback more than traditional approaches (Dilling et al., 2024). Furthermore, institutional support fundamentally influences development. Technical support, consistent access, encouragement, and explicit integration policies remove barriers (Amemasor et al., 2025; Ertmer et al., 2012). Institutions that provide infrastructure, financial support, and clear expectations foster efficacy, enabling successful implementation. Conversely, institutional barriers significantly hinder integration and reduce efficacy even among motivated educators (Theodorio, 2024; Ertmer et al., 2012).

Discussion and Recommendations

The article is organized around the same three guiding questions, and therefore, the synthesis confirms that Bandura's four sources of self-efficacy remain relevant in digital environments. The synthesis also confirms that empirical studies have found many ways to increase preservice teachers' confidence in their ability to teach with technology. For example, authentic and frequent digital teaching experiences, observation of successful digital teaching practices, and direct, credible feedback from other professionals will help increase preservice teachers' confidence in their ability to teach with technology. Self-efficacy is positively correlated with students' achievement, teachers' willingness to innovate in instruction, and teachers' professional resilience, and it has also been identified as a more reliable predictor of teachers' use of technology in the classroom than technical skill alone.

Secondly, regarding global trends and institutional frameworks, the synthesis identifies TPACK and DigCompEdu as the two most widely accepted frameworks for defining teachers' digital readiness. Both frameworks focus on the relationships among technological, pedagogical, and content knowledge, and establish specific competence areas and progression levels for developing these knowledge domains. However, the literature also supports the idea that frameworks yield the desired results only when used to guide program design and the development of digital experiences, coaching, and assessment. In addition, the rapidly evolving nature of artificial intelligence, immersive technologies, learning analytics, and hybrid learning is creating new expectations for teachers' digital competencies and making explicit digital pedagogy preparation necessary rather than optional.

Lastly, the Kazakhstani context combines the ambitious goals of national digital and AI policy initiatives with several structural limitations. Although "Digital Kazakhstan", large-scale Coursera integration and AI frameworks represent favourable policy conditions for improving digital pedagogy preparation among preservice teachers, rural-urban digital gaps, uneven physical infrastructure and variability in quality of digital pedagogy preparation among schools in rural areas limit the opportunities available to preservice teachers, particularly those located in remote and rural locations. This situation underscores the need for a multi-level approach that considers and addresses individual, pedagogical, and institutional factors.

Curricula in teacher education programs should align with TPACK and DigCompEdu and incorporate digital pedagogy into all subjects and methods courses. All courses and assessments should include deliberate efforts to provide preservice teachers with mastery and vicarious experiences, targeted feedback and intentional support for managing anxiety and stress associated with technology use.

Furthermore, teacher education programs should provide preservice teachers with a variety of authentic digital practicum experiences, including online, blended, and simulated formats distributed throughout their training. They should also offer opportunities for systematic reflection and formative feedback. Preservice teachers ought to receive structured mentoring and coaching from digitally proficient educators or participate in collaborative learning communities to bolster their digital self-efficacy.

Institutional policies and quality assurance mechanisms should identify digital pedagogy and self-efficacy as core learning outcomes. Furthermore, institutions should provide preservice teachers with access to sufficient resources (i.e., adequate hardware and software), technical support, and ongoing professional development for preservice teachers' mentors and teacher educators; and continuously assess preservice teachers' self-efficacy using validated tools.

Finally, digital equity needs to become a priority. Therefore, targeted investments in connectivity, devices, and support for rural and underserved institutions are necessary, along with context-sensitive practicum models that enable preservice teachers in rural or underserved locations to engage in authentic digital teaching experiences. Future research should investigate the long-term effects of self-efficacy, assess the effectiveness of various digital pedagogy interventions, and examine the interactions among policy, infrastructure, and program design and how these interactions affect preservice teachers' digital self-efficacy across different settings.

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