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Enhancing professional skills of prospective teachers in Kazakhstan through digital technologies

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ABSTRACT

The study's relevance stems from the increasing integration of digital technologies (DT) in education and the growing need for future educators to develop digital competencies. As teaching methods evolve to incorporate innovative tools, understanding how DT can effectively enhance professional skills (PS) is critical for preparing prospective teachers to meet the demands of 21st-century classrooms. This study aims to investigate digital technology's effectiveness in enhancing prospective teachers' PS. The research sample comprised 178 prospective teachers from the Abai Kazakh National Pedagogical University. Participants in the digital training constituted the sample of prospective teachers in the experimental group (EG). The results' correlation shows that the groups' indicators before and after the digital training differed significantly. The beneficial dynamics of dependent variables brought about by the digital training attest to the efficacy of the current pedagogical support in terms of enhancing the PS of teacher candidates. Given the country's ongoing educational reforms and efforts to modernize the system, this study fills a crucial gap by providing region-specific insights and offering practical insights for enhancing the PS of prospective teachers, which can be applied in pedagogical universities. These findings help to bridge the theory-practice gap by investigating the practical applications of digital tools in skill development.

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1. INTRODUCTION

The ability to integrate digital tools into teaching is a key professional skills (PS) for educators worldwide. Understanding how prospective teachers can effectively develop these skills ensures that education systems remain globally competitive [1], [2]. PS include not only technical expertise but also personal qualities, abilities, and capabilities that enable an employee to effectively fulfill their job responsibilities within an organization [3], [4]. Without a clear sense of belonging to their profession, a specialist may struggle with both professional adaptation and effective professional training [5]–[7].

This self-regulation involves aligning one's own capabilities with the demands of the profession, ensuring that the specialist can effectively meet the requirements of their professional role [8]–[10].

Professional success is heavily dependent on the development of personal and professional self-regulation in a future specialist. Students' desire to gain knowledge and develop skills, abilities, and relationships in their chosen direction is closely associated with how effectively their professional self-identification was organized within the university and their initial perceptions of their future professional activity [11]. The increased digitization of education following COVID-19 highlights the critical need to prepare teachers to effectively integrate and leverage technology in their classroom practices [12]. Teachers in the modern classroom must be proficient in both traditional pedagogical skills and digital competencies. However, many regions are experiencing a shortage of teachers with digital skills [13], [14].

Kazakhstani education highlights the long-standing tension between the rapid advancement of the digital world and the entrenched conservatism of university curricula, organizational structures, and teaching methodologies [15]. Consequently, the current state of PS among primary school teachers in Kazakhstani schools suggests that university training for prospective teachers could be more closely aligned with the needs of contemporary primary education [16]. One of the primary obstacles to the extensive use of digital technologies (DT) in teaching professions is the lack of necessary skills for effectively utilizing digital products, services, and content. Despite students' practical interest in the professional application of these technologies, they are often unprepared for such activities due to gaps in their professional training.

While many studies explore the role of DT, there is limited research specifically targeting how these tools enhance the PS of prospective teachers during their training phase, particularly in countries like Kazakhstan [17]. Furthermore, current digitalization strategies in Kazakhstan focus largely on infrastructure and administrative modernization, with insufficient attention given to developing digital pedagogical competencies among future educators. Teacher training programs in Kazakhstani universities often emphasize theoretical knowledge over practical digital competencies, leaving graduates unprepared to effectively integrate modern tools into real classroom settings.

This gap is further widened by the lack of systematic assessment of digital pedagogy training and the absence of standardized frameworks for incorporating DT into teacher education. Existing research rarely evaluates current DT training practices in primary education or provides a comprehensive approach to identifying gaps and suggesting improvements. The urgency of this research is underscored by the rapid digital transformation of education in Kazakhstan, driven by national initiatives such as "Digital Kazakhstan" and the Concept of Digital Transformation and Cybersecurity 2023–2029. As primary schools increasingly adopt digital learning environments, the mismatch between teacher preparation and classroom demands risks undermining the effectiveness of educational reforms. Without a structured approach to strengthening prospective teachers' digital competencies, the quality of primary education and, consequently, broader goals related to digital literacy and innovation could be compromised.

The novelty of this study lies in explicitly addressing these gaps by evaluating the role of DT in developing prospective teachers' PS during their initial training phase an area that has been largely overlooked in Kazakhstan and comparable educational systems. Unlike previous research, this study not only assesses the effectiveness of digital technology training but also highlights systemic shortcomings and provides evidence-based recommendations for improving teacher education practices in a rapidly digitalizing context. Accordingly, this study aims to investigate the effectiveness of DT in enhancing the PS of prospective teachers. Digital tools have the potential to scale up training and improve the quality of education, making this research highly relevant. The study's central research question is on how effective are DT in enhancing the PS of prospective teachers.

2. THE COMPREHENSIVE THEORETICAL BASIS

When shaping the personality of a teacher at a university, it is essential to examine the future professional through the lens of the qualities, attributes, and characteristics that contribute to their success in the profession. Identifying and understanding the structure of these professionally important personal qualities, which foster active professional development, serves several purposes. First, it helps form a comprehensive understanding of the teaching profession. Second, it enables the design of curricula and programs that align with the demands placed on university graduates by their chosen field. Third, it provides the university with scientifically grounded data on how to develop the qualities in students that are necessary for effective professional activity, thereby better preparing them for independent work in their chosen profession [18]. It should be noted that the term "professional skills" is often used interchangeably in the literature with concepts such as "professionalism", "professional training", "professional mastery", and "qualification" [19]. Researchers frequently do not distinguish considerably between these terms, which complicate the overall analysis of the multidimensional concept of a teacher's PS [20].

Modern education imposes new demands on teachers, particularly with the introduction of a competency-based approach and the digitalization of education [21]. On one hand, digitalization offers expansive teaching opportunities, such as access to highly qualified teachers from prestigious universities, the use of visual aids, the ability to reach a wide audience, and the option of distance learning when necessary. On the other hand, there are some limitations, as certain aspects of learning such as the development of social competencies, specific skills and abilities in primary school children, and certain professional competencies in university students can only be effectively conveyed through live, in-person interaction. There are also challenges related to the additional time required for class preparation, the lack of necessary technological competencies among teachers, and insufficient motivation among both students and teachers [22]–[24]. Several researchers noted the increasing demand for specialists with digital professional competencies, yet there is a noticeable shortage of teachers equipped with these skills [25]. Some researchers have noted the risks of intellectual degradation linked to the regular use of DT [26]. Overcoming these challenges requires innovative research, effective use of DT, and the application of this knowledge to stimulate the development of PS in teacher candidates [27]. Additionally, the study examines adaptive digital communication and the ability to effectively use online platforms for interacting with students, parents, and colleagues. It also considers skills in digital content creation and management, such as designing interactive educational materials, multimedia resources, and online course modules. A further area of focus is data-driven teaching and decision-making, which involves leveraging educational analytics and artificial intelligence or AI-based recommendations to enhance the learning experience.

The subchapter serves as a structural foundation for the research by defining key concepts, relationships, and theoretical perspectives that guide the study. It provides a systematic representation of the issue under study and establishes a logical connection between variables, theories, and the research objectives. Figure 1 illustrates the structured relationship between the training interventions (input), implementation process, and expected outcomes, which form the core components of this study. The model maps the relationships between input, process, and outcomes, ensuring a clear and structured understanding of how digital technology affects teacher preparation.

Training intervention (input) focuses the initial conditions influencing teacher training. It differentiates between specialized digital training interventions (which integrate digital tools into pedagogical methods) and traditional training methods (which rely on conventional teaching strategies). The key objective at this stage is to determine whether a specialized digital training approach leads to better preparedness among future teachers compared to traditional training.

The implementation process describes how the training intervention is applied in real educational settings. It compares the digital approach (e.g., integrating AI-based learning platforms, learning management system (LMS), and interactive digital resources) with traditional teaching methodologies (e.g., textbook-based learning, face-to-face lectures). The process stage examines the effectiveness of digital technology in delivering PS and evaluates its impact on instructional strategies.

Outcomes (dependent variable) represent the expected results of the implemented training intervention. The study focuses on two primary outcomes: skill development and professional growth. This stage assesses whether teachers trained through digital methods demonstrate stronger competencies than those trained through traditional approaches.

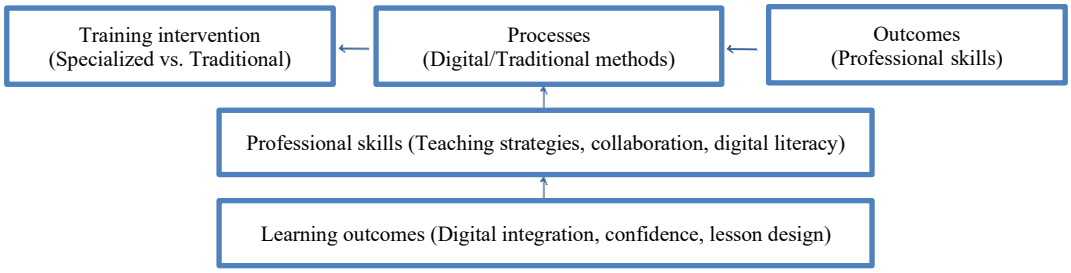

Figure 1. Conceptual framework of the study

3. METHOD

3.1. Research design

This study employed a quasi-experimental pretest-posttest design to examine potential cause-and-effect relationships. This design involves administering a pretest. An assessment conducted before the intervention and a posttest. It evaluates the participants following the intervention [28]. Figure 2 shows the research stages, activities, and indicators measured.

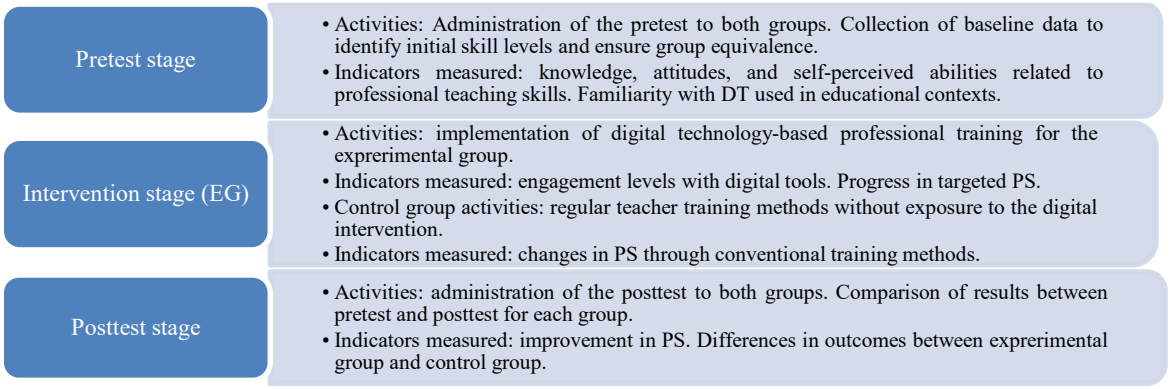

Figure 2. Research stages

3.2. Research sample formation

All prospective teachers enrolled at Abai Kazakh National Pedagogical University who met the study's eligibility criteria were invited to participate. Eligibility criteria included being an enrolled student in a teacher preparation program and a willingness to participate in the study. To determine an appropriate sample size, Cochran's formula for calculating sample size in a simple random sampling method was applied [29], as in (1):

$$n_0 = \frac{z_2 p(1-p)}{e2} \quad (1)$$

After applying the formula, adjustments were made based on the total population size of eligible prospective teachers at Abai Kazakh National Pedagogical University. The final sample consisted of 178 respondents, randomly divided into two groups to maintain comparability. The first is control group (CG) consisted of 87 participants (traditional training methods). The second is experimental group (EG) consisted of 91 participants (digital technology-based training intervention).

Before the intervention, pretest scores were collected to verify that both groups were statistically comparable in terms of their initial PS levels. This step confirmed that post-intervention differences were due to the digital training intervention rather than pre-existing disparities between groups. By employing simple random sampling and baseline verification, this study ensures that findings are scientifically valid, replicable, and applicable to future teacher training programs.

3.3. Procedure

This procedure ensures a thorough and transparent method for evaluating the effectiveness of DT in improving prospective teachers' PS. The study lasted approximately six months, from September to February 2023, with a total of 25 weeks. Sessions took place both online and offline, with one one-hour session held each week. There were total of 13 offline and 12 online sessions. Table 1 summarizes the primary focus areas and specific skill development targets. Various methods and techniques were used during the sessions to improve PS. These methods were integrated into individual lectures based on the topic. Various activity formats were introduced and used in different lectures. The PS lectures were primarily about the pedagogical process and education. Abai Kazakh National Pedagogical University's educational methodologists and Ph.D. holders in computer science provided digital training.

3.4. Instruments and data collection

The survey aims to assess the effectiveness of digital training in DT on prospective teachers' PS. It includes questions that evaluate participants' perceptions, experiences, and skill development. Table 2 shows the survey structure.

3.5. Data analysis

The analysis of data collected from the pretest-posttest experimental design was conducted using statistical methods, with a focus on determining the impact of the intervention and exploring relationships between variables. Correlation analysis was used to identify significant relationships between variables, indicating factors that influence skill development. A one-way analysis of variance (ANOVA) was used to determine whether the intervention resulted in a statistically significant increase in PS for EG compared to CG.

Table 1. The topics within the digital training

Training topic	Key focus areas	Skill development
LMS	Creating, managing, and evaluating digital course materials (e.g., Moodle, Google classroom)	Technical proficiency in LMS platforms and data management
Online teaching platforms	Using platforms like Zoom, Microsoft Teams for virtual classrooms and interactive sessions	Effective virtual communication and interactive teaching strategies
Digital lesson design	Developing engaging, technology-enriched lesson plans aligned with learning objectives	Designing creative, student-centered lessons with technology
Collaborative tools	Team collaboration using tools like Trello, Slack, or Google workspace	Improved teamwork and coordination in digital environments
Digital resource management	Organizing, sharing, and accessing teaching resources in cloud environments (e.g., Google Drive)	Efficient management of digital teaching assets

Table 2. Research instrument

Variable	Objective	Statement	Measurement scale
Training intervention (IV)	Identify training method exposure	What type of training have you received? (traditional/digital)	Categorical (traditional/digital)
Digital competency development (MV)	Assess digital literacy and ability to integrate DT into teaching	Rate your confidence in using LMS (Moodle, Google Classroom).	Likert scale (1-5)
		How often do you use online teaching platforms (Zoom, Microsoft Teams)?	Ordinal (never–always)
		Can you troubleshoot technical issues independently?	Likert scale (1-5)
Teaching integration (DV1)	Evaluate the ability to incorporate DT into teaching strategies	How frequently do you use digital resources in lesson plans?	Ordinal (never–always)
		Rate your ability to design interactive digital lessons.	Likert scale (1-5)
		Do you feel confident aligning digital tools with lesson objectives?	Binary (Yes/No)
Collaboration and communication skills (DV2)	Measure the impact of DT on teamwork and professional interaction	How often do you use digital collaboration tools (Trello, Slack) to work with colleagues?	Ordinal (never–always)
		Rate your comfort in sharing resources via cloud platforms (Google Drive, OneDrive).	Likert scale (1-5)
		How effective are digital tools in improving team coordination?	Likert scale (1-5)
Teaching effectiveness and professional growth (DV3)	Assess changes in teaching confidence and effectiveness	How confident are you in integrating digital tools into your teaching practice?	Likert scale (1-5)
		Do you feel the training improved your ability to deliver lessons effectively?	Binary (Yes/No)
		Rate the relevance of the training content to your teaching needs.	Likert scale (1-5)
		What were the most valuable aspects of the training program?	Open-ended
		What challenges did you face during the training?	Open-ended
		How would you suggest improving the training program?	Open-ended

4. RESULTS AND DISCUSSION

4.1. What are the results of a pretest administered to the participants before intervention?

As can be seen in Table 3, low digital literacy in CG is associated with traditional teaching methods, weaker collaboration skills, and lower confidence in using digital tools. This is reflected in the negative correlations between digital literacy and teaching strategies (r=-0.35), collaboration skills (r=-0.29), and confidence in digital tools (r=-0.42). In EG, similar negative correlations were applied between digital literacy and teaching strategies (r=-0.30), collaboration skills (r=-0.25), and confidence in digital tools (r=-0.38), reflecting the assumption that lower digital literacy in EG is also linked to more traditional teaching methods and lower collaboration and tool usage confidence. The teaching strategies and collaboration skills show strong positive correlations in both groups, indicating that teachers with better strategies tend to collaborate more effectively and vice versa.

4.2. What are the results of the posttest administered to participants following the interventions?

Table 4 shows a moderate positive correlation (r=0.45, $p<0.05$) between improving digital literacy and teaching strategies in CG, but not as strong as in EG. After following traditional teacher training methods, the CG shows moderate to strong positive correlations between digital literacy, teaching strategies, collaboration skills, and confidence in digital tools. However, the improvements are less pronounced than in

EG, reflecting the limited impact of traditional methods on enhancing digital skills. In contrast, EG, which received the digital technology-based intervention, shows stronger positive correlations across all variables, particularly between digital literacy and confidence in digital tools (r=0.62). This highlights the effectiveness of digital technology interventions in enhancing digital literacy, teaching strategies, collaboration, and confidence in using digital tools.

The posttest results show that the digital technology-based intervention had a more significant positive impact on the EG, which supports the hypothesis that DT can improve prospective teachers' PS more effectively than traditional teacher training methods [30], [31]. Table 5 shows the results of a one-way ANOVA that compares the posttest scores between CG and EG. CG and EG had a significant difference (F=9.72, p=0.002) as revealed by the one-way ANOVA. EG's higher score on digital literacy indicates that the digital technology-based intervention had a significant impact on their digital literacy compared to CG. There was a significant difference in teaching strategies (F=15.84, p<0.001), with EG achieving better results. According to the findings, the digital technology intervention had a significant positive impact on teaching strategies. The two groups' collaboration skills differed significantly (F=7.59, p=0.006), with EG outperforming the CG. This suggests that the intervention helped EG participants improve their collaboration skills. There was also a significant difference in confidence when using digital tools (F=10.47, p=0.001), with EG having significantly more confidence. This demonstrates the positive impact of the digital technology intervention in increasing participants' confidence in using digital tools. This finding is consistent with previous research indicating that digital literacy and teaching strategies are best developed through specialized, technology-focused training rather than conventional educational methods [32], [33].

Table 3. Correlation analysis results of the pretest for CG and EG

Group	Variable	Digital literacy	Teaching strategies	Collaboration skills	Confidence in digital tools
CG	Digital literacy	1	-0.35	-0.29	-0.42
(n=87)	Teaching strategies	-0.35	1	0.49	0.51
	Collaboration skills	-0.29	0.49	1	0.44
	Confidence in digital tools	-0.42	0.51	0.44	1
EG	Digital literacy	1	-0.30	-0.25	-0.38
(n=91)	Teaching strategies	-0.30	1	0.50	0.52
	Collaboration skills	-0.25	0.50	1	0.45
	Confidence in digital tools	-0.38	0.52	0.45	1

Table 4. Correlation analysis results of the posttest for CG and EG

Group	Variable	Digital literacy	Teaching strategies	Collaboration skills	Confidence in digital tools
CG	Digital literacy	1	0.45	0.39	0.51
(n=87)	Teaching strategies	0.45	1	0.52	0.53
	Collaboration skills	0.39	0.52	1	0.47
	Confidence in digital tools	0.51	0.53	0.47	1
EG	Digital literacy	1	0.55	0.48	0.62
(n=91)	Teaching strategies	0.55	1	0.59	0.60
	Collaboration skills	0.48	0.59	1	0.55
	Confidence in digital tools	0.62	0.60	0.55	1

Table 5. One-way ANOVA results for comparing posttest scores (CG vs. EG)

Variable	Group	Mean	SD	F-Statistic	p-value
Digital literacy	CG	65.30	12.15	9.72	0.002
Teaching strategies	EG	74.50	10.01		
Collaboration skills	CG	58.25	11.88	15.84	<0.001
	EG	72.10	9.98		
Digital literacy	CG	60.40	13.10	7.59	0.006
Teaching strategies	EG	68.30	11.72		
Collaboration skills	CG	56.75	14.02	10.47	0.001
	EG	72.90	12.45		

4.3. Limitations and future research

While the study's findings offer valuable insights, several limitations should be acknowledged. The study utilized a specific sample of prospective teachers from a single university (n=178), which may limit the generalizability of the results to other teacher training programs, especially those in different contexts or countries. Future research should prioritize including larger and more diverse samples across multiple institutions and geographic regions to enhance the external validity of the findings. Expanding the sample would allow for more robust comparisons and help determine whether the observed outcomes are consistent

across various teacher education programs. Additionally, longitudinal studies could investigate the long-term impact of digital technology training on teachers' skills and classroom practices. Future studies might also explore related variables, such as student learning outcomes and teacher satisfaction with digital technology integration. Examining these factors would provide a more comprehensive understanding of the effectiveness and broader implications of digital technology training programs.

5. CONCLUSION

This study shows how specialized digital technology training improves prospective teachers' PS. The intervention greatly improved the EG digital literacy, teaching strategies, and confidence in using digital tools. In contrast, the CG, which received traditional training methods, showed minimal improvement. The findings highlight the importance of incorporating technology-focused training into teacher preparation programs in order to provide future educators with the skills they need to teach effectively in the digital age. The study findings make a practical contribution to research on developing PS in prospective teachers and can be implemented in pedagogical universities, indicating a new direction in the preparation of future specialists for professional activities.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The corresponding author [ZA] may provide study data upon reasonable request.

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