



Evaluating the impact of digital tools on innovative teaching practices among future educators

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Abstract

This article explores the application of digital technologies, including the Procreate graphic program, in creative education in Kazakhstan, with a focus on the importance of teacher involvement and digital literacy. As educational practices evolve through digital transformation, it is essential to understand how these transformations impact innovative teaching practices. A quantitative, cross-sectional survey design was employed to assess these relationships among 1,432 respondents at a Kazakhstani educational institution. The results demonstrate that digital technologies significantly enhance innovative teaching practices, leading to more dynamic and interactive learning environments. Moreover, digital literacy serves as a positive moderator, enhancing the bond between digital technologies and pedagogical innovation. Teachers who possess greater digital competence are more likely to effectively incorporate available technological resources, thereby enabling more creativity in their lectures. Moreover, teacher engagement serves as a critical avenue through which the successful integration of digital tools into classrooms can lead to creative instruction. Overall, these results emphasize the crucial need to provide targeted training to develop the digital skills of educators and to continue with in-service training programs. As digital literacy emerges as a crucial skill in 21st-century education, equipping teachers with the skills to use technology effectively will allow them to fully leverage its potential to improve student learning outcomes. Moreover, this research holds significant theoretical

value in understanding the adoption of digital technology, teacher engagement, and the implications of new teaching methodologies, thereby enriching the ongoing conversation about digital transformation in education.

Keywords: Digital tools, Procreate graphics program, innovative teaching, digital literacy, teacher engagement, educational technology

Introduction

Haleem et al. (2022) argue that a shift in teaching practices driven by digital innovation presents new challenges and opportunities for educators, administrators, and policymakers. Anthonysamy et al. (2020) note that digital materials can foster digital literacy skills, enhance student engagement, and promote education. Hence, the study emphasized the need for equity legislation to ensure access to digital resources as well as investment in targeted infrastructure and professional development. This will promote education, as is the case in Kazakhstan, where teachers and students are already benefiting from the digital educational revolution. This research demonstrates that tech-enlightened and active instructors enhance classroom innovation. Kazakhstan serves as a notable example of how digital technology can facilitate the development of critical thinking and active learning in educational reforms

(Hursen, 2021). The ability of digital technology to stimulate creativity depends on instructors' knowledge of digital resources and their professional development. Digital technology has a significant impact on creative pedagogy, according to a study by Shiri and Baigutov (2024a). According to Kárpáti Bereczki (2021), the usage of digital gadgets in the classroom may boost student creativity and critical thinking. Calavia et al. (2021) suggest that digital platforms alter classroom dynamics by fostering collaborative learning and creative problem-solving. Yustika and Iswati (2020) observed that technology-savvy instructors explore new things, which increases student learning. Furthermore, teaching and learning practices have globally benefited significantly from the development of technologies and software tools like Procreate, which is a powerful and versatile digital painting app suitable for all levels of artists; the tool is said to be gaining popularity. Despite these

advances, Kazakhstan lags behind in digital literacy, teacher professional development, and research on new pedagogies. Understanding how teacher professional development affects digital technology in creative education is crucial to closing this gap. This study examines how Kazakhstani prospective teachers can utilize digital technology to enhance their creativity. Kazakhstan's schools may benefit from computer literacy and faculty engagement in instructional innovation.

According to Hennessy et al. (2022), professional development programs enable instructors to adopt new pedagogical methods. They found that targeted professional development and training improve teachers' use of digital resources to stimulate creativity in the classroom, providing even more motivation for instructors to attend technology-focused professional development. Kazakhstan's digital education revolution involves adopting new technologies and adapting teaching approaches to a rapidly changing environment. The 2017 Digital Kazakhstan strategy shows the government's commitment to digital education and literacy. The initiative emphasizes the use of classroom technology to prepare pupils for future

challenges. Digital learning platforms, instructor training, and teaching resources should be prioritized to facilitate effective classroom delivery.

In Kazakhstan, the integration of digital technology, for example, through the use of the Procreate program in teaching and student learning, is changing the curriculum, assessment, pedagogy, and educator-student interactions. Digital technologies promote collaboration and help teachers to adjust classes to meet the different learning needs of the students. Interactive educational applications and internet platforms play a significant role in the active learning process, empowering students to retain more knowledge. The COVID-19 pandemic has highlighted both the benefits and drawbacks of online education. Internet platforms were essential for many Kazakhstani schools' hybrid and distance learning approaches throughout the outbreak. This catastrophe has prompted educators and governments to rethink teaching and learning in light of digital resilience and preparedness. Digital technology in Kazakhstan's schools raises concerns about access and equity. Digital tools and infrastructure are often more readily available in richer metropolitan schools but are usually lacking in poorer rural schools. Closing these gaps requires

infrastructural development in the rural areas and reform in legislation to ensure fair access, subsidies, and digital literacy initiatives for both children and teachers. Given that teachers are at the center of digital learning, more instructors will be needed in rural areas to bridge this digital divide and improve digital learning. Teachers require training in technology integration, innovative pedagogy, and digital tool competency to effectively utilize digital resources in the classroom. Long-term training in pedagogical innovation and digital literacy can help teachers create an engaging learning atmosphere that fosters critical and creative thinking (Hennessy et al., 2022). Educators need professional development, as well as a culture of innovation and experimentation, to harness digital technology and transform education. To enhance student engagement and improve academic performance, instructors should be motivated to experiment with new concepts, cooperate, and adapt digital technology to various learning styles (Calavia et al., 2021).

Professional development: This can be achieved through teacher networks, conferences, and other professional settings. The Kazakhstani digital education system opens access to global

cooperation and information. Kazakhstan can learn from various countries by applying its best practices, creative approaches, and cutting-edge technologies to enhance its education system (Education Reimagined, 2022). Collaboration, research, and exchange programs for educators and students can enhance learning, foster cross-cultural understanding, and promote digital citizenship. Future education in Kazakhstan will depend on the integration of digital technology, pedagogical reforms, effective educators, lawmakers, and stakeholders. In a digitized, tech-enabled world, education quality and student success require innovation, digital literacy, and equitable access. Therefore, the use of digital technology in education may have a positive impact on Kazakhstan's education system in terms of teaching and learning, student engagement, creativity, and preparation for the digital age. By focusing on improving infrastructure, developing its teachers, and driving innovation, Kazakhstan could become a leader in educational innovation and deliver quality education to all. It assessed the impact of digital technology on education in Kazakhstan, identifying the main trends, challenges, and opportunities of the digital revolution.

Literature review and hypotheses development

Digital Tools – Innovative Teaching Practices

Preservice teachers' exposure to digital tools fosters innovative teaching, according to research by Stambekova et al. (2024) on the transformational impact of technology on education. VR simulations, procreate graphic design programs, internet collaboration tools, mobile apps, and interactive whiteboards may enhance teaching. Haleem et al. (2022) argue that digital technology enhances the pedagogical relationship between teachers and learners. These tools facilitate innovative teaching by enabling educators to customize lessons to address diverse learning preferences and get the students actively involved in the class activities. In this digital era, education is characterized by flexibility; hence, each student's needs are met.

According to Tang et al. (2022), digital technologies in the classroom enhance students' creativity and problem-solving skills. Technology-based group projects may help students think critically and creatively (Bereczki & Kárpáti, 2021). Education with a strong digital emphasis helps students learn and gets future educators ready for a world that is becoming more digitally oriented.

Pongsakdi et al. (2021) found that pre-service teachers are more adept at using technology in the classroom when they use digital tools throughout their training. Furthermore, teachers who possess self-confidence are found more likely to experiment with innovative techniques and tools. It is also gathered that strategic use of digital tools improves student engagement and teacher satisfaction (Roque-Hernández et al., 2023). In corroboration, another study asserts that digital technologies enhance creativity and learning in the classroom (Li et al., 2022). According to studies of Shiri & Baigutov (2024), teaching that equips educators on how to use digital tools well fosters creativity in the classroom. Modernizing teaching methods and preparing instructors for the classroom require fostering collaborative problem-solving, building self-confidence, and personalizing education—benefits that digital technology effectively enables.

Hypothesis 1: The use of digital tools has a positive influence on innovative teaching practices among future educators.

Moderating role – Digital literacy level

Tang et al. (2022) found that teachers with a strong digital background can pass the knowledge about the use of these

digital tools down to their students. Analyzing and utilizing educational technologies and digital resources are essential components of digital literacy (Nikou & Aavakare, 2021). Technology-savvy educators engage pupils,

create, and adjust to new developments (Vacca, 2020). Some studies indicate that teachers with varying levels of digital competency exhibit distinct attitudes toward technology integration (Bereczki & Kárpáti, 2021). Tech experts argue that technology fosters collaboration, learning, and creativity among students. This is a tactic that encourages teachers to explore new ways to leverage technology in the classroom. It creates an environment that is conducive to innovative teaching. Moreover, teaching students to use professional graphic programs, from basic to advanced, is a critical factor in engaging them and producing valuable artists in the field. With digital literacy, educators feel more at ease using digital platforms and converting instructional materials to digital formats (Akayoglu et al., 2020). When instructors utilize technology with confidence, they can effectively address students' needs and initiate engaging discussions in the classroom. Nguyen et al. (2021) suggest that educators can continue to utilize their creativity when

teaching digital literacy. Programs for professional development help educators collaborate, utilize technology, and stay current.

Hypothesis 2: The level of digital literacy moderates the relationship between the use of digital tools and innovative teaching practices, such that higher digital literacy levels strengthen this relationship.

Mediating role – Teacher engagement

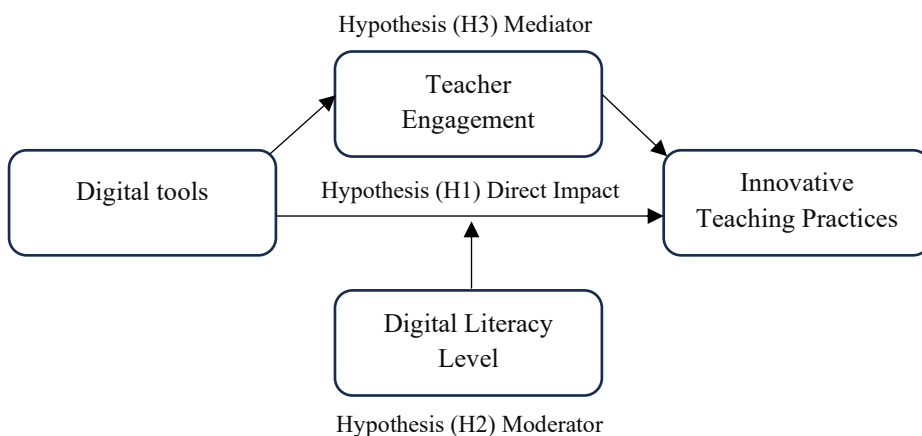
According to Fairman et al. (2022), professional development for teachers increases learning and creativity. Teachers may receive assistance with technology use from professional development programs that teach digital literacy and technology integration, as well as the Procreate graphic design program. Teachers can share, learn from, and develop new teaching strategies by participating in seminars and professional learning groups. According to Bragg et al. (2021), quality professional development enhances teachers' technical, reflective, and instructional abilities. Active teachers are more likely to experiment with new strategies utilizing digital platforms to adapt instruction to the needs of each student. Regular professional development enhances teachers' confidence and motivation to integrate technology into the classroom (Şen &

Yildiz, 2022). Through professional development, teachers can advance their careers and utilize technology to support students' learning. This not only helps to create and promote a culture of continuous improvement as instructors adapt to new standards and technologies, but also enables accreditation for their efforts. During the digital transition, teacher preparation plays a crucial role in mediating student success. (Perez et al., 2021) In professional development programs, peer mentorship, collaborative

learning, and frequent feedback can help teachers maximize the use of digital tools available to their students.

Hypothesis 3: Teacher engagement in professional development programs mediates the relationship between the use of digital tools and innovative teaching practices, such that greater teacher engagement enhances the positive impact of digital tools on teaching innovation

Figure 1: Research model



Methodology

Research design

This study employed a quantitative, cross-sectional survey design to investigate the relationship between digital tool usage, digital literacy, and

innovative teaching practices among pre-service teachers. The objective was to understand how digital transformation influences pedagogical innovation in the context of teacher education across Kazakhstan.

Participants and sampling

A total of 1,432 pre-service teachers were selected using a stratified random sampling method to ensure a representative sample across various regions, institutional types (public and private), and geographic settings (urban and rural) in Kazakhstan. The relatively large sample size was intentionally chosen to enhance the study's statistical power and ensure the generalizability of its findings across diverse educational contexts in Kazakhstan. Given the country's vast geographical expanse, as well as its educational diversity—including urban and rural institutions, public and private teacher training colleges, and varying levels of technological infrastructure—a large and stratified sample was necessary to capture a wide spectrum of experiences and perspectives.

The stratification was undertaken to facilitate sampling without bias and to represent a broad spectrum of viewpoints on the integration of technological tools into education. The focus was on pre-service teachers, who are currently undertaking pedagogical training and are responsible for determining future practice. The insights of these educators yield important perspectives on the perceptions and adoption of educational

technologies by the next generation of teachers and professors in the classroom.

Instruments

Data were collected using a self-developed, structured questionnaire based on existing, validated instruments adapted to fit the Kazakhstani educational context. The questionnaire assessed four key constructs:

- The use of digital tools: This explored the frequency and type of digital technologies employed in educational settings, including interactive whiteboards, educational applications, online collaboration tools, and virtual reality simulations.
- Digital literacy: Participants evaluated their digital competency, including their analytical skills, comfort with technology, and ability to use digital resources to foster student creativity and engagement.
- Professional development: This item measured the extent of participation in continuing professional development (CPD) programs focused on

digital pedagogy and technology integration.	Digital tool usage: 0.89
- Innovative teaching practices: This section gauged participants' application of creative, student-centered instructional methods facilitated by technology.	Digital literacy: 0.82
	Teacher engagement: 0.92
	Innovations in teaching practices: 0.83
	Thus, all constructs exhibit high internal consistency (Table 1).
Responses were measured using a 5-point Likert scale, adapted linguistically and contextually to reflect the local educational environment.	Ethical considerations All ethical procedures were conducted in accordance with institutional research guidelines. Before data collection, this study was approved by Abai Kazakh National Pedagogical University (Approval Code: 41, dated March 19, 2024). Participants provided informed consent, received assurances of anonymity, and were informed of their right to withdraw from the study at any point without penalty. Data were collected and stored securely to maintain confidentiality.
Validity and reliability The questionnaire was also checked for content validity by some educational technology experts and piloted with a small group of pre-service teachers. Changes made based on feedback are minimal.	
Cronbach's alpha values for the main scales were:	
Results Table 1 shows the demographic characteristics of the participants. The sample is roughly balanced, with 603 men and 820 women. The 26–30 age group had the most significant number of participants (705), followed by the 20–25 age group (492) and the 31–35 age group (235). This distribution suggests that	most participants are young people pursuing professional development in a teacher education program. They include 831 public school pupils and 601 private college students. This distribution reflects the diverse academic backgrounds of the participants, which span numerous schools. Some 466 of them were from rural areas, but most (966) were from

cities. Urban population pressure may impact the availability of education and opportunities, particularly the urban-rural divide, which could affect urban-rural study outcomes. The majority of participants (701) have no teaching experience, and 520 have less than one year. Two hundred and eleven have 1-3 years of experience. The profile suggests that a sizable proportion of participants are either new teachers or in the process

of becoming one, consistent with the study's focus on educators-in-training. All in all, this demographic information presents a comprehensive view of the study's subjects, providing a framework for understanding the results of Kazakhstan's digital revolution and teacher education, which is essential for a deeper understanding of the outcome (Table 1).

Table 1: Demographic characteristics of participants

Characteristic	Category	Frequency
Gender	Male	603
	Female	820
Age (years)	20-25	492
	26-30	705
	31-35	235
Educational Institution	Public University	831
	Private University	601
Region	Urban	966
	Rural	466
Teaching experience	None	701
	Less than 1 year	520
	1-3 years	211

Table 2 presents the composite reliability and average variance extracted (AVE) for

each experimental variable based on data from 1432 individuals. Several metrics

are necessary to assess the reliability and validity of a research construct. The Use of Digital Tools variable is dependable and valid, with 21 entries. The high factor loading of 0.87 indicates that the questions consistently measure digital tool usage. Cronbach's alpha value of 0.89 and composite reliability of 0.91 indicate that the items on this scale effectively evaluate the intended construct. The underlying concept of digital tool usage explains 68% of the observed variables' variance, meeting the usual convergent validity requirement with an AVE of 0.68.

Moreover, the 23-item Digital Literacy Level construct is both valid and reliable. A factor loading of 0.78 indicates that the examined factors significantly reflect

digital literacy. The scale demonstrated sturdiness and internal consistency, with a composite reliability of 0.86 and a Cronbach's alpha coefficient of 0.82. Digital literacy is a latent variable, with an average variance extracted (AVE) of 0.61, which accounts for 61% of the variance in observed variables. Teaching engagement is a 24-item test with good validity and reliability. The high factor loading of 0.88 indicates a strong link between the visible items and the instructor's participation. Cronbach's alpha coefficient of 0.90 and composite reliability of 0.92 indicate that the scale exhibits good internal consistency and reliability. An AVE of 0.70 indicates strong convergent validity, as teacher participation accounts for 70% of the variance in the visible variable (Table 2).

Table 2: Composite reliability and average variance extracted (AVE) (n = 1432)

<i>Variables</i>	<i>Items</i>	<i>Factor loading</i>	<i>Cronbach's alpha</i>	<i>Composite reliability</i>	<i>AVE</i>
<i>Use of digital tools</i>	21	0.87	0.89	0.91	0.68
<i>Digital literacy level</i>	23	0.78	0.82	0.86	0.61
<i>Teacher engagement</i>	24	0.88	0.90	0.92	0.70
<i>Innovative teaching practices</i>	21	0.79	0.83	0.87	0.63

Finally, the 21-item innovative teaching practices demonstrate reliability and validity. A factor loading of 0.79 indicates that the factor is significantly connected to innovative teaching techniques. The scale's Cronbach's alpha value of 0.83 and composite reliability of 0.87 indicate good internal consistency and reliability. The specific parameters are AVE = 0.63, indicating that the latent concept of innovative teaching techniques accounts for 63% of the variance in observable variables, demonstrating convergent validity. The study's reliable and valid measurement tools are presented in Table 2. It validates findings about online techniques, digital literacy, teacher engagement, and creative teaching methods. These metrics are crucial for ensuring the validity of the study's correlations and conclusions.

Table 3 presents the relational connections between significant study variables from a large sample of 1432 participants. The use of digital resources

is strongly associated with innovative teaching practices ($r = 0.65, p < 0.001$). It shows that teachers who frequently use digital resources are more likely to employ innovative teaching tactics. This suggests that teachers who incorporate more technology into their classrooms may be shifting toward teaching practices that foster creative and critical thinking. Digital literacy has a strong, positive relationship with the use of digital tools ($r = 0.72, p < 0.001$) and teacher engagement ($r = 0.68, p < 0.001$). Instructors with digital skills are more likely to use them in their classes and participate in technology-related professional development. These relationships demonstrate how digital proficiency influences teachers' behaviors in terms of classroom adoption of technology. Teachers demonstrate higher levels of engagement when they use digital tools ($r = 0.58, p < 0.001$) and when they have strong digital literacy ($r = 0.68, p < 0.001$). (Table 3)

Table 3: Correlation matrix (n = 1432)

Variables	Use of digital tools	Digital literacy level	Teacher engagement	Innovative teaching practices
Use of digital tools	1.00	0.72	0.58	0.65
Digital literacy level	0.72	1.00	0.68	0.54
Teacher engagement	0.58	0.68	1.00	0.49
Innovative teaching practices	0.65	0.54	0.49	1.00

The findings of the SEM, which considered the hypothesized relationships among digital tools, digital literacy, teacher engagement, and innovative teaching practices, are reported in Table 4. The significance of these correlations is indicated by the path coefficients, standardized coefficients, p-values, and associated results, which are also consistent with results from earlier studies. Hypothesis 1 states that the use of digital tools positively affects innovative teaching practices, and this is well supported by a path coefficient of 0.72 (standardized coefficient = 0.45, $p <$

0.001; Table 5). This result is in agreement with Garzón Artacho et al. (2020), The 2020 glossary highlights how the use of digital tools within the learning environment engages students creatively, making space for innovative learning models.

Secondly, Hypothesis 2 suggests that the digital literacy level moderates the relationship between the use of digital tools and innovative teaching practices. This is supported by the path coefficient (0.22, standardized coefficient 0.18, $p = 0.023$), indicating that increased digital literacy will also lead to a more

significant positive influence of digital tools on innovative teaching practices. This conclusion aligns with Alakrash and Abdul (2021), highlighting the importance of digital literacy in shaping educators' mindsets and capabilities for effectively applying technology in innovative teaching. Thirdly, Hypothesis 3 proposes that teacher engagement mediates the relationship between the use of digital tools and innovative teaching practices. The path coefficient of 0.38 (standardized coefficient = 0.30, $p = 0.005$) provides strong support for this hypothesis, indicating that professional development may facilitate

instructors' integration of digital tools into creative pedagogy. According to Bowman et al. (2022), this evidence revealed that increasing classroom technology usage to enhance teaching ranked active teacher engagement as the most essential element. Therefore, the SEM results for the model in Table 4 reveal that digital technologies, literacy, and teachers' participation have a significant impact on creative teaching. These findings expand theoretical insights for research discussions and demonstrate that schools can support education by enhancing digital literacy and faculty development programs (Table 4).

Table 4: Structural Equation Model (SEM) results and hypothesis testing

Hypothesis	Path coefficient	Standardized coefficient	p-value	Result	Support from previous studies
H1: Use of digital tools → innovative teaching practices	0.72	0.45	<0.001	Supported	Garzón Artacho et al. (2020) found that digital tools enhance engagement and creativity in classrooms.
H2: Digital literacy level moderates use of digital tools → innovative teaching practices	0.22	0.18	0.023	Supported	Alakrash Abdul (2021) emphasized the role of digital literacy in shaping attitudes

					toward technology.
H3: Teacher engagement mediates use of digital tools → Innovative teaching practices	0.38	0.30	0.005	Supported	Bowman et al. (2022) highlighted the impact of the teacher engagement on instructional improvement.

Discussion

Digital literacy and tools, such as the Procreate graphic program, were measured in our study. Teacher involvement and innovative classroom methods have a significant impact on Kazakhstani educators. A 1432 -person research examines how the digital revolution has changed educational methods and dynamics. Innovation is closely tied to the use of digital tools in the classroom. Research indicates that instructors who frequently utilize Internet resources incorporate innovative concepts into their classes (SEM, $p < 0.001$). This suggests that technology in the classroom promotes creativity, as noted by Zhao and Frank (2020). These studies suggest that digital technology may enhance student-centered learning and academic results in Kazakhstani schools.

The study also evaluated how students' digital literacy mediates the use of digital resources and creative education. SEM shows that digital literacy promotes creative pedagogy ($p = 0.023$, standardized coefficient = 0.18, route coefficient = 0.22). Voogt et al. (2017) suggest that teachers' confidence and expertise influence their classroom creativity. These findings suggest that Kazakhstan's educational reform should incorporate digital skills training and professional development for educators. The study also assessed how teacher engagement improved digital resource utilization and creative learning. The structural equation modeling (SEM) analysis found a significant mediation effect between digital technology professional development programs and creative education (path coefficient = 0.38, standardized coefficient = 0.30, $p = 0.005$).

Continuous learning and skill development enhance the integration of education technology, according to Guskey's (2002) research. The emphasis on professional development in Kazakhstan's educational reforms makes it imperative to coordinate efforts to support teachers' use of digital technology. Although this study focused on specific connections, its findings apply to all educational settings that utilize digital technologies. Teachers in Kazakhstan face the same opportunities and challenges as their global colleagues due to the rapid development of digital technologies. These educational resources enhance student learning and get them ready for the digital era. Schools may foster innovation, digital literacy, and teacher participation to foster creativity, critical thinking, and cooperative problem-solving. Worldwide, modern technology enables student-centered, experiential, and customized learning.

Theoretical implications

The educational philosophy around digital technology, digital literacy, teacher participation, and creative pedagogy will be significantly impacted by this study. Good instructors possess both subject-matter and classroom technology knowledge, according to Technological Pedagogical Content Knowledge

(TPACK)(Shiri & Baigutov, 2024c). It is supported by the good link that exists between the use of digital tools and creative teaching. Technology could encourage creative teaching methods. Teachers with a strong digital literacy create dynamic classroom environments that foster creativity, teamwork, and critical thinking. Constructivism encourages the use of technology in student-centered, inquiry-based learning.

The study examines how teacher involvement and digital literacy, such as Procreate graphic programs, impact learning and the use of digital skills by educators. From the perspective of Socio-Technical systems, an approach that examines the social and technological links inside organizations and ongoing professional development raises instructors' proficiency with digital tools. Digitally adept teachers can utilize engaging lessons to educate students and enhance their skills. Since instructional strategies and technology are closely intertwined, educational institutions must adapt to keep pace with the modern realities.

The government's initiatives to digitally transform classrooms and school reform are significantly impacted by this study. Adoption of digital tools and behaviors requires legislative frameworks that

support the diffusion of innovations hypothesis. Effective policies should prioritize technology equality, educator support and training, and learning infrastructure. It may be possible to enhance the integration of technology and foster long-term innovation in education by coordinating legislative initiatives with research-based digital literacy and teacher participation strategies. Developmental psychologists are concerned about the study's emphasis on digital teaching methods and their impact on children's cognitive and socioemotional development. In online learning environments, intuitive user interfaces and interaction have the potential to foster critical thinking, creativity, and teamwork. Working with peers who are both beginners and experts helps people learn best, according to Vygotsky's zone of proximal development. By utilizing digital technologies, teachers can help students thrive intellectually and emotionally by building upon existing knowledge and fostering meaningful connections within the classroom.

Managerial implications

This research may provide management insights to legislators, school administrators, and others concerned with classroom digital resource usage, such as the availability and skills required

to use Procreate graphic programs, which can further enhance students' engagement and skills (Shiri & Baigutov, 2024b). Strategic investments in digital resources and infrastructure can help schools effectively integrate technology into their curricula. This requires dependable internet, current technology and software, as well as digital tools that encourage students' cooperation and interaction. Managers and administrators should prioritize the technological needs of students and teachers when allocating funds. Technologically enabled schools stand a better chance of implementing innovative teaching methods that improve student engagement and accomplishment.

High-quality professional development and training programs are needed for educators to become digital citizens and successful classroom instructors. Education and management leaders should develop and implement CPD programs to enhance teachers' comprehensive digital skills. This kind of program should emphasize hands-on learning, group projects, and personalized instruction. Teachers need sponsorship to acquire the requisite digital skills and professional development to boost classroom creativity. Responsible and efficient classroom technology usage

needs legal and administrative frameworks and norms. Policies should emphasize digital literacy and guide on incorporating technology-enhanced pedagogies into lesson plans to ensure that all students have equitable access to digital resources. Policymakers should support innovative teaching methods that utilize technology to engage students and enhance their learning. Management may stimulate innovation and flexibility in adapting to technological change by integrating policies that prioritize academic and training trends.

Promoting cooperation and creativity is a remarkable approach for administrators to encourage teachers to explore new teaching techniques and technologies. Innovation labs and learning communities allow educators to collaborate on digital learning tools. By providing a space where innovation, creativity, and lifelong learning are encouraged, supervisors can offer support for instructors to experiment with and adapt technology to meet the diverse learning styles of their students. The study highlights that an innovation culture, legislation that supports the professional development of teachers, strategic planning, and investment in technology to facilitate teaching in classrooms and enhance students' success are necessary. School

officials should focus on these elements. These issues can be addressed proactively by managers who lead educational innovation and coach teachers to utilize technology effectively, thereby enhancing student achievement and preparing them for life in a digital world.

Conclusion

Through this study, the importance of digital literacy attitudes among pre-service teachers and the use of technological tools in developing innovative pedagogical practices in Kazakhstan is demonstrated. The results reveal how the application of digital tools influences teacher engagement, as well as the creative pedagogies. Teachers who also regularly use digital resources, such as the Procreate graphic design program, are more likely to implement new teaching methods, inspiring creativity in the classroom.

Moreover, the study highlights digital literacy as a mediating factor in supporting student-centered learning. Structural Equation Modeling (SEM) analysis revealed that digital literacy has a positive effect on creative pedagogy, supporting previously identified aspects of the significance of teachers' technical and pedagogical knowledge in integrating digital tools efficiently. Teacher engagement was also found to play a

crucial role in integrating digital tools into classroom practices, hence emphasizing the importance of ongoing professional development programs. This indicates that Kazakhstan needs to implement reforms in education to train educators on the skills necessary for implementing secondary school and technology in schools, thereby improving student performance. As the world transitions to online education, Kazakhstani teachers face the same prospects and problems as their foreign colleagues. Schools can create an environment that promotes creativity while encouraging critical and collaborative problem-solving among their learners by promoting digital literacy, increasing teacher engagement, and supporting professional development. All in all, this study demonstrates that implementing digital technologies in education is the most effective way to prepare students for success in a modern technological world.

Limitations and research directions

Though insightful, the study's shortcomings must be considered. Due to cross-sectional data, causal associations cannot be established. Future longitudinal research may reveal how instructors' and students' digital literacy evolves. Second, as the study only

involved Kazakh teachers, the findings may not apply to other cultures and

educational settings. Comparative studies across countries and educational systems can help explain how contextual factors influence the adoption of digital tools, digital literacy, teacher engagement, and innovative teaching strategies.

Ultimately, institutional support, student involvement, and emerging technologies such as VR and AI may influence classroom digital tool usage and outcomes. The study concludes by examining the intricate relationships between digital tools, digital literacy, teacher engagement, and innovative teaching methods, thereby contributing to the existing literature on digital transformation in education. These findings demonstrate the revolutionary capacity of technology to enhance education and prepare instructors for contemporary classrooms. Educational stakeholders may promote innovation and professional development to empower students and promote lifelong learning.

Declarations

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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