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DIGITAL EDUCATIONAL ENVIRONMENT AS A RESOURCE FOR DEVELOPING DIGITAL COMPETENCIES OF FUTURE SPECIAL EDUCATORS: CHALLENGES AND PROSPECTS IN THE REPUBLIC OF KAZAKHSTAN

Abstract. This article examines the perceptions of future special educators regarding the development of digital competencies in the context of the evolving digital educational environment in the Republic of Kazakhstan, focusing on challenges and prospects. The study was guided by four research questions and utilized a descriptive survey research design. The study population consisted of 239 future special educators from three leading higher education institutions in the Republic of Kazakhstan – Abai Kazakh National Pedagogical University, Al-Farabi Kazakh National University and L. N. Gumilyov Eurasian National University. Data were collected between January and March 2026. Given that the population size was manageable, complete enumeration was used; no sampling technique was applied. A 40-item author-developed questionnaire titled "Challenges and Prospects of Forming Digital Education Environments Questionnaire" (CPFDEER) was used. Face and content validity was ensured by three experts in Educational Measurement and Evaluation. Internal consistency was assessed using Cronbach's alpha (Cluster 1 = 0.81, Cluster 2 = 0.82, Cluster 3 = 0.81, Cluster 4 = 0.83, overall $\alpha = 0.82$). Data were analyzed using mean and standard deviation with SPSS version 26.0. The results showed that respondents perceived that digital learning environments support quality training for future special educators. The findings highlight perceived challenges such as technical issues, limited access to technology, and inadequate training. This study provides insights into respondents' perceptions of how digital learning environments support special education.

Keywords: digital education environments, educator training, special education, special educators.

Introduction

Globally, education is part and parcel of man because of the role it plays in the cognitive, affective and psychomotor development of man and his environment in any given community. Education is, therefore, an instrument through which people attain all-around success and become active members of society. The transformation of the education sector due to the advent of information and communication technology (ICT) is creating new opportunities for effective teaching and learning, as well as for collaboration, marking an essential shift from traditional teaching methods to digital approaches (Bond et al., 2020; Zhao et al. 2021). Similarly, the digital education environment emerged due to the integration of ICT and modern technologies in distance learning (Yessenbekova, et al., 2025). Consequently, future special educators who provide instruction to learners with special needs need to pursue specialized training to acquire the relevant skills and ICT competencies to use digital educational environments (Basilotta-Gomez-Pablos et al., 2022; Falloon, 2020). This makes the formation of digital environments for training special educators a necessity.

In simple terms, a digital learning environment is an online platform that provides an interactive, comprehensive learning experience. According to Fernández-Batanero et al. (2022), the digital education environment encompasses various resources and digital tools, such as online libraries, multimedia resources, learning management systems, and virtual classrooms. However, all these digital tools and resources provide learners with maximum access to a wealth of information, help foster good communication and collaboration among educators and learners, and also offer personalized learning experiences tailored to the needs and abilities of individuals (Ferrer et al., 2022; Kerimbayev et al., 2023). Besides, the digital education environment tends to prepare learners for the demands of the digital age, promote the quality of teaching and learning, and increase learners' academic engagement and motivation (Zhao et al., 2023; Claro et al., 2024). However, several problems impede the formation of a digital education environment for training special

educators. One of the key problems appears to be a lack of infrastructure, such as poor internet connectivity, inadequate computer hardware and digital resource, a challenge well documented during the COVID-19 pandemic and in Kazakhstan context (OECD, 2021; Yakavets et al., 2023).

This problem affects the growth and development of the digital education environment, making it very difficult for future special educators to participate effectively in virtual learning activities and access online resources. In addition, it appears that the lack of infrastructure is driven by poor funding, making it challenging to maintain existing digital equipment and procure new equipment. It appears that inadequate educator training constrains the digital education environment.

According to Guillén-Gámez and Mayorga-Fernandez (2020), future special educators need to be trained to use digital technologies in teaching, as most are ill-equipped with the relevant knowledge and skills. Thus, inadequacy in skills and knowledge regarding how to integrate digital tools into their teaching practices impede the effectiveness of the digital learning environment and the future special educators' ability to provide quality education to learners with special educational needs (Dias-Trindade et al., 2020). In addition, inadequate maintenance and technical support appear to have contributed to the problem of inadequate training. This makes it Herculean for future special educators to troubleshoot technical problems and also with their teaching activities (Dang et al, 2024; De Obesso et al., 2023).

Differently stated, inequality and the digital divide in accessing digital technologies tend to affect the formation of digital education environments, particularly for training future special educators (Claro et al., 2024). Digital divide refers to differences in access to technology among individuals, regions, and institutions. This divide appears to be common in developing societies. In the context of the Republic of Kazakhstan, which is implementing inclusive education reforms under the state program for Education Development 2020-2025, this challenge remains relevant (Yessenbekova et al., 2025) Consequently, Ainscow (2020) posited that educators working in these societies are left behind, as it is more challenging to access online resources and effectively participate in digital education environments. Another challenge, according to Fernandez-Batanero et al. (2022), that needs to be addressed is inadequate accessibility and inclusivity. This is because digital education environments may often neglect students' needs, especially those with special educational needs.

Despite these factors that seem to impede digital education environments, the prospects for training future special educators remain promising. As Cobero-Almenara et al. (2022) stated, future special educators have access to technologies, and innovative teaching methods through digital educational environments. Through this, the skills and competencies of future special educators in teaching learners with special educational needs are enhanced (Dang et al. 2024; Gallego Joya et al., 2025). Digital education environments create opportunities for collaboration, networking, and professional development among special educators, which go a long way toward enhancing their job retention and satisfaction. Besides, there are very few studies that address the problems and prospects of forming digital education environments for training special educators in Central Asian context, and filling this knowledge is germane (Basilotta-Gomez-Pablos et al., 2022). Based on the foregoing, it becomes prudent to examine the challenges and prospects of forming digital education environments for training future special educators in the Republic of Kazakhstan.

Statement of the Problem

In many developed and developing societies including the Republic of Kazakhstan, there appear to be many constraints on the development of digital education environments for training future special educators, such as limited access to digital resources, inadequate infrastructure, and insufficient educator training (OECD, 2021; Yakavets et al., 2023). Consequently, it becomes a challenging task for future special educators to acquire quality teaching, particularly in this period of rapid technological growth and development. The current situation is that the digital education environment for future special educators appears to be characterized by traditional teaching and learning methods that often neglect the diverse abilities and needs of learners with special needs, leading to limited accessibility and inclusive education (Ainscow, 2020; Fernandez- Batanero et al., 2022).

If these challenges confronting the formation of digital environments for training future special educators are not addressed, the majority of learners, particularly those with special educational needs, will be left behind. To the best of knowledge, the best practices for the formation of digital environments to address the diverse needs of future special educators in Kazakhstan have not yet been identified. Part of the problem stems from the paucity of empirical studies on digital education environments for future special educators in this context. This

leaves educators and educational policymakers with limited guidance on how to use digital technologies in special education programs (Zhao et al., 2021; Claro et al., 2024). Hence, it becomes needful to examine the perceptions regarding challenges and prospect of the digital education environment for training future special educators in Kazakhstan.

Research Aims

The general aim of this research is to examine the perceptions regarding challenges and prospects of forming digital education environments for training future special educators. Specifically, the study sought to determine:

1) The ways of forming digital education environments to enhance the training of future special educators
2) The problems associated with the formation of digital education environments for future special educators.
3) How can the problems confronting the formation of digital education environments for future special educators be reduced?
4) How the prospects of digital education environments can be used as a tool for improving the training of future special educators.

Research Questions

For the purpose of addressing the above research aims, the following questions were raised:

1) In what ways can digital education environments be formed to support the training of future special educators?
2) What are the problems confronting the formation of digital education environments for future special educators?
3) What measures can be adopted to reduce the problems confronting the formation of digital education for future special educators?
4) In what ways can the prospects of a digital education environment be used for improving the training of future special educators?

Significance of the Study

The findings of this research would be of immense benefit to educational stakeholders, including students with special educational needs, special educators, educational institutions, educational policymakers, curriculum planners, and future researchers, when this work is completed and published in journals.

The findings of this research will be of immense benefit to students with special educational needs, as they will be informed about the problems and prospects of forming a digital education environment. This will go a long way towards enhancing their access to quality and inclusive education system. Moreover, the findings of the study will provide learners with special educational needs with personalized, flexible educational experiences that cater to their needs and abilities. This is achievable when the work is published in journals and proceedings that students can access.

The result of this research will be of immense benefit to special educators by providing insights into effective implementation and by designing digital educational environments that address the diverse needs and abilities of learners with special educational needs. This will go a long way towards enhancing their skills and competencies required in teaching learners with special educational needs, particularly when digital resources are geared towards meeting the diverse needs of students. Special educators will be well-equipped with this finding by attending and participating in conferences, seminars, and workshops where papers on digital education environments are presented and discussed.

Educational institutions will also benefit from the findings of this research, as they will be guided in developing and implementing digital educational environments with the sole aim of supporting future special educators' training. This will enhance the academic achievement of learners with special educational needs and promoting job satisfaction among special educators. This will be achieved through the publication of journals and consultation with the educational administrators.

The findings of this research will be of immense help to educational policymakers, as they will be better informed regarding the development of suitable guidelines and policies for the formation of digital education environments in special education. By doing so, access to quality education for students with special educational needs will be improved. This will be achieved through journal publications and consultations with educational policymakers worldwide.

For curriculum planners, the findings of this study will help them consolidate effective teaching in

digital education environments for pre-service special educators. This is achievable when this study is published online in a journal for easy consultation by curriculum planners in the educational system.

Finally, future researchers will find the outcome of this study interesting. This is because the findings of this research will add to the already existing body of knowledge on the formation of digital learning environments. This study will serve as a baseline for other researchers to build on. Hence, researchers conducting studies on special education and digital learning environments will find the study beneficial.

Literature review

Concept of Digital Education Environment

Digital education environment as a concept has become a matter of concern to so many educational stakeholders, such as curriculum planners, educational policy makers, government, school authorities, researchers, among others, because of the advent of digital technologies in education, as well as the need to jettison traditional approaches and embrace innovative approaches to teaching and learning. As noted by Ferrer et al. (2022), the digital education environment is a virtual platform that provides students with comprehensive, interactive learning experiences.

The digital education environment includes various resources and tools, such as virtual classrooms, multimedia content, learning management systems, and digital libraries (Yessenbekova et al., 2025; Kerimbayev et al., 2023). In the special education context, digital environment in education is an online tool that provides future special educators with the relevant resources and tools needed for quality education, including assistive technologies for inclusion (Fernandez-Batanero et al.., 2022; Ainscow, 2020).

According to Falloon (2020) and Basilotta-Gomez-Pablos et al. (2022), digital educational environments support learners with special educational needs in accessing quality teaching and learning within an inclusive education system through teacher's digital competence. Some attributes of a digital education environment include adaptability, flexibility, and accessibility, which allow learners to learn at their convenience and time (Guillén-Gámez & Mayorga-Fernández, 2020; Fallon, 2020). Digital education environments serve as a vehicle for networking, professional development, and collaboration among future special educators (Bond et al., 2020)

By way of synthesis, one can infer that a digital education environment is a critical attribute of a special education program, hinged on providing learners with special educational needs access to quality teaching and learning, as well as all-inclusive education. In this study, the digital education environment is regarded as a virtual platform that supports future special educators with resources and tools to promote quality learning among students with special educational needs, fostering equity, inclusion, and diversity.

The formation of digital education environments to enhance the training of future special educators

Forming a digital education environment is a process that involves integrating technology, collaboration, and pedagogy to enhance the training of exceptional educators. According to Zhao et al. (2021), digital education environments foster access to technologies, innovative teaching approaches, and resources, particularly among future special educators. Online and blended learning are among the approaches to the formation of digital education environments (Bond et al., 2020). As stated by Bravo-Agapito et al. (2021), the diverse needs of future special educators are met through online and blended learning, and student-centered approaches using modern technologies. Another way to create digital education environments is to incorporate modern technologies such as artificial intelligence, virtual reality, and augmented reality into special educators' training. As opined by Claro et al. (2024), these digital technologies can provide interactive and immersive learning experiences. In-service training for educators should be carefully channeled to incorporate digital technologies and aligned with DigCompEdu frameworks (Cabero-Almenera et al., 2020; Vuorikari et al., 2022; Dias-Trindade et al., 2020).

By way of recapitulation, it was deduced that the formation of a digital education environment to enhance future special educators' training requires a systematic approach that integrates digital technologies, collaboration, and pedagogy. When these approaches are effectively utilized, special educators develop the required competencies and skills to provide quality instruction to learners with special educational needs.

The challenges confronting the formation of digital education environments for future special educators

There appear to be several problems affecting the formation of digital education environments, which also impede the effective use of digital technologies in educating learners with special needs. As OECD (2021)

rightly stated, one of the key problems is inadequate infrastructure, including digital resources, computer hardware, and internet connectivity. There seems to be a problem of inclusivity and accessibility in the formation of digital education environments (Fernández-Batanero et al., 2022).

Furthermore, another constraint on the formation of a digital education environment for special educators is inadequate technical support and maintenance and perceptions of educators' competence (Dang et al., 2024; De Obesso et al., 2023). In the absence of technical support, future special educators may find it extremely difficult to use digital technologies effectively. From another perspective, Zhao et al. (2021) noted that inadequate in-service training for future special educators is another key factor impeding the development of digital environments, as it limits their ability to integrate effective digital technologies into their pedagogical practices.

To sum up, the problems confronting the formation of digital education environments for the training of future special educators appear to be complex and therefore require a comprehensive solution. When these problems are clearly understood, educators and educational policymakers will have the opportunity to work together to create effective, inclusive, and accessible digital education environments that support the diverse learning needs of learners with special educational needs.

Strategies for reducing the problems confronting the formation of digital education environments for the training of future special educators

Salvaging the problems affecting the formation of digital education environments for the training of future special educators requires a comprehensive approach that includes investment, collaboration, and innovation. According to Gallego et al. (2025), providing continuous professional development and targeted training for future special educators is considered one of the key strategies. Investment in infrastructure such as digital resources, computer, hardware and reliable internet connectivity is also crucial (Kerimbayev et al. 2023). In addition, fostering stronger collaboration among educational policymakers, educators, and digital technology providers is essential. Such collaborative efforts can facilitate the development of inclusive and accessible digital education environments capable of addressing existing challenges. This will help address the needs of exceptional educators, including those of learners with special needs. Apart from that, educators could also engage in effective collaboration among themselves, as it creates room for them to share the best resources and practices, reduce excessive workload, and enhance the effectiveness of the digital learning environment (OECD, 2021). Evidence from Kazakhstan pedagogical universities shows that an integrated approach combining technology-enhance pedagogy significantly improved digital competence (Dang et al., 2024; De Obesso et al. 2023). Conclusively, reducing the problems associated with the digital education environment for the training of future special educators requires comprehensive strategies, investment and collaboration.

The prospects of digital education environments as a tool for improving the training of future special educators

The prospect of digital education environments offers many ways to improve future special educators' training and the academic performance of learners with special educational needs. As Zhao et al. (2021) noted, future special educators could have maximum access to various digital technologies, resources, and innovative teaching approaches through the integration of digital education environments. Digital competence is a strong predictor of perceived learning value and inclusion in Kazakhstan context (Dang et al 2024, Yessenbekova et al., 2025). Learning analytics serve as a platform through which future special educators can identify areas where learners require greater support (Bond et al. 2020). The second point to note is to effectively utilize digital education environments to enhance networking and collaboration among special educators. To further support this point, digital education environments enable students with special needs to gain greater access to assistive and adaptive technologies, as well as personalized learning plans. Moreover, parent-educators engagement and effective communication can be improved through digital education environments (Bravo-Agapito et al., 2021). To summarize, it was deduced that the prospect of digital education environments offers different opportunities to improve future special educators' training and the academic achievement of learners with special educational needs. When these prospects are leveraged, educators and other educators create digital education environments that are highly effective and innovative, helping address the diverse challenges affecting students with special needs in the 21st century.

Gap Identification

The literature reviewed so far has revealed an apparent gap in the formation of digital education environments for future special educators' training in Kazakhstan context. Although studies reviewed showed the merits of digital education environments, there appears to be a lack of empirical evidence on the problems and prospects of integrating them specifically for future special educators in Central Asian context. While existing studies focuses largely on general online learning (Bond et al., 2020; Ferrer et al., 2022), studies specifically on digital competencies are limited (Fernandez-Batanero et al., 2022, Cabero-Almenara et al., 2022; Basilotta-Gomez-Pablos et al., 2022).

Theoretical Framework

This study adopted two theories: Technological Pedagogical Content Knowledge (TPACK) and Self-Determination Theory (SDT) to advance its argument.

Technological Pedagogical Content Knowledge (TPACK)

The theory states that effective teaching in a digital education environment depends on integrating three aspects of knowledge: content knowledge, pedagogical knowledge, and technological knowledge. The affinity among these three domains of knowledge creates an intersection of additional knowledge, including the central TPACK, as well as pedagogical content knowledge, technological pedagogical knowledge, and technological content knowledge. In relation to the present study, TPACK theory informs the investigation of future special educators' ability to effectively integrate emerging technologies into their teaching practices to enhance learners' academic outcomes. Thus, TPACK theory underscores the relevance of special educators possessing Technological Pedagogical Content Knowledge (TPACK), as it enables them to utilize digital technologies and resources in their pedagogical practices, which will go a long way toward enhancing the academic performance of learners with special needs. Thus, when content, digital technologies, and pedagogy are integrated into digital education environments, special educators gain many opportunities to create an engaging, all-inclusive academic environment that addresses the academic problems of students with special needs.

Self-Determination Theory (SDT)

Self-Determination theory posits three innate psychological needs: relatedness, autonomy, and competence. These three innate psychological needs underpin intrinsic motivation and optimal learning. In this research, self-determination theory was used to argue that personalized learning paths and flexible pacing often support autonomy in digital education environments. It is also important to affirm that competence is enhanced through constructive feedback, while clear, related objectives are nurtured through collaborative discussions and group projects. When these needs are satisfied, academic engagement, academic performance and persistence among learners with special education needs and future special educators are enhanced. This theory, therefore, serves as a tool for designing interventions that foster academic performance, motivation, and engagement for special educators, particularly in a digital education environment.

Be that as it may, the two theories reviewed so far complement each other in the context of the present study. While TPACK serves as a framework for effectively integrating content, digital technology and pedagogy in the formation of a digital learning environment, SDT provides platforms for addressing the psychological needs that impede learning and academic motivation. Through the combination of these theories, this research is geared towards investigating how digital education environments could be structured to support future special educators' training and to improve the academic performance of learners with special education needs.

Methods

This subheading provides a clear description of the methods used in conducting the present study, presented as follows: research design, study population, sample and sampling technique, instrument for data collection, instrument validation, instrument reliability, method of data collection, and method of data analysis.

This research employed a descriptive survey design. A descriptive survey research design was considered suitable for the present study because it is an opinion-type study that sought to examine the perceptions of special educators regarding the challenges and prospects of forming digital education environments through the use of questionnaires.

The study population consisted of 239 future special educators studying at three leading higher education institutions in the Republic of Kazakhstan – Abai Kazakh National Pedagogical University, Al-

Farabi Kazakh National University and L.N. Gumilyov Eurasian National University at the time of the study (2025/2026 academic session).

Given that the population size was manageable, no sampling technique was applied, and the entire population was included in the study (Complete enumeration). Eligibility criteria were: final-year bachelor's students in special education programs, willingness to participate, and availability during data collection. Recruitment period was January to March 2026 (Table 1).

Table 1

Demographic characteristics of respondents

VARIABLE	CATEGORY	FREQUENCY	PERCENTAGE (%)
GENDER	Female	181	75.7%
	Male	58	24.3%
AGE	20-22 years	142	59.4%
	23-25 years	81	33.9%
	26 years and above	16	6.7%
UNIVERSITY	Abai Kazakh National Pedagogical University	92	38.5%
	Al-Farabi Kazakh National University	78	32.6%
	L.N. Gumilyov Eurasian National University	69	28.9%
LEVEL	Final-year Bachelor (4th year special education)	239	100.0%
TOTAL		239	100.0%

This research was conducted using a questionnaire designed by the researchers. The instrument is titled "Challenges and prospects of forming digital education environments questionnaire" (CPFDEEQ). The instrument consists of two sections: A and B. Section A sought information on the demographic variables of study participants, while the information needed to answer the four research questions was addressed in Section B. Section B was therefore divided into four clusters.

The first cluster sought the opinions of study participants on ways to form digital education environments to enhance the training of future special educators. The second cluster sought the study participants' opinions on the problems associated with the formation of digital education environments for future special educators. The third cluster sought the study participants' opinions on how the problems confronting the formation of digital education environments for future special educators can be reduced.

In contrast, the fourth cluster sought the opinion of study participants on how the prospects of digital education environments can be perceived as a tool to improve the training of future special educators. The instrument has a total of 40 items, based on a four-point scale: Strongly Agree (SA)-4, Agree (A)-3, Disagree (D)-2, and Strongly Disagree (SD)-1. The decision threshold is mean > 2.50 considered as agreed.

To ensure that the instrument was validated correctly, three copies of the instrument, along with the study's topic, objectives, and research questions, were submitted to three experts in the educational measurement and evaluation unit at Abai Kazakh National Pedagogical University. The corrections and inputs from the experts led to certain modifications, such as the addition of some items and the correction of typographic errors, before the final production of the instrument.

The reliability of the instrument was determined through a pilot test of 20 future special educators in another public university, which is outside the study location. The scores obtained were analyzed using Cronbach's alpha. The reliability coefficients were 0.81 for the ways of forming digital education environments to enhance the training of special educators, 0.82 for the problems associated with the formation of digital education environments for special educators, and 0.81 for how the problems confronting the formation of digital education environments for special educators can be reduced.

In contrast, 0.83 was obtained for items addressing how the prospects of digital education environments can be used as a tool to improve the training of special educators, with an overall reliability coefficient of 0.82. Thus, the instrument was considered reliable for collecting data for the study. According to Taber (2018), the reliability coefficients of 0.81 and above is acceptable.

Ethical approval was obtained from the Research Ethics Committee of Abai Kazakh National Pedagogical University, Approval No. ABAI-REC-2026/02-14/SEP dated 15th January 2026. Informed

consent was obtained from all participants. Participation was voluntary, confidentiality and anonymity were assured, no personal identifiers were collected, and participants had the right to withdraw at any time without consequences

The researchers administered the instrument to the study participants with the help of three research assistants who were future special educators in the institution. The instrument was administered to future special educators during their workshops and seminars between January and March 2026 using the Direct Delivery Method (DDM). All the 239 copies of the questionnaire were carefully retrieved and used for analysis (100% return case).

In this research, the mean and standard deviation were used as statistical tools for data analysis with SPSS version 26.0. The mean was used to answer the questionnaire items in accordance with the research questions. In contrast, the standard deviation was used to test for the homogeneity or otherwise of the mean ratings of study participants.

For decision-making, items with mean scores of 2.5 and above were considered agreed upon by the study participants. It is important to note that these mean rating reflect respondents' perceptions and do not prove that digital environments enhance instruction or student performance, as this is a descriptive survey.

Results

Research Question 1: In what ways can digital education environments be formed to support the training of special educators?

Data generated in Table 2 reveal that providing technical support for educators was rated 3.50, which was followed by providing flexibility in learning experiences and encouraging educators to use digital tools in teaching, with mean scores of 3.45 and 3.40, respectively, indicating that these are significant ways digital education environments can be formed to support the training of future special educators.

Nevertheless, the study participants accepted all the questionnaire items, as these items received mean ratings above 2.50, with a grand mean score of 3.28 and a standard deviation of 0.64. This implies that the respondents' perceived that the formation of digital education environments supports the training of future special educators.

Table 2

Mean rating and standard deviation of study participants on the formation of digital education environments to support quality training for future special educators

S/N	The ways digital education environments can be formed to support the training of special educators include:	Mean	SD	Decision
1.	Enhancing access to training resources	3.21	0.62	Agreed
2.	Providing flexibility in learning experiences	3.45	0.58	Agreed
3.	Facilitating collaboration among special educators	3.01	0.71	Agreed
4.	Providing opportunities for the development of technical skills	3.35	0.65	Agreed
5.	Supporting the diverse needs of special educators	3.12	0.68	Agreed
6.	Enhancing the quality of training for special educators	3.28	0.63	Agreed
7.	Encouraging educators to use digital tools in teaching	3.40	0.60	Agreed
8.	Increasing access to professional development opportunities	3.22	0.66	Agreed
9.	Providing technical support for educators	3.50	0.55	Agreed
10.	Improving the outcome of learners for special educators	3.18	0.69	Agreed
	Grand mean for research question one	3.28	0.64	Agreed

Research Question 2: What are the problems confronting the formation of digital education environments for special educators

In Table 2, inadequate training regarding the use of digital tools, poor internet connectivity, and high-cost technology were regarded as the main problems confronting the formation of digital education environments for future special educators, with mean scores of 3.42, 3.38, and 3.32, respectively.

Furthermore, all the questionnaire items were rated as agreed by the study participants, with a cluster mean score of 3.21 and a standard deviation of 0.67. This indicates that the respondents perceive items in Table 3 as the key problems affecting the formation of digital education environments for future special

educators.

Table 3

Mean rating and standard deviation of study participants on the problems confronting the formation of digital education environments for future special educators

S/N	The problems affecting the formation of digital education environments include:	Mean	SD	Decision
1.	Poor access to technology	3.30	0.64	Agreed
2.	Inadequate training regarding the use of digital tools	3.42	0.59	Agreed
3.	Technical issues	3.20	0.67	Agreed
4.	Poor internet connectivity	3.38	0.61	Agreed
5.	Negative attitude of educators towards the use of digital tools	3.05	0.72	Agreed
6.	Lack of skills	3.15	0.70	Agreed
7.	Digital education environments are not user-friendly	2.90	0.75	Agreed
8.	Inadequate technical report	3.25	0.66	Agreed
9.	High-cost technology	3.32	0.63	Agreed
10.	Lack of institutional support	3.10	0.71	Agreed
11.	Grand mean for research question two	3.21	0.67	Agreed

Research Question 3: What measures can be adopted to reduce the problems confronting the formation of digital education?

The findings in Table 4 reveal that provision of maximum technical support (3.45), provision of quality training on digital tools (3.40), Provision of institutional support (3.35), improving internet connectivity (3.32) and increasing access to digital technology (3.28) are the key strategies for reducing the challenges to the formation of digital education environments.

In addition, the study participants agreed to all the questionnaire items 21-30, indicating that the respondents perceive them as the key measures for reducing the problems confronting the development of digital education for the training of future special educators.

Table 4

Mean rating and standard deviation of study participants on measures reducing the problems confronting the formation of digital education

S/N	The measures reducing the problems confronting the formation of digital education include:	Mean	SD	Decision
1.	Provision of quality training on digital tools	3.40	0.60	Agreed
2.	Increasing access to digital technology	3.28	0.65	Agreed
3.	Provision of maximum technical support	3.45	0.58	Agreed
4.	Improving internet connectivity	3.32	0.62	Agreed
5.	Making digital education environments user-friendly	3.20	0.68	Agreed
6.	Provision of institutional support	3.35	0.64	Agreed
7.	Reducing the high cost of technology	3.18	0.70	Agreed
8.	Increasing collaboration among special educators	3.12	0.71	Agreed
9.	Provision of adequate incentives for special educators	3.05	0.73	Agreed
10	Regular evaluation of digital education environments	3.22	0.67	Agreed
11	Grand mean for research question three	3.26	0.66	Agreed

Research Question 4: In what ways can the prospects of a digital education environment be used for improving the training of special educators?

Data in Table 5 indicated that the future of the digital education environment would enhance special educators' skills, provide specialized learning experiences, provide opportunities for professional development, increase access to education for students with special educational needs, and enhance the quality of education for learners with special needs as they obtained mean scores of 3.40, 3.38, 3.30, 3.35 and 3.38,

respectively.

However, the participants of the study accepted all items presented to them, with a grand mean score of 3.27 and a standard deviation of 0.65, indicating that they perceive that the prospect of a digital education environment will improve the training quality of future special educators and also foster the academic achievement of learners with special education needs.

Table 5

Mean rating and standard deviation of study participants regarding how the prospects of a digital education environment can be used for improving the training of future special educators

S/N	The prospects of a digital education environment can be used for improving the training of special educators through:	Mean	SD	Decision
12.	Enhancing students' academic engagement	3.23	0.66	Agreed
13.	Providing specialized learning experiences	3.38	0.61	Agreed
14.	Increasing access to education for students with special needs	3.30	0.64	Agreed
15.	Improving communication between parents and educators	3.20	0.68	Agreed
16.	Providing opportunities for professional development	3.35	0.63	Agreed
17.	Enhancing the quality of education for learners with special needs	3.28	0.65	Agreed
18.	Increasing students' academic motivation	3.18	0.70	Agreed
19.	Providing opportunities for collaboration among learners	3.12	0.71	Agreed
20.	Improving the academic achievement of learners	3.22	0.67	Agreed
21.	Enhancing special educators' skills	3.40	0.60	Agreed
22.	Grand mean for research question four	3.27	0.65	Agreed

Discussion

The findings clearly reveal that respondents perceived that digital education environments foster the training of future special educators. The findings imply that study participants agreed on the relevance of digital education environments in providing maximum opportunities for professional development, ensuring that training resources are accessible and also enhancing flexible learning experiences. The grand mean score indicates that respondents perceive that digital educational environments can support the quality of training for future special educators.

To support this result, Ainscow (2020) and Fernandez-Batanero et al. (2022), agreed that when digital education is perceived as effective, it promotes effective teaching and learning and also encourages an all-inclusive education system. In another related finding, Falloon (2020) maintained that integrating digital technologies, content knowledge, and pedagogy is a significant way to promote effective teaching and learning.

This finding is also consistent with those of Claro et al. (2024), Zhang et al. (2025) and Kerimbayev et al. (2023) which stress that educators acquire the relevant knowledge and skills needed to promote quality pedagogical practices through well-designed digital education environment. Interpreting these findings through the lens of the TPACK framework, digital learning environments could be used to enhance the integration of pedagogical, content, and technological knowledge, as they would aid future special educators in effectively developing the knowledge, skills, and competencies required for teaching effectiveness.

Secondly, the results vividly reveal the perceived problems affecting the formation of digital education environments, especially for future special educators, such as technical issues, poor access to digital technology, and inadequate training in digital tools. These findings are consistent with those of Guillén-Gámez and Mayorga-Fernández (2020) and Dias-Trindade et al. (2020), that competence, autonomy, and relatedness enhance academic engagement. In a similar vein, Yakavets et al. (2023) supported that limited access to digital technologies and inadequate training hinder the effective integration of digital tools in education in Kazakhstan context. Moreover Kerimbayev et al. (2023) identified a significant digital divide between national and regional universities in Kazakhstan.

The findings also identified key strategies that could be perceived to mitigate problems impeding the formation of digital education environments. In this regard, the findings reveal that increasing access to digital

technology, training future special educators on digital tools, and providing technical support are perceived as the main strategies for reducing impediments.

It is necessary to integrate emerging technologies with content knowledge and pedagogical practices to promote quality teaching and learning with evidence from pedagogical universities in Kazakhstan as noted by Dang et al. (2024); De Obesso et al. (2023) and Gallego Joya et al. (2025). In addition, educators are more likely to use digital educational environments effectively when adequate technical support and high-quality training are provided.

Interestingly, the findings by Vuorikari et al. (2022) supported the urgent need to provide educators with training and support to enable them to integrate digital technologies effectively across the entire education system. These strategies could foster the autonomy, relatedness and competence of future special educators through the lens of Self-Determination Theory. Through training and technical support, educators could enhance their competence in using digital tools and resources and support their autonomy in pedagogical practices. Finally, the findings show that the prospect of digital education environments could be perceived to enhance future special educators' training. This result is in line with the findings by Ferrer et al. (2022) that academic engagement and motivation are more likely to improve through relatedness, competence and autonomy. In another view, Bravo-Agapito et al. (2021) noted that educators acquire the knowledge and skills to use digital resources and tools effectively through well-designed digital education environments.

The findings by Cabero-Almenera (2022) agreed that future special educators perceive digital environments as capable of providing specialized learning experiences, including assistive technologies for students with special education needs. Thus, it is worth noting that respondents perceived that prospect of digital education environments could improve training of future special educators. It is important to reiterate that these are perceptions; as this study is descriptive and survey-based using only mean and standard deviation, it does not prove effectiveness on student performance. Causal inferences cannot be made. The results of this research have important implications for educational stakeholders, such as students, educators, and educational policymakers. The findings of this study indicated that integrating digital education environments into future special educators' training promotes the quality of teaching and learning and improves students' academic performance.

It therefore becomes necessary for educational stakeholders to prioritize the formation of a well-designed digital education environment that encourages inclusivity, flexibility, accessibility in academic activities and also creates many opportunities for professional development. In addition, reducing the problems associated with the formation of digital education environments, including inadequate training and poor access to digital technology, is necessary to ensure that the integration of digital technology in the teaching-learning process is a reality.

The findings also highlighted that providing maximum training on how to use modern technologies, increasing access to digital technologies, and providing technical support are the most effective measures for reducing impediments to the formation of digital education environments. Imperatively, the successful implementation of digital education environments will go a long way toward transforming the education system and improving the lives and educational outcomes of learners with special educational needs.

Conclusion

This study investigated perceptions regarding formation of digital education environments for future special educators' training in the Republic of Kazakhstan with emphasis on key challenges and prospects. The findings show that respondents perceived that digital education environments can support high-quality training for future special educators, provide opportunities for professional development, and ensure that training resources are easily accessible. The results also indicated perceived key factors impeding the formation, such as the absence of training on technical issues and digital tools, as well as poor access to digital technologies. It was perceived that integrating digital education environments into traditional teaching approaches could create a personalized, effective academic environment.

The findings of this research have practical implications for higher education institutions, curriculum developers, and policymakers involved in special educator training. Higher education institutions could use these perceived challenges to develop programs geared towards promoting digital competency among future special educators. Curriculum planners could be motivated to effectively integrate digital environments into

the curricula of special education, while educational policymakers could allocate resources to improve access to digital technologies and address technical issues. However, the limitations of the study may affect the generalizability of the findings.

There is no study without limitations. The study was a descriptive survey measuring perceptions only, not actual competence or student outcomes; hence, causal claims cannot be made. The study population of 239 future special educators from three pedagogical universities in Kazakhstan, affects generalizability beyond similar contexts. The study relied on self-reported questionnaire; use of interviews, checklists, and observation could have improved depth. Moreover, no inferential statistics were applied; only mean and standard deviation were used. Future studies could adopt mixed methods, larger samples across Central Asia, and longitudinal designs to examine long-term impact of digital environments on actual digital competencies and outcomes of special education programs.

Conflict of Interest Statement

The authors declare no potential conflicts of interest regarding the research, authorship, or publication of this article.

Author Contributions

Kamilya Arinova: Conceptualization, Methodology, Collection and Curation, Supervision, Proofreading, Writing – Review and Editing. Yerkin Nurmakhanov: Literature Review, Data Analysis, Visualization, Writing – Original Draft, Final Editing.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that no artificial intelligence (AI) tools were used in the preparation of this manuscript.

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