International Journal of Evaluation and Research in Education (IJERE)
Vol. 14, No. 6, December 2025, pp. 5003~5013
ISSN: 2252-8822, DOI: 10.11591/ijere.v14i6.34236

Enhancing informatics teacher training in Kazakhstan through dual education and specialized educational platforms

Alima Seitaliyeva[1], Nurzhan Shyndaliyev[1], Dinara Kalmanova[2], Assemgul Kaipova[3], Kaussar Mukhtarkyzy[4]
[1]Department of Computer Science, Faculty of Information Technology, L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
[2]Department of Space Engineering and Technology, Institute of Physical and Technical Sciences, L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
[3]Department of Epidemiology and Biostatistics, Bioinformatics and Information Technologies, Astana Medical University, Astana, Kazakhstan
[4]Department of Information Technology, Faculty of Technology, K. Kulazhanov Kazakh University of Technology and Business, Astana, Kazakhstan

Article Info

Article history:

Received Dec 22, 2024
Revised Jul 7, 2025
Accepted Jul 28, 2025

Keywords:

Dual education
Educational platforms
Informatics teacher training
Kazakhstan education reform
Methodological competence

ABSTRACT

This study addresses the gap between traditional informatics teacher training in Kazakhstan and the practical demands of modern classrooms. It explores the integration of dual education and the informaticedu.kz digital platform as a means to enhance methodological and practical competencies among future teachers. A mixed-methods design was used, involving 24 students from Pavlodar Pedagogical University. Data were collected through structured questionnaires and qualitative interviews. Quantitative responses were analyzed using descriptive statistics, t-tests, and correlation analysis, while qualitative data underwent thematic analysis. The findings showed that the platform significantly supported lesson planning and methodological development, particularly among 4th-year students who rated the tool more positively than 3rd-year students. High correlations were found between understanding lesson structure and effective planning. However, participants reported a lack of interactive content such as case studies and problem-solving tasks. The results suggest that integrating dual education with specialized digital platforms enhances informatics teacher training. Still, to maintain relevance and effectiveness, platforms must evolve to include more interactive and adaptive features tailored to different training stages.

Corresponding Author:

Nurzhan Shyndaliyev
Department of Computer Science, Faculty of Information Technology
L.N. Gumilyov Eurasian National University
Astana, Kazakhstan
Email: nurazhan0412@gmail.com

1. INTRODUCTION

In Kazakhstan, the growing demands of a modern labor market have heightened the need for innovative approaches to teacher training, particularly in the preparation of informatics educators. Recent studies highlight a persistent disconnect between the competencies offered by higher education institutions and the expectations of employers regarding practical readiness and adaptability of graduates [1]. This misalignment is particularly evident in informatics education, where university graduates often lack the applied digital and pedagogical skills required in real-world environments. To address these challenges, the dual education model—defined as the structured integration of academic instruction with hands-on

professional training—has been increasingly recognized for its potential to foster professional mobility and readiness among future educators [2]. This approach supports the formation of socially and professionally mobile individuals by linking universities more closely with employers. Moreover, this model aligns with the State Program for the Development of Education and Science (2020-2025), which prioritizes enhancing the quality and competitiveness of teacher training programs to strengthen the nation's human capital [3].

Dual education is a structured form of education that integrates classroom-based theoretical learning with workplace-based practical training, typically in close partnership with industry stakeholders [4]. Globally, dual education models have been extensively implemented in countries like Germany, Austria, and Switzerland, where they have successfully aligned education with labor market needs [5], [6]. These systems provide students with structured, practice-oriented training that ensures a seamless transition from education to professional practice. Inspired by these models, Kazakhstan has begun to integrate dual education into its vocational education system and is now extending these efforts into higher education to meet evolving professional demands [7], [8].

This study addresses the scientific question of how the integration of dual education and specialized educational platforms can enhance the training of future informatics teachers in Kazakhstan. Specifically, it investigates whether these approaches effectively bridge the gap between traditional teacher education and the advanced competencies required in secondary and higher education. Informatics education in Kazakhstan faces a significant gap between secondary school curricula and the advanced competencies required in higher education, such as algorithmic thinking, programming, and digital literacy [9]. By exploring the use of the informaticedu.kz platform, this research examines how educational technologies can enhance the readiness of future informatics teachers, both theoretically and practically.

The study aims to evaluate how the integration of dual education and specialized platforms can address these gaps by enhancing teacher training quality and bridging the divide between academic learning and workplace requirements. This research is particularly significant in the context of Kazakhstan's evolving educational landscape, where digital literacy and practical training have become essential for preparing teachers to meet the needs of the 21st-century classroom. Furthermore, it identifies critical barriers to implementation and offers insights into how technological solutions can contribute to Kazakhstan's educational reform. The novelty of this study lies in being the first in Kazakhstan to implement and evaluate a subject-specific digital platform developed by the authors (informaticedu.kz) within a dual education framework for informatics teacher training, thus bridging theoretical instruction and practical school experience.

2. LITERATURE REVIEW

In Kazakhstan, reform efforts in teacher education have increasingly turned to dual education as a response to the disconnect between theoretical instruction and the digital economy's practical demands [10]. Dual education refers to a structured model that combines classroom-based academic training with supervised workplace experience, often in collaboration with industry stakeholders [2], [11]. While Kazakhstan is still developing its national framework, dual education has long been institutionalized in countries such as Germany, Austria, and Switzerland. There, the model has effectively aligned education with labor market needs, reducing youth unemployment and enhancing graduates' job readiness [12], [13]. Dual education originated in Germany during the early 20th century as part of Georg Kerschensteiner's "labor school" model, emphasizing the importance of vocational training [14].

The sustainability of dual education relies on structured and ongoing collaboration between universities and industries, fostering mutual benefits and alignment with market demands. Financial support from governments and employers plays a crucial role in its success. For instance, the German Council for Science and Humanities has emphasized aligning dual education programs with evolving labor market demands to ensure their long-term relevance [12]. In contrast, Kazakhstani initiatives face systemic challenges—such as limited institutional capacity and inconsistent employer involvement—hindering sustainable implementation at the higher education level [10], [15], [16].

Although Kazakhstan has made promising strides in vocational settings, efforts to scale dual education to universities have revealed structural weaknesses. The ERASMUS+KAZDUAL project (2021) represents a strategic initiative to address these gaps by embedding dual education models within university frameworks [17], [18]. This shift reflects an effort to adapt successful European principles to Kazakhstan's unique policy and economic context.

Technology-enhanced learning is a key enabler in this reform process. While GeoGebra and similar digital tools have proven effective in science, technology, engineering, and mathematics (STEM) education globally [19], [20], the deployment of informatics-specific platforms like informaticedu.kz has aimed to improve both pedagogical practice and digital fluency in teacher training [21]. Yet, a comparative look

suggests that while international platforms often emphasize interactivity and learner autonomy, Kazakhstan's current tools are still evolving in functionality.

Informatics education is critical in Kazakhstan's digital economy, yet it remains underdeveloped in secondary schools, where curricula often focus on basic computing skills rather than advanced topics like programming or information modelling [22], [23]. The dual education approach, supported by specialized platforms, addresses these gaps by providing future teachers with access to advanced tools and real-world experience. Research highlights the importance of equipping informatics teachers with competencies in programming, networking, and digital literacy to prepare students for the demands of a globalized economy [24]. However, traditional teacher training programs often fail to integrate these skills with practical applications, underscoring the need for reform through dual education models.

The success of dual education in informatics relies heavily on the use of educational platforms that support both theoretical and practical learning. In Kazakhstan, various domestic systems and platforms, such as e-learning CDT, Univer, Platonus, and SmartUniversity, have been developed to facilitate this integration [25]. These platforms offer tools like electronic textbooks, lesson planning resources, and methodological support, enabling future teachers to design effective lesson plans, expand their pedagogical strategies, and enhance their practical teaching skills. However, studies reveal limitations in the platform's content diversity, highlighting the need for more interactive resources such as case studies, problem-solving tasks, and collaborative tools [26]. Expanding these features can significantly enhance the platform's impact on teacher training and better prepare educators for the complexities of modern classrooms.

Mentorship is a key component of dual education, bridging the gap between theoretical knowledge and real-world application [27], [28]. In Kazakhstan, the lack of strong partnerships between universities and industries limits the effectiveness of this mentorship. Employers often report that graduates lack practical skills, reinforcing the need for stronger collaboration between educational institutions and the private sector [29].

Addressing these challenges requires robust legal frameworks and financial incentives to encourage industry participation. The integration of mentorship programs within dual education can provide students with the guidance needed to succeed in professional environments, ensuring a smoother transition from academia to the workforce. Kazakhstan's participation in international projects, such as ERASMUS+ and the German-Kazakh Vocational Education Project (GeKaVoc), has provided valuable insights into implementing dual education [17]. These collaborations emphasize the importance of aligning educational reforms with global best practices while tailoring them to local contexts. Future efforts should focus on expanding the use of digital platforms, fostering stronger university-industry partnerships, and addressing legal and financial barriers. By adopting these strategies, Kazakhstan can fully realize the potential of dual education in transforming teacher training and preparing educators for the demands of the digital age.

3. METHOD

A mixed-methods approach was employed in this study, integrating qualitative and quantitative data collection techniques to provide a comprehensive evaluation of the informaticedu.kz platform within the dual education framework. This design was selected to balance the breadth of quantitative data with the depth of qualitative insights, ensuring robust triangulation, and a nuanced understanding of platform effectiveness. The design included structured interviews to gather in-depth insights into participants' experiences and a structured questionnaire to quantitatively assess the platform's effectiveness. This combination allowed for the triangulation of findings, enhancing the validity and reliability of the results. To systematically explore the impact of dual education and digital platforms on informatics teacher training, the research specifically investigates the question: how does the integration of dual education and a specialized educational platform enhance the preparation of future informatics teachers? Addressing this inquiry required an assessment of both quantitative and qualitative dimensions, ensuring a holistic understanding of the platform's effectiveness.

The study was conducted with 24 students from Pavlodar Pedagogical University enrolled in the "6B01530 informatics" program during the 2023-2024 academic year. These students, in their 3rd and 4th years of study, participated in a dual education system that combined theoretical training at the university with practical teaching experiences at secondary schools No. 2 and No. 46 in Pavlodar City. Participants were selected using purposive sampling to ensure they had sufficient exposure to both theoretical coursework and real-world school placements, aligning with the goals of the study. To minimize confounding variables, all participants followed the same curriculum and platform access within the same academic setting, reducing instructional, and contextual variability. Although the sample size is limited, it aligns with qualitative research standards where in-depth insights are prioritized over broad generalizability. The participants were selected to ensure a balanced representation of both theoretical and practical training experiences, allowing for a meaningful evaluation of the platform's effectiveness. Future studies could expand the sample size to increase generalizability.

The informaticedu.kz platform, developed by the authors in 2022, played a central role in this study. This platform was designed to support dual education by offering resources such as electronic textbooks, video lectures, webinars, interactive tools, and methodological support. It includes seven sections, each aimed at addressing specific aspects of informatics teacher training. The platform served as a bridge between theoretical university training and practical school placements. For instance, electronic textbooks aligned with university curricula provided foundational knowledge, while lesson planning tools and interactive modules were applied during school placements to create and deliver informatics lessons. Feedback from school mentors helped students refine their teaching methods. The study's 24 participants were the first cohort to fully integrate the platform into their training, using it across both university coursework and practical applications in schools. This unique integration allowed for an evaluation of its effectiveness in bridging theoretical and practical training gaps. The study utilized two primary instruments:

- Structured questionnaire: designed to measure the perceived effectiveness of the informaticedu.kz platform, the questionnaire included 10 key factors related to lesson preparation, methodological support, and the integration of theoretical and practical learning. Respondents rated these factors on a Likert scale from 1 (low importance) to 10 (high importance).
- Structured interviews: conducted to complement the questionnaire, these interviews explored participants' qualitative experiences with the platform, identifying strengths, limitations, and areas for improvement. The structured format ensured consistency across responses, enabling systematic analysis.

To ensure content validity, the structured questionnaire was reviewed by 2 experienced computer science educators who assessed its relevance, clarity, and alignment with the study objectives. Feedback from this expert panel led to minor revisions in item phrasing and structure. Internal consistency reliability was assessed using Cronbach's alpha, which yielded an overall value of 0.87, indicating a high level of reliability. Individual items showed strong consistency, with alpha coefficients ranging from 0.81 to 0.88.

Data were collected over a four-week period in 2024. The questionnaire was administered electronically via Google Forms, allowing participants to respond at their convenience, and it was piloted with a small subset of students to confirm clarity and reliability before full deployment. Interviews were conducted in person and recorded for transcription and analysis. To ensure methodological rigor, interviews were transcribed verbatim and thematically coded by two independent researchers; inter-rater reliability was calculated, and key themes were validated through member checking with selected participants. Throughout the study, ethical principles of informed consent, confidentiality, and anonymity were strictly observed and approved by the institutional ethics committee. The data analysis comprised three key steps:

- Descriptive statistics: mean values and standard deviations were calculated for each of the 10 factors assessed in the questionnaire to provide an overall understanding of participants' ratings.
- Comparison testing: independent t-tests were performed to examine differences in perceptions between 3rd- and 4th-year students regarding the platform's features.
- Correlation analysis: Pearson's correlation coefficients were used to explore relationships between the factors assessed, highlighting key connections, such as how understanding lesson structure related to methodological support.

Qualitative data from the interviews were thematically analyzed to identify recurring themes and participant insights. This analysis focused on extracting meaningful patterns related to the platform's usability, impact on teacher training, and areas requiring improvement. The structured questionnaire underwent expert review by two experienced computer science educators to ensure content validity. Additionally, Cronbach's alpha was used to assess the internal consistency of the questionnaire, yielding an overall reliability score of 0.87, indicating a high degree of reliability. Reliability testing for individual factors also confirmed strong internal consistency, with alpha values ranging from 0.81 to 0.88.

This study involved a purposive sample of 24 informatics students, which, although relatively small, aligns with standards for mixed-methods and exploratory research aimed at gaining in-depth insights rather than statistical generalizability. Similar sample sizes have been used effectively in educational pilot studies where context-specific evaluation is prioritized [30], [31]. Nevertheless, we acknowledge that the limited sample constrains the generalizability of findings. This limitation is explicitly recognized in the discussion and conclusion, and we recommend future research with larger, more diverse cohorts to validate and extend the present results.

4. RESULTS

This section presents the findings from the analysis of the questionnaire responses and structured interviews. The results are organized into descriptive statistics, comparison analysis, correlation analysis, and reliability testing. Descriptive statistics were calculated to summarize participants' perceptions of the

informaticedu.kz platform across 10 factors, as demonstrated in Table 1. These results highlight the platform's strengths and areas for improvement in enhancing informatics teacher training. Participants rated the platform highest for its ability to assist in creating well-thought-out lesson plans (M=7.833, SD=1.167) and for providing prompt methodological support (M=7.333, SD=1.274). Conversely, the platform was rated lowest in terms of making lesson preparation easier (M=2.917, SD=1.381) and offering advantages over other resources (M=3.125, SD=1.296).

Table 1. Descriptive statistics for the 10 factors

Opinion statement	Mean	Std. Deviation
Ready-made samples of computer science lessons made my preparation easier	2.917	1.381
I did not notice particular advantages of this platform compared to other resources	3.125	1.296
The platform helped me to understand the structure of a computer science lesson	6.208	0.833
The platform allowed me to expand my ideas about teaching methods	3.167	1.523
The platform helped me create well-thought-out informatics lesson plans	7.833	1.167
Working with the platform focused my attention on key aspects of lesson preparation	3.708	1.197
The platform helped me develop unique lesson projects	5.792	2.167
The platform provided prompt methodological support	7.333	1.274
The platform helped me account for different components in planning lessons	6.917	1.213
The platform reduced the time needed for lesson preparation	4.792	1.444

Independent t-tests were conducted to explore differences between the responses of 3rd- and 4th-year students, as seen in Table 2. No significant differences were observed for other factors, including methodological support and lesson planning. The analysis revealed significant differences in two key areas:

- Ready-made samples of lessons: 4th-year students rated this feature significantly higher (t=2.12, p=0.039).
- Expansion of ideas about lesson structure: 4th-year students again provided higher ratings (t=2.31, p=0.029).

Table 2. Comparison of year 3 vs year 4 students' perceptions

Comparison groups	T-Statistic	P-Value	Degrees of freedom	Effect size (Cohen's d)
Ready-made samples of lessons	2.12	0.039	22	0.45
Platform helped in lesson preparation	1.89	0.072	22	0.38
Platform expanded ideas about lesson structure	2.31	0.029	22	0.48
Created well-thought-out lesson plans	0.98	0.336	22	0.20
Prompt methodological support	2.45	0.021	22	0.52

Pearson's correlation coefficients were calculated to examine relationships between the 10 factors, as shown in Figure 1. These findings suggest that improving one aspect of the platform, such as lesson structuring, may positively influence other related features, like lesson planning. Strong positive correlations were observed between:

- The platform's ability to expand ideas about lesson structure and creating well-thought-out lesson plans ($r=0.60$, $p<0.01$).
- Ready-made samples and prompt methodological support ($r=0.35$, $p<0.05$).

A visual analysis of the mean importance ratings for each educational platform feature, as shown in Figure 2, provides further insight into participants' perceived utility of the informaticedu.kz platform. The most highly rated feature was the platform's capacity to assist in creating well-thought-out lesson plans, followed closely by its ability to provide prompt methodological support. These findings underscore the platform's effectiveness in enhancing instructional planning and professional preparation. Other highly valued features included improved adaptability in lesson planning, support in understanding lesson structure, and the development of unique lesson projects, indicating that the platform contributes meaningfully to both procedural, and creative dimensions of teacher training. Conversely, the lowest-rated features were "ready-made samples made preparation easier" and "no particular advantages compared to other resources", suggesting that users perceived limited benefits from passive content and expressed a preference for more interactive, customizable, or practice-oriented tools. The relatively low scores for expanding ideas on teaching methods and focusing attention on key lesson elements further indicate that while the platform supports core planning tasks, it may lack features that actively stimulate pedagogical creativity or self-reflection. Overall, the visual data representation aligns with the quantitative findings and emphasizes the need for continued development of interactive and dynamic content to maximize training effectiveness.

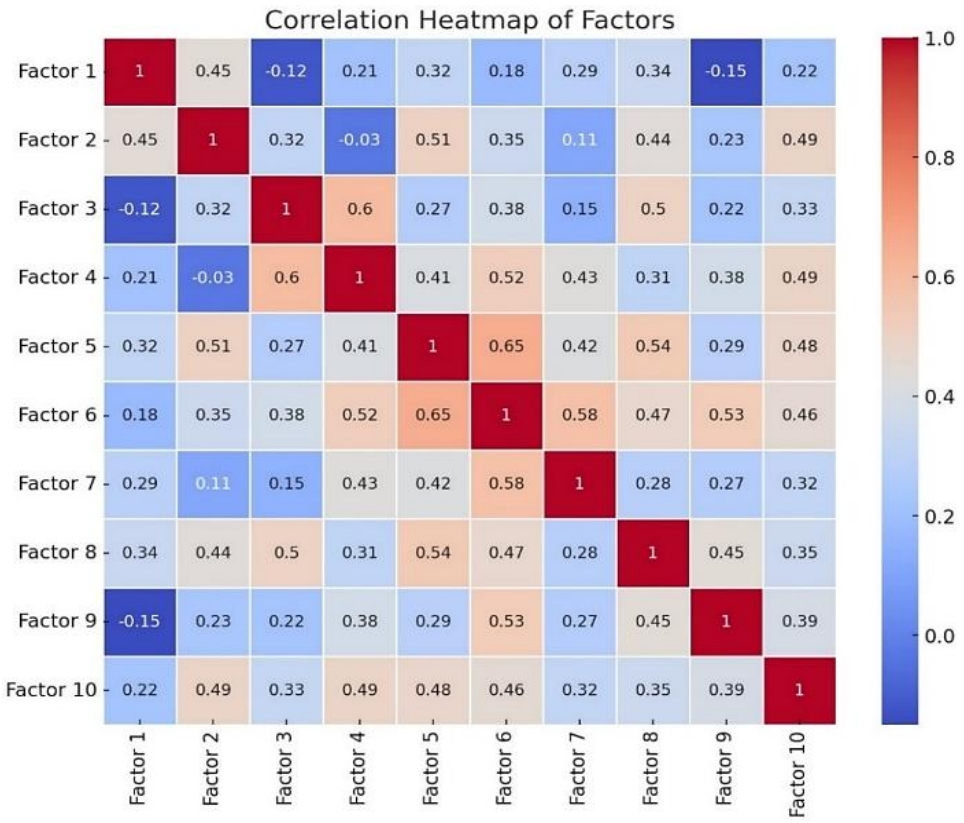

Figure 1. Cognitive process dimension

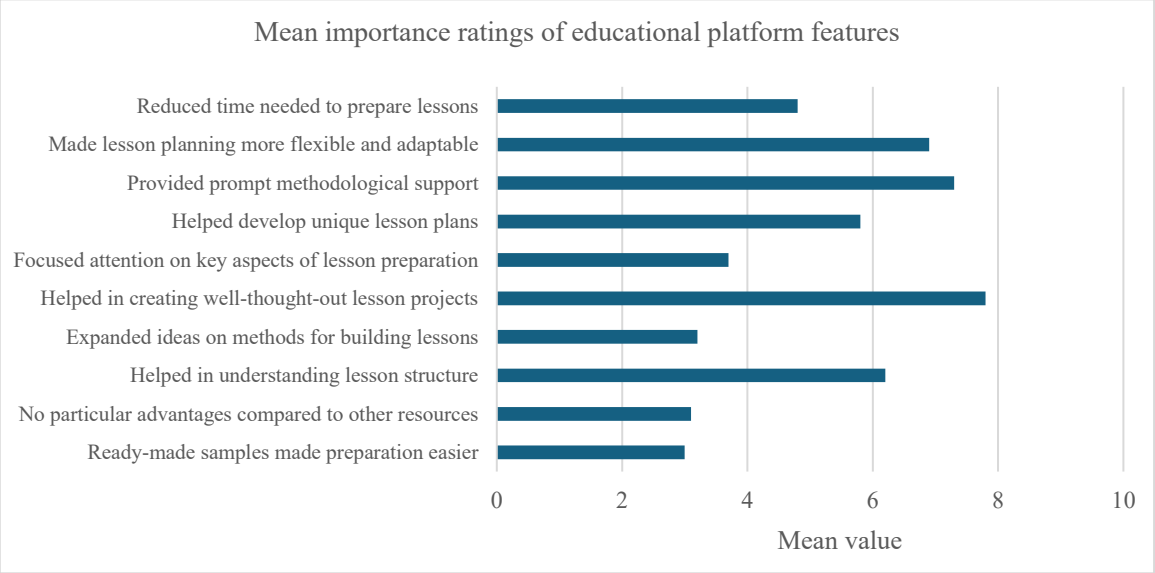

Figure 2. Mean importance ratings of educational platform features

Cronbach's alpha was calculated to evaluate the internal consistency of the structured questionnaire, as shown in Table 3. The overall reliability score was 0.87, indicating high reliability. Individual items demonstrated strong consistency, with Cronbach's alpha values ranging from 0.81 to 0.88. This confirms the reliability of the instrument in assessing participants' perceptions of the platform.

Table 3. Cronbach's alpha results for questionnaire factors

Factor	Cronbach's alpha
Ready-made samples of computer science lessons	0.85
Platform helped in understanding lesson structure	0.83
Expanded ideas on methods for building lessons	0.87
Created well-thought-out informatics lesson projects	0.82
Focused attention on key aspects of lesson preparation	0.84
Abandoned typical lesson plans in favor of unique ones	0.86
Provided prompt methodological support	0.81
Considered various lesson components	0.88
Reduced time needed to prepare interactive lessons	0.83
Overall Cronbach's alpha	0.87

5. DISCUSSION

The findings of this study highlight the effectiveness of integrating dual education and the informaticedu.kz platform in preparing future informatics teachers in Kazakhstan. This section interprets the results, discusses their implications, and identifies areas for improvement.

5.1. Pedagogical implications

The dual education model demonstrated its ability to bridge the gap between theoretical knowledge and practical skills, addressing one of the core challenges in traditional teacher training. The platform's strengths, particularly in facilitating lesson planning and providing methodological support, indicate that combining dual education with technological solutions significantly enhances professional readiness. These findings align with global practices that emphasize the importance of real-world applications in education [5], [32].

Importantly, the strong correlation between competencies like lesson structuring and methodological clarity indicates that the platform is not only delivering resources but also reinforcing foundational teaching practices. However, the current reliance on pre-structured materials may inadvertently limit creative lesson adaptation. Future iterations should promote customizable content to cultivate both procedural competence and pedagogical flexibility.

5.2. Platform limitations and student progression

Despite its strengths, participants reported that the platform did not clearly outperform other existing resources, particularly in terms of simplifying lesson preparation. This may reflect the platform's limited interactivity—currently focused on static resources like e-textbooks and guides. Student feedback identified a need for more dynamic tools, including problem-based learning modules, collaborative exercises, and case simulations.

Interestingly, 4th-year students rated some features—like ready-made lesson samples—higher than 3rd-year students. This may suggest that pedagogical maturity influences platform engagement. As students advance, they seem to better recognize and utilize scaffolded content. These findings imply that differentiated features by academic level could optimize training impact.

5.3. Scalability and transferability

While the study focused on informatics education, its implications extend to broader teacher training reforms. The dual education framework, supported by platforms like informaticedu.kz, offers a viable model for scaling technology-enhanced teacher preparation across STEM fields. It also aligns with Kazakhstan's national strategy for digital transformation in education [3], [9], [11]. For institutions aiming to adopt similar models, it is crucial to continuously refine platform design based on user feedback and instructional need. This includes incorporating modular resources that promote both individual and group learning while maintaining alignment with curricular standards.

5.4. Limitations and future research

Several limitations constrain the study's generalizability. The sample size of 24 students, though sufficient for qualitative insights, limits broader application. Additionally, the study was confined to a single platform and did not examine long-term retention or transfer of skills into classroom practice.

Future research should include longitudinal tracking to measure the durability of outcomes and extend the sample across multiple institutions. Moreover, integrating emerging features—such as AI-based feedback tools or gamification—may enhance engagement and learning depth. Comparative studies with other platforms would further contextualize the observed impacts.

This study confirms the value of integrating dual education with advanced educational platforms in preparing future informatics teachers. By addressing both theoretical and practical dimensions, these

approaches equip educators with the skills and knowledge necessary for success in a rapidly evolving educational landscape. However, continuous development of the platform and its content is essential to ensure that it remains responsive to the needs of students and the broader demands of education in Kazakhstan.

6. CONCLUSION

This study highlights the significant potential of integrating dual education with specialized educational platforms, such as the informaticedu.kz platform, in preparing future informatics teachers in Kazakhstan. The dual education model effectively bridges the gap between theoretical knowledge and practical application, addressing one of the major challenges in traditional teacher training. The platform was found to be particularly effective in supporting structured lesson planning and providing methodological guidance, both of which contribute directly to enhanced teaching competency and professional readiness.

However, the study also revealed areas for improvement. The platform's limited content diversity and lack of interactive features were identified as significant shortcomings. Expanding the platform to include resources such as interactive tasks, case studies, and problem-solving exercises would enrich the learning experience and better align with the evolving needs of modern education.

The study emphasizes the importance of tailoring the platform's features to different stages of teacher training, as perceptions of its usefulness varied between 3rd- and 4th-year students. Specifically, more advanced students valued features related to ready-made lesson samples and expansion of lesson ideas, suggesting that training tools should adapt to pedagogical maturity levels. Ultimately, the integration of dual education and advanced educational platforms aligns with Kazakhstan's broader educational reform goals, fostering innovation, and improving the quality of teacher training. To sustain and build on these gains, ongoing development of educational resources and continuous collaboration between educational institutions, industries, and policymakers are essential. Future research should focus on scaling these findings, exploring long-term impacts on professional teaching careers, and integrating emerging technologies, such as artificial intelligence and gamification, into educational platforms. By addressing these areas, Kazakhstan can solidify its position as a leader in innovative and effective teacher training, ensuring that future educators are well-equipped to meet the challenges of contemporary classrooms.

FUNDING INFORMATION

There was no funding involved to this project.

AUTHOR CONTRIBUTIONS STATEMENT

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

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Alima Seitaliyeva	✓	✓			✓	✓			✓		✓			
Nurzhan Shyndaliyev					✓		✓			✓		✓	✓	✓
Dinara Kalmanova		✓	✓					✓		✓		✓		✓
Assemgul Kaipova					✓		✓			✓		✓		
Kaussar Mukhtarkyzy	✓	✓		✓	✓	✓		✓	✓					

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.

INFORMED CONSENT

All participants were informed about the purpose and procedures of the study and gave their informed consent voluntarily. Participation was entirely optional, and respondents were assured of their anonymity and confidentiality throughout the research process. No personally identifiable information was collected, and data were used solely for academic and research purposes.

ETHICAL APPROVAL

This study was conducted in accordance with the ethical standards of educational research and received formal approval from the Ethical Committee of L.N. Gumilyov Eurasian National University. The research protocol, including the objectives, methodology, and instruments used (questionnaire and structured interviews), was reviewed and approved by the committee prior to the commencement of data collection.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author [NS] or the first author [AS], upon reasonable request. The data include participant responses to structured questionnaires and transcribed interviews, which contain information that could potentially compromise the privacy of individuals. As such, the data are not publicly available due to ethical and confidentiality restrictions, in accordance with the guidelines approved by the Ethical Committee of L.N. Gumilyov Eurasian National University.

REFERENCES

[1] A. A. Seitaliyeva, N. T. Shyndaliyev, D. M. Kalmanova, and D. S. Zhamangarin, "Application of the elements of the dual system of education in higher educational institutions," *Studies in Systems, Decision and Control*, vol. 223, pp. 167–174, 2024, doi: 10.1007/978-3-031-51997-0_13.

[2] V. A. Belikov, P. Y. Romanov, D. I. Pavlenko, and A. M. Filippov, "Students' professional mobility in organizations of vocational secondary education as a result of dual education system," *Perspektivy Nauki i Obrazovania*, vol. 43, no. 1, pp. 72–85, 2020, doi: 10.32744/pse.2020.1.5.

[3] Official Information Source of the Prime minister of the Republic of Kazakhstan, "President's address «constructive public dialogue – the basis of stability and prosperity of Kazakhstan»," The Press Service of the Government of the Republic of Kazakhstan. Accessed: Oct. 22, 2024. [Online]. Available: https://primeminister.kz/en/address/02092019

[4] P. D. Euler, *Germany's dual vocational training system: a model for other countries?* Gutersloh, Germany, Bertelsmann Stiftung, 2013.

[5] T. Deissinger and P. Gonon, "The development and cultural foundations of dual apprenticeships – a comparison of Germany and Switzerland," *Journal of Vocational Education & Training*, vol. 73, no. 2, p. 197, 2021, doi: 10.1080/13636820.2020.1863451.

[6] S. Hoidn and V. Šťastný, "Labour market success of initial vocational education and training graduates: a comparative study of three education systems in Central Europe," *Journal of Vocational Education & Training*, vol. 75, no. 4, pp. 629–653, Aug. 2023, doi: 10.1080/13636820.2021.1931946.

[7] G. Abildinova, E. Abdykerimova, A. Assainova, K. Mukhtarkyzy, and D. Abykenova, "Preparing educators for the digital age: teacher perceptions of active teaching methods and digital integration," in *Frontiers in Education*, Nov. 2024, vol. 9, p. 1473766, doi: 10.3389/feduc.2024.1473766.

[8] G. Z. Doskeyeva, R. A. Kuzembekova, S. Y. Umirzakov, A. S. Beimisheva, and R. A. Salimbayeva, "How can dual education in technical and vocational institutions improve students' academic achievements and mitigate youth unemployment in Kazakhstan," *Community College Journal of Research and Practice*, vol. 49, no. 8, pp. 516–531, 2025, doi: 10.1080/10668926.2023.2295472.

[9] E. V. Filimonova, "Results of analysis of problems of professional training of computer science teachers in the field of information modeling," (in Russian), *Prepodavatel XXI vek*, no. 1, 2020, p. 93, 2020, doi: 10.31862/2073-9613-2020-1-93-108.

[10] A. Aizhan and G. A. Virginia, "A comparative study of stakeholder engagement in the dual education system: a case of Germany, the United States and Kazakhstan," *Journal of Technical Education and Training*, vol. 15, no. 3, pp. 154–168, Sep. 2023, doi: 10.30880/jtet.2023.15.03.014.

[11] N. A. Ibadildin, A. Y. Artykbayeva, and S. M. Borashova, "Project management in the development of dual learning in the education system of Kazakhstan," *Central Asian Economic Review*, no. 2, pp. 45–57, Jul. 2022, doi: 10.52821/2789-4401-2022-2-45-57.

[12] S. R. Haasler, "The German system of vocational education and training: challenges of gender, academisation and the integration of low-achieving youth," *Transfer: European Review of Labour and Research*, vol. 26, no. 1, pp. 57–71, Feb. 2020, doi: 10.1177/1024258919898115.

[13] L. Funk, "Vocational training reduces youth unemployment, IW study finds," eurofound.europa.eu. Accessed: Oct. 22, 2024. [Online]. Available: https://www.eurofound.europa.eu/en/resources/article/2004/vocational-training-reduces-youth-unemployment-iw-study-finds

[14] H. Rudolph, "Raising children, educating citizens: Chinese readings of the German pedagogue Georg Kerschen Steiner," in S*ino-German Encounters and Entanglements: Transnational Politics and Culture, 1890–1950*, J. M. Cho, Ed., Cham: Palgrave Macmillan, 2021, pp. 157–187, doi: 10.1007/978-3-030-73391-9_7.

[15] N. Tastanbekova, B. Abenova, M. Yessekeshova, Z. Sagaliyeva, and G. Abildina, "Development of professional skills in the context of higher school dual education," *International Journal of Emerging Technologies in Learning*, vol. 16, no. 10, pp. 179–193, May 2021, doi: 10.3991/ijet.v16i10.19373.

[16] K. Alpysbayev, A. Mukhamadiyeva, M. Kanabekova, A. Orazgaliyeva, and B. Elmira, "Gender analysis of the global labour market and comparative analysis of Kazakhstan, 2019-2021," *Applied Econometrics and International Development*, vol. 24, no. 1, pp. 1–18, 2024.

[17] E. Saparbayeva, M. Abdualiyeva, Y. Torebek, N. Madiyarov, and A. Tursynbayev, "Leveraging digital tools to advance mathematics competencies among construction students," *Cogent Education*, vol. 11, no. 1, p. 2319436, Dec. 2024, doi: 10.1080/2331186X.2024.2319436.
[18] G. Kabanbayeva, M. Gureva, P. Bielik, and G. Ostasz, "Academic mobility and financial stability: a case of ERASMUS student exchange program," *Journal of International Studies*, vol. 12, no. 1, pp. 324–337, Mar. 2019, doi: 10.14254/2071-8330.2019/12-1/22.
[19] Z. Duskazieva, "The role of mentoring in the dual system of youth education in the period of digitalization of society," in *E3S Web of Conferences*, Dec. 2020, vol. 210, p. 18124, doi: 10.1051/e3sconf/202021018124.
[20] Z. Z. Mazlan and H. Zulnaidi, "The nature of gender difference in the effectiveness of GeoGebra," *ASM Science Journal*, vol. 18, pp. 1–10, Nov. 2023, doi: 10.32802/asmscj.2023.1044.
[21] E. Bitakou, M. Ntaliani, K. Demestichas, and C. Costopoulou, "Assessing massive open online courses for developing digital competences among higher education teachers," *Education Sciences*, vol. 13, no. 9, p. 900, Sep. 2023, doi: 10.3390/educsci13090900.
[22] Z. Zulpykhar, M. Ongarbayeva, A. Tungatarova, and Z. Altynbekova, "On-line examinations with proctoring: features, students' preferences and related factors, academic honesty," *World Transactions on Engineering and Technology Education*, vol. 21, no. 4, pp. 287–292, 2023.
[23] D. Belessova, A. Ibashova, A. Zhidebayeva, G. Shaimerdenova, and V. Nakhipova, "The impact of 'scratch' on student engagement and academic performance in primary schools," *Open Education Studies*, vol. 6, no. 1, p. 20220228, 2024, doi: 10.1515/edu-2022-0228.
[24] Y. V. Tryus and I. V. Herasymenko, "Approaches, models, methods and means of training of future it-specialists with the use of elements of dual education," *Journal of Physics: Conference Series*, vol. 1840, no. 1, p. 012034, 2021, doi: 10.1088/1742-6596/1840/1/012034.
[25] Z. Nurbekova and B. Nurbekov, "Digitalization of the education system in Kazakhstan: experience, problems and perspectives," *Strategies for Policy in Science and Education-Strategii na Obrazovatelnata i Nauchnata Politika*, vol. 31, no. 4s, pp. 218–226, 2023, doi: 10.53656/str2023-4s-19-dig.
[26] S. Sakenova, "Kazakhstan and Germany focus on technical and vocational education," The Astana Times, May 2023. Accessed: Oct. 22, 2024. [Online]. Available: https://astanatimes.com/2023/05/kazakhstan-and-germany-focus-on-technical-and-vocational-education/
[27] N. Pavlova, "Methodological component of professional training of future teachers of computer science in the conditions of a higher educational institution," (in Ukranian), *Bulletin of the Bohdan Khmelnytskyi Cherkasy National University. Series: Pedagogical Sciences*, no. 4, pp. 62–66, 2020, doi: 10.31651/2524-2660-2020-4-62-66.
[28] J. T. May, C. O. R. Littzen, H. W. Morrison, and L. J. Loescher, "Experiences of dual PHD-DNP nursing students during doctoral education," *Journal of Professional Nursing*, vol. 36, no. 5, pp. 348–355, Sep. 2020, doi: 10.1016/j.profnurs.2020.02.004.
[29] Z. Karatayeva, G. Abildinova, C. Karaca, and K. Mukhtarkyzy, "Integrated application of digital technologies in interconnected energy sources in renewable energy education," *World Transactions on Engineering and Technology Education*, vol. 22, no. 3, pp. 196–204, 2024.
[30] J. W. Creswell and V. L. P. Clark, *Designing and conducting mixed methods research*, 3rd ed. Thousand Oaks, CA: SAGE Publications Inc., 2017.
[31] G. Guest, A. Bunce, and L. Johnson, "How many interviews are enough? An experiment with data saturation and variability," *Field Methods*, vol. 18, no. 1, pp. 59–82, Feb. 2006, doi: 10.1177/1525822X05279903.
[32] S. Quirós-Alpera, A. O. S. B. Roets, R. Robina-Ramírez, and A. Leal-Solís, "Bridging theory and practice: challenges and opportunities in dual training for sustainability education at Spanish Universities," *Societies*, vol. 15, no. 2, p. 32, Feb. 2025, doi: 10.3390/soc15020032.

BIOGRAPHIES OF AUTHORS

Alima Seitaliyeva graduated from the Kazakh National Pedagogical University named after Abai with a degree in computer science. Currently, she is studying for a doctoral degree in computer science at the L.N. Gumilyov Eurasian National University. Scientific interests – formation of cognitive interest of students, the system of dual education. She can be contacted at email: alimaseitalieva@gmail.com.

Nurzhan Shyndaliyev is candidate of pedagogical sciences, acting associate professor, Department of Informatics, L.N. Gumilev Eurasian National University, Astana, Kazakhstan. In 1995, he graduated from the Faculty of Physics and Mathematics of Almaty State Pedagogical University named after Abai and received the profession of teacher of physics and computer science subjects. Since 2011, candidate of pedagogic sciences on the specialty "13.00.08 - Theory and Methodology of Vocational Education". His research interests lie on STEM education, robotics, network and network technologies, computer architecture, cloud computing, parallel computing. He can be contacted at email: nurazhan0412@gmail.com.

Dinara Kalmanova graduated from the Aktau State University named after Sh. Yesenov with a degree in physics. In 2020, she defended her dissertation in the specialty "13.00.01 - General pedagogy, history of pedagogy and education (pedagogical sciences)" and received the degree of candidate of pedagogical sciences. Currently, she is an acting associate professor of the Department of Space Engineering and Technology at the Eurasian National University named after L.N. Gumileva. She is the author of more than 60 scientific works, including 1 monograph, 3 articles in the Scopus database. Her scientific interests included formation of cognitive interest of students, power supply system for spacecraft. She can be contacted at email: dinarakalmanova54@gmail.com.

Assemgul Kaipova graduated from Turan-Astana University in 2010, specializing in information systems. In 2022, she defended her thesis on the specialty information systems and received the academic degree of master of technical sciences. Currently, she is a senior lecturer at the Department of Biostatistics, Bioinformatics and Information Technology. She is the author of more than 10 scientific papers, 1 article in Scopus database. She can be contacted at email: asem010177@gmail.com.

Kaussar Mukhtarkyzy is a Ph.D., senior lecturer, Department of Information Technologies, Kazakh University of Technology and Business, Kazakhstan, Astana. She is the author of 7 Scopus-indexed publications with an h-index of 3. Her research interests include digital education, augmented reality in STEM, and technology-enhanced teacher training. She can be contacted at email: kaussar.mukhtarkyzy@gmail.com.