

Integration of digital technologies into the methodology of teacher training in the system of dual education

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ABSTRACT

The problem of introducing digital resources into the dual education system is still not sufficiently covered. This study aims to analyze the effectiveness of digital technologies in training future teachers in the dual education system in the context of the Kazakh educational process. The study involved 2 groups of students: control and experimental. The experimental group was trained in the dual education system using digital technologies. The study was conducted at the following universities: Ozybekali Zhanibekov South Kazakhstan Pedagogical University (41 participants) and Shakarim University of Semey (40 participants). The study used standardized questionnaires and testing methods at two stages (before and after integrating digital tools). The following indicators were analyzed: passive and active activities and creativity. The results emphasize the importance of using LMS, online mentoring, planning and assessment resources, and cloud services. The integration of digital technologies into dual education has positively impacted the level of creativity and reduced the passivity of students in the experimental groups of both universities. However, the activity remained almost unchanged. This identified the need for additional interventions. The conclusions indicate that digital technologies in dual education contribute to the growth of creativity and reduce passivity, which was determined by the results in experimental groups.

Keywords: Dual education, Pedagogical innovation, Professional development, Future teachers.

1. Introduction

In the current environment, which is marked by active adaptive changes, the process of integrating digital technologies into the education system is becoming an integral part of modern society. In the modern education system of Kazakhstan, these trends are also widespread; in particular, the importance of digitalization in education in Kazakhstan is defined at the state level. The Digital Kazakhstan Strategy provides not only for the development of infrastructure but also for ensuring access to high-quality education for all categories of the population through the widespread use of digital technologies. Since one of the key components of the success of this strategy is the training of qualified personnel, an important aspect is the integration of digital technologies into the process of teacher training, within the framework of dual education [1]. In general, the system of teacher training is a complex and multicomponent process that requires the use of stable methodological foundations and continuous improvement. In the current conditions of education modernization, one of the priority areas is to strengthen the practice-oriented nature of teacher training [1], [2]. The dual system of education, which combines theory with practice, is perceived as an effective mechanism for bringing the content of teacher education closer to the real requirements of practice. Therefore, the dual system of education involves a combination of theoretical training in higher education institutions [2]. This system is becoming increasingly important in Kazakhstan. However, the implementation of dual education in teacher training requires a certain

organizational and methodological infrastructure. The mandatory components of the dual system are agreements between the university and basic organizations (schools) on joint training, joint development of curricula and programs, provision of internships (assignment of schools, classes), and appointment of mentors from the school for each student. However, despite the progress in the development of this model, the integration of digital technologies into dual education is still under-implemented, which jeopardizes its effectiveness and modernity. This is one of the main problems to be solved in order to adapt teacher training to the requirements of the New Educational Policy of Kazakhstan. However, current scientific works focus on general methodological concepts, but the issue of introducing digital resources remains peripheral. Therefore, research in this area has not yet reached a systematic approach to integrating digital technologies into the dual model of education. There is a significant need to develop and test models of digital integration in the national context of Kazakhstan. This may affect the provision of a high level of training of teachers who are able to work effectively in the context of digitalization of the educational process.

The main goal of this study is to critically assess the transformative power and pedagogical potential of digital technologies in the professional development of future teachers in the context of the Kazakh dual education system. This study aims to critically analyze how digital integration contributes to the professional engagement, creativity, and learning activity of future teachers, as well as to determine the usefulness of such technologies for improving teacher training. The study focuses on how these processes occur in the unique institutional and cultural environment of Kazakh education.

The study answers the following important research questions to achieve this goal:

1. Which digital tools in the dual teacher education system in Kazakhstan demonstrate the greatest degree of adaptability and educational relevance?
2. What level and type of digital participation do student teachers studying in dual education programs currently demonstrate?
3. What patterns and differences can be seen in the degrees of passivity, activity, and creativity of future teachers between the experimental and control groups?
4. What impact in terms of encouraging creativity, active participation, and reducing passivity in learning, does the introduction of digital technologies into dual education have on the professional development path of future teachers?

2. Literature review

2.1 The concept of dual education and its role in teacher training

The concept of dual training in relation to the training of pedagogical personnel can be considered as a model of the educational process when professional and pedagogical training is carried out through constant alternation or parallel combination of university education with pedagogical activity in basic institutions (schools) under the guidance of mentors. According to recent studies, the importance of this model is difficult to overestimate, since it increases the quality of teacher training [2], [3]. This model affects the fact that future teachers become more competent and ready for work; it also reduces the adaptation time of young specialists in the workplace and strengthens the connection between the pedagogical education system and school practice [4]. Ultimately, dual training impacts to improving the quality of general education, since the teacher comes to school more prepared, with practical experience and developed skills [4]. However, the scientific literature indicates that the use of dual elements is a complex process that requires methodological thoughtfulness [5], [6]. It is necessary to ensure that the academic load in the university and in practice is balanced, the content of theoretical courses is promptly updated considering the experience that students have gained in schools, and mentors have the necessary conditions for effective work with students [7]. Nevertheless, the accumulated experience shows that the advantages of the dual approach outweigh the possible difficulties, and therefore many countries and educational organizations are increasingly actively implementing dual programs for teacher training [5], [7], [8]. In general, modern scientific works indicate a few advantages of introducing a dual education system. This approach allows students to gain real experience in the workplace. Accordingly, their practical skills are improved [8]. According to recent studies, a close connection with the labour market is also noticeable [5], [8]. This means that students could work in companies or enterprises. Such a system allows them to better understand the needs of the labour market, as well as to obtain contacts and recommendations from employers. Overall, this approach significantly increases their chances of employment after graduation.

2.2. Review of international experience in improving methodological principles of training pedagogical personnel in dual education

Experience in implementing the dual system in the training of teaching staff has been accumulated both abroad and in Kazakhstan [9], [10]. In the scientific literature, it is accepted that the classic model of dual education is the German system of vocational education [10], [11]. Pedagogical practice in this system is a mandatory practical stage in the form of a referentariat (i.e., pedagogical internship) lasting from 18 to 24 months [12]. During the referentariat, graduates, under the supervision of mentors (experienced teacher-mentors and specialized methodologists), teach lessons in schools and master the profession in practice. Only after completing this practical training and passing the state exam do they receive the right to teach independently [12]. An important point is that the referentariat is integrated into the training system and is strictly controlled by state institutions. As recent studies have shown, in Germany the share of practice in the overall structure of teacher training has been constantly increasing in recent years, and now it is impossible to obtain a teacher qualification without undergoing long-term practice at school [12]. Studies from other European countries have also pointed out the importance of the dual education system. In Finland, there are special training schools (university partner schools) at universities, where students of pedagogical faculties undergo a lot of practice under the guidance of university lecturers and mentors from the school [13]. This practice is similar to the dual in essence. At the same time, in the UK there are School Direct and teaching internship programs (PGCE with QTS), within the framework of which a significant part of the training takes place directly in schools [13]. Separate attention should be paid to the experience of the USA. In recent years the USA has developed a program of pedagogical residencies, which are a kind of analogue of the dual model in teacher training [13]. Residency involves a bachelor's degree graduate spending a full academic year working in a school under the guidance of an experienced teacher-mentor while simultaneously completing a master's degree or certification courses in a pedagogical profile. In developing countries, dual elements are being introduced into pedagogical education. In South Africa and several other African countries, the concept of Work-Integrated Learning (WIL) has been introduced into pedagogical programs at the level of state policies [13]. In addition, a pedagogical internship model is being implemented in Lesotho: a final-year student goes to teach at a school remote from the university for a significant period while continuing his studies in absentia [13]. At the same time, in Kazakhstan, a dual system at the state level was initially introduced in technical and vocational education (TVE) [11]. However, since 2014–2015, pilot projects have been implemented together with German partners, and relevant regulations have been adopted. In 2016, the Order of the Ministry of Education and Science of the Republic of Kazakhstan No. 50 approved the Rules for the Organization of Dual Education, which influenced the consolidation of the definition of dual education and the procedure for concluding contracts with employers [14]. In 2023, the Ministry of Science and Higher Education of the Republic of Kazakhstan approved separate rules for the organization of dual education in universities and postgraduate education. This clearly indicates support for this idea at the highest level. In accordance with these rules, dual programs can also be implemented for pedagogical areas of training. Specific examples show positive results. Pavlodar Pedagogical University, named after Alkey Margulan, has been actively implementing the dual system in the educational program “Pedagogy of Preschool Education and Training” since 2021 [15]. Special experimental groups of students have been formed at this university, whose training is organized in close cooperation with kindergartens and schools [15]. Theoretical classes are held at the university, and practical classes are held in basic educational organizations [16]. Accordingly, more than 238 students are already studying under the dual system in this specialty. During research, it became obvious that the optimal ratio is 40% of the educational material during practical work and 60% at universities [15]. Accordingly, such a formed proportion makes it possible to maintain the fundamentals of theoretical training but to form a significant part of the competencies in the conditions of real professional activity.

2.3. The use of digital tools in contemporary education

Scientific works indicate that modern digital tools have a huge impact on the transformation of the educational process. It has been proven that these technologies generally change traditional teaching methods and provide new opportunities for student and teacher interaction [17], [18]. Important digital tools are the so-called learning management systems. Such platforms as Moodle and Google Classroom allow for convenient organization of the learning process and provide access to materials, automatic test checking, and interaction between students and teachers. Some universities also actively use virtual laboratories [19]. As has been proven in modern works, these technologies allow students to perform laboratory work online, which is especially important for technical and natural sciences. Virtual laboratories also affect the implementation of the process of modeling experiments,

which makes learning more accessible and convenient. According to modern works, simulation systems are actively used for practical training in areas where models of real-life situations help students learn without the real consequences of mistakes [19], [20]. Thus, such tools allow students to develop practical skills in a safe environment [21]. In scientific space, attention is also drawn to the use of virtual and augmented reality, which affects the formation of high-quality interactive environments [22]. Such learning spaces immerse students in real or modified situations to learn complex concepts [23]. Despite the successes in integrating digital technologies into the educational process, there are significant research gaps in Kazakhstan, especially in the field of pedagogical practice. There is a lack of empirical research. In particular, the study of the dual format of learning in real conditions is not possible without enough empirical studies on the effectiveness of digital technologies. At the same time, many studies focus on certain aspects of digitalization, such as the analysis of LMS and VR/AR, but they do not focus on the impact of these technologies in dual education. This study will try to address these gaps and describe the importance of the dual education system.

3. Research method

This study is experimental, comparative and includes two stages of observation (before and after the experiment). The key purpose of the study was to identify the impact of different interventions on three key indicators of participants' performance: passivity, activity and creativity in two universities - Ozybekali Zhanibekov South Kazakhstan Pedagogical University and Shakarim University of Semey. Two groups were selected for comparison: a control group and an experimental group to compare the participants' performance. This approach is recognized in the international scientific community as important for comparative pedagogical research.

3.1. Sample and participants

The study involved 2 groups of students: control and experimental. The experimental group was taught in a dual education system using digital technologies. The sample was purposive, and information about the survey was distributed via official university corporate emails. Accordingly, the study involved:

- 1) Control groups (students who did not undergo any interventions or changes in learning conditions)
 - a) There were 41 participants in the Ozybekali Zhanibekov South Kazakhstan Pedagogical University.
 - b) At Shakarim University of Semey 40 participants.
- 2) Experimental groups (Students who were exposed to the dual education system with the use of digital tools).
 - a) In the Ozybekali Zhanibekov South Kazakhstan Pedagogical University 41 participants.
 - b) At Shakarim University of Semey, 40 participants.

All participants were randomly selected from the two above-mentioned universities.

3.2. Instruments and procedure

The study was conducted in stages. The study paid special attention to the introduction of digital educational technologies as an important component of modernizing teacher training. The following digital tools were used in the experiment:

1. LMS platforms (Moodle) - for organizing the educational process, posting educational materials and monitoring student progress
2. Virtual laboratories
3. Simulators of pedagogical situations
4. VR/AR technologies - used to immerse students in interactive learning situations.

In addition, digital tools were integrated into Moodle courses in the experimental groups of 2 pedagogical universities. Figure 1 shows the model of dual education with the introduction of digital technologies used in Kazakhstan universities.

Digital technologies have been identified as a significant factor influencing the level of engagement among future teachers within the dual education system. To assess this impact, standardized questionnaires and testing methods were employed at two stages of the study: before and after the integration of digital tools. The study focused on three primary indicators: passive activity, active activity, and creativity. Standardized instruments and questionnaires were used to measure each of these indicators.

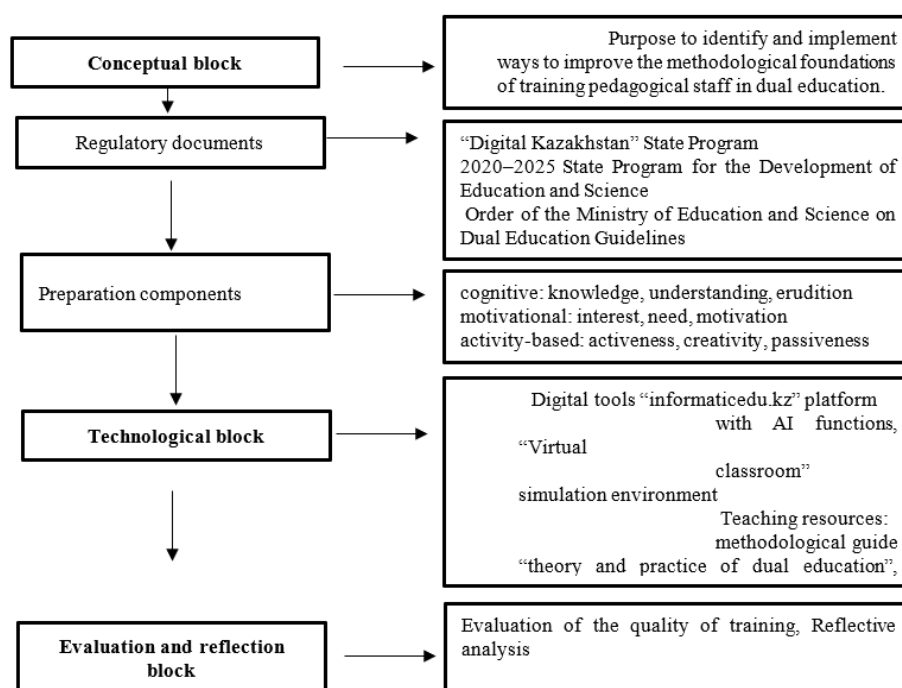


Figure 1. Dual education model with the introduction of digital technologies

A key tool in the research was the author-developed survey entitled “Level of digital engagement of students in the pedagogical education system.” The questionnaire, which measured activity in the digital environment, was specifically adapted to the context of teacher training and evaluated digital engagement based on factors such as the frequency of LMS usage, participation in virtual laboratories, and the display of initiative (see Appendix). Additionally, an adaptive scale was utilized to assess the digital engagement of students in dual education, which categorized respondents into three levels: a high level, indicating active interaction with digital resources, consistent initiative in completing tasks, and a high degree of creativity; a medium level, reflecting moderate usage of digital tools; and a low level, signifying fragmented or minimal digital engagement (see Table 1).

Table 1. Adaptive scale of digital engagement of students in dual education

Level	Characteristics	Criteria
High	Students actively interact with digital platforms, demonstrate initiative in completing online tasks, and have a high level of creativity.	<ul style="list-style-type: none"> ≥ 1 virtual lab/week (≥ 65%) > 5 hours/week on online assignments ≥ 2 forum posts/week Average assignment score ≥ 83/100
Medium	Students use digital resources at a moderate level, sometimes initiate tasks, but have less stability and consistency.	<ul style="list-style-type: none"> 1 virtual lab/week (50–64%) 4–5 hours/week on online assignments 1–2 forum posts/week Average assignment score 75–82/100
Low	Digital engagement is fragmented, students are mostly passive in online activities, and learning outcomes are below average.	<ul style="list-style-type: none"> < 1 virtual lab/week (< 50%) < 4 hours/week on online assignments < 1 forum post/week Average assignment score < 75/100

3.3. Data analysis

The data analysis was also a step-by-step process involving statistical methods. In particular, the McNemar statistical test was used to process the empirical data. It was used to compare changes in the categories of passivity, activity, and creativity before and after each group's introduction of digital interventions.

At the same time, Pearson's chi-square test was used to compare the results between universities (experimental and control groups). This made it possible to identify the difference in the impact of digital tools on behavioral categories.

P-value levels

$p < 0.05$ – statistically meaningful variations between groups.

$p > 0.05$ – no statistically important changes.

4. Results and discussion

4.1. Results

Modern transformations in the education system are taking place under the general influence of digitalization, which will require a significant rethinking of approaches to the training of future teachers [24]. Against this background, the introduction of digital technologies into the organization of methods and professional training in the context of the integration of dual education is especially relevant. In fact, this approach (dual education) makes it possible to combine theoretical learning in educational institutions with the acquisition of practical experience through workplace activities. Dual education also has other advantages. It provides opportunities for much deeper learning, active development of professional skills, and implementation and adaptation to the requirements of real educational environments [25]. In such circumstances, it is important to consider the key aspects of digital technology integration, including the use of online platforms, virtual simulators, cloud services, and individual distance learning tools in the complex process of training future teachers [26]. Another important aspect is that such tools clearly contribute to the improvement of the quality of education and the further development of the digital competence of future teachers. Also relevant is the ability to effectively use the latest technologies to achieve the goals of pedagogical practice.

In the context of the development of pedagogical culture in Kazakhstan, the use of digital tools in the system of teaching future teachers in the dual learning format is systematic. Against the general background, the experience of the Ozybekali Zhanibekov South Kazakhstan Pedagogical University, Shakarim University of Semey, Pavlodar Pedagogical University, and Kazakh-American University stands out. The study of the practical experience of these institutions has made it possible to identify some of the most adapted digital technologies that are important for the effective implementation of the educational process (see Table 2).

Table 2. The most adapted digital technologies

№	Technology	Description
1	Platforms for implementing distance and blended learning (LMS)	The well-known and effective tools Moodle, Google Classroom, other local or less popular educational platforms are important in use both in universities and in secondary schools. As a result of such technologies, the process of parallel teaching of several disciplines, active exchange of methodological materials, the process of electronic assessment, and work on reporting documentation of education seekers and teachers is implemented.
2	Online tutoring systems	When using the dual learning system in combination with the capabilities of digital technologies, it is important to use systems for monitoring the activities of education seekers, including establishing feedback between the teacher and education seekers. The most common tools are mechanisms for chats and video meetings (via Zoom, Microsoft Teams, etc.), which allow for regular consultations.
3	Planning and assessment	The available analytics tools in the LMS allow you to record the number of completed tasks in automatic mode, actively discuss solutions on forums, and optimally use the time spent on solving tasks. The existence of digital assessment tables is an opportunity for mentors and teachers to jointly assess and adjust the dynamics of the development of each student.

№	Technology	Description
4	Cloud services	Digital tools Google Drive, Microsoft OneDrive are an important base for distributing methodological materials, quickly exchanging presentations, analytical reports, etc.
5	Multimedia resources	The use of video materials in dual education is a modern global practice, so the use of various video editors is a common phenomenon for student work. The use of video lessons, video instructions, etc. is also relevant for teachers and mentors

Source: compiled by the authors of the article

An important task was to determine the level of digital engagement. For this purpose, particularly the Digital Engagement Scale (DES) was used to characterize the activity in using digital educational platforms, including Moodle and Google Classroom. The measurements revealed that 83% of students at Ozybekali Zhanibekov South Kazakhstan Pedagogical University used the LMS at least three times a week, with an average statistical number of logins of 4.3 per week (see Figure 2). At the same time, 75% of respondents from Shakarim University in Semey did the same, with an average of 3.7 logins per week (see Figure 3).

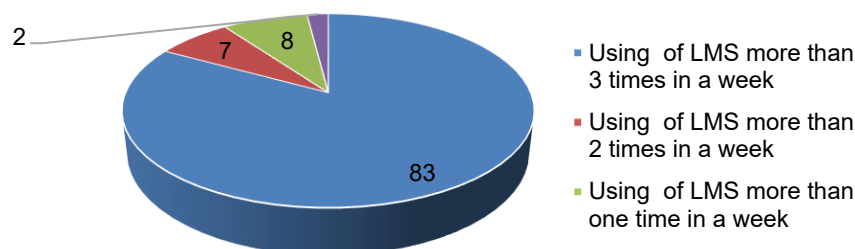


Figure 2. Using of LMS at Ozybekali Zhanibekov South Kazakhstan Pedagogical University

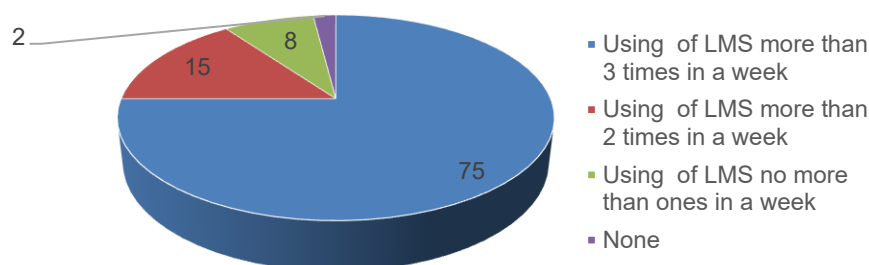


Figure 3. Using LMS at Shakarim University in Semey

The use of virtual laboratories showed that 68% of Ouzbekali Zhanibekov South Kazakhstan Pedagogical University joined the work in at least one virtual laboratory per week, while at Shakarim University of Semey, the same indicator was only 53% (this demonstrates less active use of such practical online modules). The indicators of initiative in the implementation of online tasks were also different in some respects. Students from Ozybekali Zhanibekov South Kazakhstan Pedagogical University spent approximately 5.2 hours per week on assignments, while students from Shakarim University in Semey spent only 4.6 hours. However, the level of involvement in general forums was approximately the same for representatives of both universities: on average, students from Ozybekali Zhanibekov South Kazakhstan Pedagogical University had 2.1 messages per week, while representatives of Shakarim University of Semey had an average of 2 such messages. The performance of the tasks resulted in an average score of 83 out of 100 possible and 79 out of 100 possible for the two universities, respectively (the advantage is with the students of Ozybekali Zhanibekov South Kazakhstan Pedagogical University). Thus, among the respondents, a high level of digital engagement was found in 17 people (42.5%). These students regularly interacted with digital platforms and actively participated in virtual experiments, initiated discussions in forums and independently searched for additional sources of information. An average level of digital engagement was recorded in 15 students (37.5%). This group generally demonstrated

stable participation in the educational process, but their activity was irregular or less proactive. A low level of digital engagement was characteristic of 8 students (20%). They had occasional participation in work with virtual laboratories, rarely joined online discussions. Therefore, it can be summarized that students at both universities demonstrated a high level of digital engagement, but the performance of students at Ozybekali Zhanibekov South Kazakhstan Pedagogical University was determined to be slightly higher by all criteria. This aspect may indicate a much more active introduction of digital methods into the methodology of training future teachers (see Figure 4).

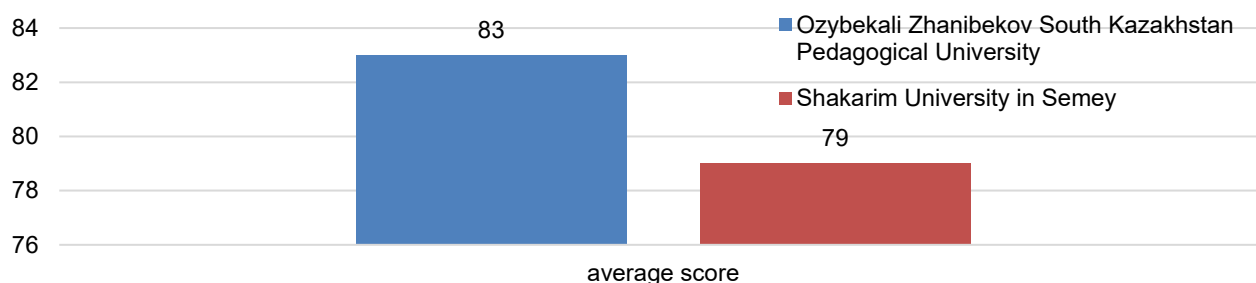


Figure 4. The performance of the tasks resulted in an average score

During the comparison of the indicator at the stage before the passive experiment, no statistically significant differences were identified ($p = 0.820$) (Pearson's chi-square test was used). Similarly, at the stage after the passive experiment, no statistically meaningful changes were found ($p = 0.429$) (Pearson's chi-square test was used). In the analysis of the control group at Ozybekali Zhanibekov South Kazakhstan University, no statistically significant changes were detected ($p = 0.083$) (McNemar's test was used).

In contrast, statistically significant changes were observed in the investigational group of the same university ($p = 0.002$) (McNemar's test was used). The analysis of the control group at Shakarim University of Semey revealed no statistically significant changes ($p = 0.317$) (McNemar's test was used). However, statistically significant changes were identified in the experimental group of the same university ($p = 0.046$) (McNemar's test was used) (see Table 3).

Table 3. Analysis of passive dynamics depending on university/group

University/group	indicators	observation stages				p
		Before the Passive Experiment		After the Passive Experiment		
		N	%	N	%	
OZHENU* (Control)	Present	15	36,6	12	29,3	0,083
	Absent	26	63,4	29	70,7	
OZHENU (Experimental)	Present	16	40,0	6	15,0	0,002*
	Absent	24	60,0	34	85,0	
Shakarim University of Semey (Control)	Present	12	30,0	11	27,5	0,317
	Absent	28	70,0	29	72,5	
Shakarim University of Semey (Experimental)	Present	11	34,4	7	21,9	0,046*
	Absent	21	65,6	25	78,1	
P		0,820		0,429		–

* OZHENU – Ozybekali Zhanibekov South Kazakhstan University

* Differences in indicators are statistically significant ($p < 0,05$)

An analysis of activity dynamics depending on university/group was conducted. Based on the data obtained, no statistically meaningful differences were identified at the stage before the experiment on activity ($p = 0.623$)

(Pearson's chi-square test was used). The conducted analysis also showed that no statistically considerable variations were found at the stage after the experiment on activity ($p = 0.952$) (Pearson's chi-square test was used). The analysis indicated that in the control group of Ozybekali Zhanibekov South Kazakhstan University, no statistically significant changes were observed ($p = 0.317$) (McNemar's test was used).

Similarly, no statistically significant changes were found in the experimental group of the same university ($p = 0.317$) (McNemar's test). In the control group of Shakarim University of Semey, no statistically significant changes were detected ($p = 0.157$) (McNemar's test). In the experimental group of the same university, no statistically significant changes were identified either ($p = 0.083$) (McNemar's test) (See Table 4).

Table 4. Analysis of activity dynamics depending on university/group

University/group	indicators	observation stages				p
		before the passive experiment		before the passive experiment		
		N	%	N	%	
OZHENU* (Control)	present	16	39,0	17	41,5	0,317
	absent	25	61,0	24	58,5	
OZHENU (Experimental)	present	14	35,0	15	37,5	0,317
	absent	26	65,0	25	62,5	
Shakarim University of Semey (Control)	present	19	47,5	17	42,5	0,157
	absent	21	52,5	23	57,5	
Shakarim University of Semey (Experimental)	present	11	34,4	14	43,8	0,083
	absent	21	65,6	18	56,2	
p		0,623		0,952		–

* OZHENU – Ozybekali Zhanibekov South Kazakhstan University

During the comparison of the indicator at the stage before the creativity experiment, no statistically significant differences were identified ($p = 0.855$) (Pearson's chi-square test was used). Similarly, at the stage after the creativity experiment, no statistically significant differences were found ($p = 0.288$) (Pearson's chi-square test was used). The analysis indicated that in the control group of Ozybekali Zhanibekov South Kazakhstan University, no statistically significant changes were observed ($p = 0.157$) (McNemar's test). In contrast, statistically significant changes were found in the experimental group of the same university ($p = 0.003$) (McNemar's test). In the control group of Shakarim University of Semey, no statistically significant changes were detected ($p = 0.083$) (McNemar's test was used). Similarly, no statistically significant alterations were detected in the experimental group of the same university ($p = 0.317$) (McNemar's test was used).

Table 5. Analysis of creativity dynamics depending on university/group

University/group	indicators	observation stages				p
		before the passive experiment		before the passive experiment		
		n	%	N	%	
OZHENU* (Control)	present	10	24,4	12	29,3	0,157
	absent	31	75,6	29	70,7	
OZHENU (Experimental)	present	10	25,0	19	47,5	0,003*
	absent	30	75,0	21	52,5	

University/group	indicators	observation stages				p
		before the passive experiment		before the passive experiment		
		n	%	N	%	
Shakarim University of Semey (Control)	present	9	22,5	12	30,0	0,083
	absent	31	77,5	28	70,0	
Shakarim University of Semey (Experimental)	present	10	31,2	11	34,4	0,317
	absent	22	68,8	21	65,6	
p		0,855		0,288		–

* OZHENU – Ozybekali Zhanibekov South Kazakhstan University

* Differences in indicators are statistically significant ($p < 0,05$)

The experiment determined the impact of digital tools on changing the levels of motivation in the dual education approach. The indicators of students' creativity, activity and passivity were considered. The comparative analysis includes control and experimental groups of selected universities. In general, the experimental groups of both universities increased their motivational component after the experiment (see Figure 5).

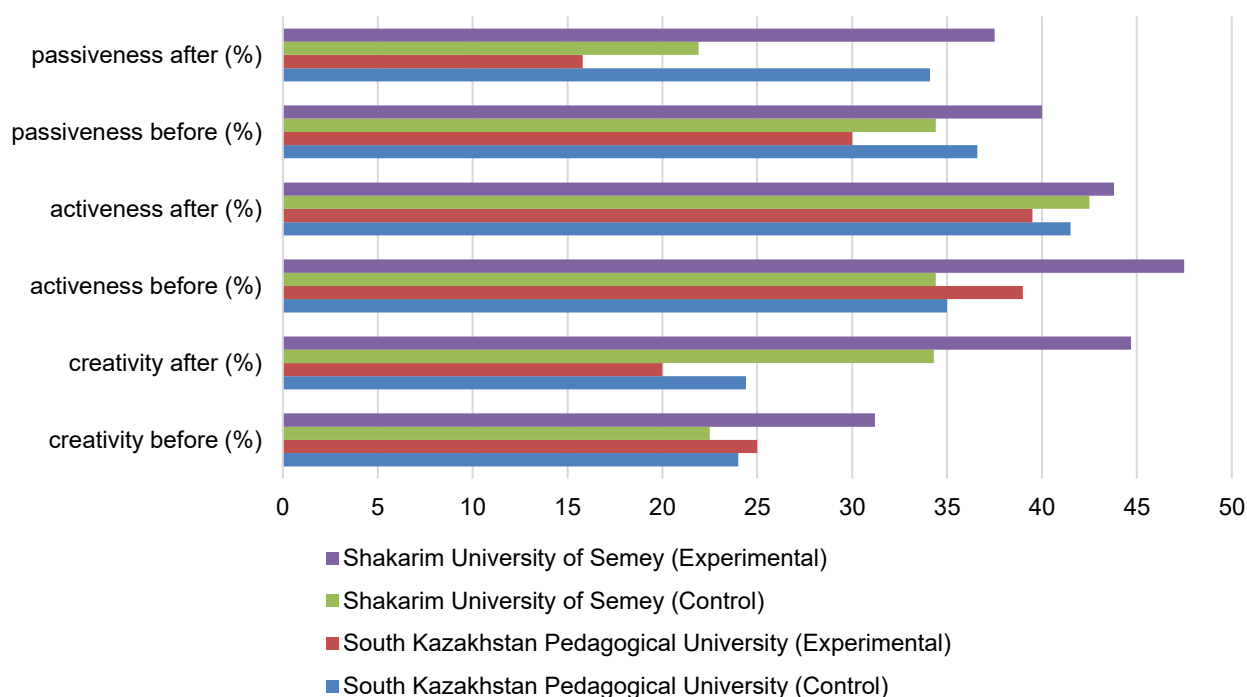


Figure 5. Pre- and Post-Experiment Data on the Motivational Component

As can be seen from Figure 12, creativity scores underwent the most significant changes among all the motivation components. In particular, at Shakarim University of Semey, the level of creativity in the experimental group increased from 31.2% to 44.7%. This generally demonstrated the positive impact of digital tools on the development of creativity. Similarly, in the experimental group of Ozybekali Zhanibekov South Kazakhstan University, an increase from 25% to 47.5% was recorded. In the control groups of both universities, the dynamics were less pronounced. At the same time, the activity rate was also quite positive. In particular, the experimental groups of both universities recorded different activity rates. At Shakarim University of Semey, there is a slight decrease, from 47.5% to 43.8%, and at Ozybekali Zhanibekov South Kazakhstan University,

from 39% to 39.5%, i.e., a slight increase. In the control groups, the increase in activity is higher, which may indicate the influence of additional factors outside the experiment.

The level of student passivity showed a decrease in all groups. In general, this indicates a positive trend. A particularly noticeable decline is observed in the experimental group of Ozybekali Zhanibekov South Kazakhstan University – from 30% to 15.8%. Shakarim University of Semey also shows a positive trend, a decrease from 40% to 37.5%. In the control groups, the decline is less pronounced. This generally confirms the effectiveness of the experimental approach.

4.2. Discussion

The modern development of digital technologies allows us to reassess the possibilities of using them for dual education. The combination of proven methods and innovative technologies has made it possible to improve the educational process, which requires a detailed analysis. Accordingly, the purpose of the proposed study is to determine the effectiveness of the use of digital technologies in the training of future teachers in the dual education system in the context of the Kazakh educational process. The implementation of this main topic involves finding answers to research questions related to the identification of the most adapted digital technologies to the conditions of dual pedagogical education in Kazakhstan, characterizing the level of digital engagement of members in the educational process, determining the dynamics of passivity, activity, and creativity in control and experimental groups, and analyzing the mixing of digital tools into the dual education system, which has an impact on the level of creativity, activity, and passivity of future teachers in Kazakhstan.

The proposed results investigate the use of digital knowhows in the dual education system of future teachers against the background of the experience of Uzbekali Janibekov South Kazakhstan Pedagogical University, Shakarim University of Semey, Pavlodar Pedagogical University, and Kazakh-American University. The analysis of existing practices in these institutions has identified some of the most adapted digital technologies that are important for the effective implementation of the educational process: platforms for distance and blended learning (LMS, Moodle, Google Classroom, etc.), online mentoring systems (Zoom, Microsoft Teams, etc.), planning and assessment, cloud services (Google Drive, Microsoft OneDrive, etc.), and multimedia resources. The obtained results confirm the findings of other scholars who note the prevalence of digital platforms in the modern educational process, which is a current general trend around the world [27], [28]. This maximizes the benefits of the dual form of education and facilitates communication between students, mentors, and teachers [29], [30]. At the same time, the latest pedagogical practice is the use of artificial intelligence systems, which is a logical continuation of the vector of digitalization of education [31], [32]. Although not all researchers recognize the need to integrate AI into the dual form of education [33], the potential of these technologies should be recognized. A likely scenario is the inclusion of AI systems as a third category of tutors and teachers in the dual form of education, as emphasized by some scholars [34], [35]. This approach will need to be considered in the Kazakhstani context in the future, as AI is only initially being introduced into the educational process.

The proposed results also characterize the level of digital engagement of students grounded on empirical material obtained at the Uzbekali Janibekov South Kazakhstan Pedagogical University and Shakarim University of Semey. It was found that 87% and 75% of students used LMS at least three times a week. Respondents actively used virtual laboratories. The indicators of initiative in the implementation of online tasks were somewhat different (5.2 hours per week to complete tasks at the Uzbekali Janibekov South Kazakhstan Pedagogical University versus 4.6 hours at Shakarim University of Semey). The level of involvement in general forums was approximately the same. The average score for the two universities was 83 out of 100 and 79 out of 100, respectively. The results confirm the findings of other scholars who argued that in modern realities, students have a high level of digital engagement [36], [37]. It is also worth considering the scientific views that the development of digitalization of education in general is influenced by the development of digitalization in the country and region [38]. Accordingly, the further evolution of digital methods of education will require considering the development of digitalization in the country in the future. In modern conditions, it is also important to consider overcoming administrative barriers to the digitalization of education, the acquisition of the necessary digital competencies by teachers and mentors, etc [39]. At the same time, given current trends, nothing prevents the further introduction of innovative technologies into the dual system of future teacher education in Kazakhstan.

The next research question addressed the dynamics of passivity, activity, and creativity in the control and experimental groups. At the initial stage of the test, no statistically significant differences were observed

between the groups across all three indicators: passivity ($p = 0.820$), activity ($p = 0.623$), and creativity ($p = 0.855$). By the end of the experiment, significant changes were recorded in the indicators of passivity and creativity within the experimental groups. At Ozybekali Zhanibekov South Kazakhstan University, the level of passivity significantly decreased ($p = 0.002$), while creativity increased ($p = 0.003$). At Shakarim University of Semey, a decrease in passivity was also observed ($p = 0.046$). Overall, these results suggest that integrating digital tools into a dual teaching system can positively impact specific components of student teachers' motivational sphere, particularly by reducing passivity and enhancing creativity. These findings align with international studies that emphasize the critical role of digital tools in fostering students' creativity and promoting their engagement [40], [41]. A significant decrease in passivity among the experimental groups (OZHENU: $p = 0.002$; Shakarim: $p = 0.046$) confirms the effectiveness of the innovative approach. Similar results have been obtained by other researchers who concluded that the use of digital platforms encourages more active participation of students, especially in flexible or dual learning systems, including also in the Kazakh experience [42], [43]. Moreover, additional studies suggest that digital environments contribute to the development of supplementary motivation for interaction ref. [44], which, in turn, helps to reduce apathy. Contrary to certain research expectations, the level of activity did not exhibit statistically significant changes in any of the groups. This may indicate that activity, as a component of motivation, possesses a more complex developmental nature and requires prolonged intervention [45], [46]. Other scholarly findings underscore that an active learning stance is cultivated through consistent pedagogical support over time [47], [48]. The most prominent result was the increase in creativity within the OZHENU experimental group ($p = 0.003$), highlighting the effectiveness of digital tools in enhancing creative engagement. The results also showed that there is a positive dynamic of motivation, however, in terms of improving the level of creativity and reducing passivity in students. Such conclusions are partially compared with the results of other researchers who pointed out the potential of digital resources to increase creativity due to interactivity and multimedia. In general, the indicators have improved somewhat due to the conditions of the dual education system. As proven in other sources, the dual form of training has a noticeable impact on the formation of career competencies of future teachers [46]. Due to early inclusion in real pedagogical activity, students develop pedagogical skills and self-confidence. Studies show that many practical situations during training allows future teachers to more effectively master classroom management methods, subject didactics, and communication skills with students and parents. At the same time, it is also necessary to highlight the main limitations. A significant drawback is the small number of respondents who participated in the study. In addition, the study covered only 2 universities in Kazakhstan. This situation limits the chance of generalizing the results to all higher pedagogical education institutions in Kazakhstan. The study also analyzed three components of motivation, namely passivity, activity, and creativity. However, other components of the motivational system (e.g., purposefulness, intrinsic/extrinsic motivation) were left out of consideration.

5. Conclusions

According to the study, future teachers' creativity and passivity are positively impacted when digital technologies are incorporated into the dual education system. Specifically, the degree of originality rose from 31.2% to 44.7% at Shakarim University in Semey and from 25% to 47.5% at the South Kazakhstan University named after Ozbekali Zhanibekov. The experimental groups primarily showed statistically significant changes in terms of inventiveness ($p = 0.003$) and passivity ($p = 0.002$ and $p = 0.046$). However, there were no notable changes in the activity indicator, which calls for more research.

Thus, it has been empirically verified that the suggested methodology of integrating digital resources into pedagogical staff training is successful. This suggests that Kazakhstan's pedagogical education system may undergo a digital change, particularly in the context of dual education, which blends academic and practical elements. The study's findings can serve as the foundation for methodological suggestions on the use of digital resources in the teaching and learning process, particularly when it comes to dual teacher education. This is particularly pertinent to academic institutions that aim to enhance the use of digital pedagogy in the instruction and professional growth of aspiring educators.

It is anticipated that additional research will offer a more thorough examination of the elements – specifically, motivational, social, and organizational – that affect students' activity levels. Long-term longitudinal studies are recommended to detect long-lasting shifts in students' behavioral attitudes because of digital teaching methods. A comparative study of the efficiency of different digital platforms and pedagogical approaches in raising the professional preparedness of aspiring teachers is also a viable avenue.

Declaration of Competing Interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

Alima Seitaliyeva, Nurzhan Shyndaliyev: study conception and design; Nurzhan Shyndaliyev: data collection; Alima Seitaliyeva, Nurzhan Shyndaliyev, Zhanar Altynbekova: analysis and interpretation of results; Alima Seitaliyeva: draft preparation. All authors approved the final version of the manuscript.

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Appendices

Appendix

Questionnaire "Level of digital engagement of students in the pedagogical education system"

1. Select your educational institution:

- A) South Kazakhstan Pedagogical University named after Uzbekali Dzhanibekov
- B) Shakarim University of Semey

2. How often do you use LMS educational platforms?

- A) Less than 1 time per week
- B) 1–2 times per week
- C) 3–4 times per week
- D) More than 5 times per week

3. How many logins to the LMS do you make each week?

- A) 1–2 logins
- B) 3–4 logins
- C) 5–6 logins
- D) 7 or more

4. How often do you work in virtual laboratories or with online simulators?

- A) Never
- B) Less than 1 time per month
- C) About 1 time per week
- D) Several times per week

5. How much time do you spend completing online tasks each week?

- A) Less than 2 hours
- B) 2–4 hours
- C) 4–6 hours
- D) More than 6 hours

6. How often do you participate in forums or chats on LMS platforms?

- A) Never
- B) 1 message per week
- C) 2–3 messages per week
- D) 4 or more

7. Please indicate your average score for interactive tasks (max 100 points)?

- A) Less than 70
- B) 70–79
- C) 80–89
- D) 90 or more

8. How would you rate your level of digital engagement?

- A) Low
- B) Medium
- C) High
- D) Very high