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Professional development of teachers in the context of digital transformation

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Abstract. The purpose of this article was to explore the issues related to the development of teachers' digital skills in the context of digital transformation, as well as the application of innovative technologies and their integration into the modern educational environment. In the course of the research, digital education, strategies for enhancing teachers' digital competence, and key factors influencing professional development were analysed. The article examined the role of digital educational technologies in the learning process and addressed the challenges related to improving teachers' digital competencies. The integration of digital technologies was aimed at increasing the effectiveness and accessibility of education. In the course of the study, the process of digitalisation of the education system of the Kyrgyz Republic, its main directions, and the results achieved were analysed. Three levels of teachers' technological competence were examined: basic digital literacy, the ability to organise technological and professional activities, and information literacy. As part of the research, an experiment was conducted with the participation of university instructors and students. The experimental groups used digital education platforms (such as Google Classroom, Moodle, Zoom, etc.) and interactive teaching methods, including video lessons, online testing, and digital simulations. A comparison of the results of the pre- and post-tests made it possible to analyse the changes in students' levels of knowledge. The results of the experiment demonstrated that knowledge acquisition indicators in the group using digital technologies increased by 25-30%. In addition, improvements were observed in students' analytical thinking, critical reasoning, and independent learning skills. Enhancing teachers' digital literacy also had a significant impact on the effectiveness of the educational process. The conducted study confirmed the positive influence of digital educational technologies on the professional development of both students and educators. However, certain issues remained unresolved, such as insufficient infrastructure, digital inequality, and challenges in teacher training. To ensure the effective use of digital technologies, it is essential to provide systematic training for teachers and improve the technical equipment of educational institutions

Keywords: digital education; teachers' competence; innovative technologies; online teaching; digital literacy; interactive methods; professional development

■ INTRODUCTION

The professional development of teachers in the context of digital transformation has become a crucial component of the modern educational process. The widespread use of digital technologies in the field of education requires teachers to acquire new skills, effectively utilise digital

educational resources, and develop innovative teaching methods. To fully harness the potential of digital educational resources, teachers' professional development must be continuous and systematic (Ismailova Navazi, 2025). Digital technologies are fundamentally transforming the

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education system. Under the conditions of digital transformation, the role of teachers differs significantly from that in the traditional education model, creating a need for the application of innovative approaches in the learning process (Tsymbal, 2020). Teachers must not only be able to use digital tools effectively but also possess appropriate skills in information security, online teaching methods, and the organisation of interactive lessons. Therefore, the effective integration of digital educational resources and the enhancement of teachers' professional training are essential factors for improving the quality of the education system (Serditova & Belotserkovsky, 2020).

Digital transformation requires the continuous improvement of teachers' professional development. The effective use of digital educational resources contributes to enhancing the quality of education and improving teachers' professional competence. To successfully implement this transformation, it is essential to combine digital technologies with traditional teaching methods, provide training in new educational approaches, and develop support measures for educators. Teachers must possess appropriate skills in working with new digital tools, applying innovative methods in the educational process, organising online learning, and ensuring information security. Enhancing the knowledge and professional expertise of educators is crucial to fully utilising the potential of digital educational resources. The relevance of digital transformation in the field of education, to a significant extent, requires a renewed role and function of teachers. Since 2020, improving the digital preparedness of teaching staff and integrating digital tools into educational processes has become one of the key global challenges. For example, V. Kolykhatov (2018) examined how digital educational tools are applied in pedagogical activities and how they influence academic success in the classroom. The study highlighted that the integration of digital tools contributed to improving the quality of education. The findings also demonstrated that teachers' interest in and readiness to use digital educational resources had a direct impact on their professional development.

A. Kurbatskiy & Yu. Vorotnitskiy (2017) emphasised the growing need for strong personal data protection and the implementation of new information security standards in digital pedagogy. Their research identified the necessity of enhancing teachers' knowledge in the field of digital security and highlighted the importance of paying special attention to this aspect. Similarly, T. Sobchenko (2021) offered recommendations for further improving the professional development of educators using digital learning platforms. He emphasised the need for comprehensive training and workshops to enhance the competencies of teachers who work with digital tools. Digital transformation is reshaping the educational environment; however, successful implementation of this process requires the adoption of innovations in education and the enhancement of teachers' digital skills. For instance, improving the digital proficiency of teaching staff and advancing online teaching methods can lead to better quality in the educational process. In this

regard, a study conducted by I. Zakharova (2010) demonstrated the necessity of balancing both technical and pedagogical training to increase teachers' digital competence.

The purpose of the study was to identify the main directions of teachers' professional development in the context of digital transformation and to explore effective ways of using digital educational resources. The objectives of the study were: to examine the theoretical foundations of teachers' professional development under digital transformation conditions; to identify the main challenges in the use of digital educational resources and ways to address them; to develop practical recommendations for enhancing teachers' digital competence; to analyse mechanisms for improving the quality of education through the use of digital technologies; to propose measures for the development of digital education environments in higher education institutions and schools.

LITERATURE REVIEW

Digital transformation has become one of the key directions in teachers' professional development. In his work, O. Diachuk (2024) stated that the widespread use of digital technologies in the educational environment requires teachers to acquire new skills and pedagogical methods. In the Kyrgyz Republic, the effective use of digital educational resources is considered one of the essential conditions for improving teachers' qualifications, renewing the learning process, and enhancing the quality of education (Zakharov & Korostelev, 2021). In response to this process, educators must pay special attention to their professional development and strive to successfully integrate digital technologies into teaching practices (Mozhayeva, 2017). Currently, digitalisation in Kyrgyzstan has been implemented at all levels of education, facilitating increased accessibility to technical, vocational, and higher education (Kochin *et al.*, 2020). One of the primary goals of higher education is to train competent and professional specialists capable of working effectively in a digital environment. Under these conditions, it is necessary to develop both theoretical and practical approaches to the use of information and communication technologies (ICT) to support students' professional development. Additionally, involving students in scientific research activities, fostering cognitive interest, and implementing modern models of pedagogical education remain key directions in the learning process (UNESCO, n.d.).

The use of digital educational resources significantly expands the possibilities of the learning process and facilitates increased access to knowledge. Digital technologies have become an integral part of education systems in many countries around the world. They ensure the availability of learning materials and create conditions for effective and convenient teaching. Effective utilisation of digital educational resources requires teachers to possess appropriate qualifications and students to have the necessary knowledge and skills. One of the main advantages of such resources is the ability to create personalised learning paths and curricula for each student. Interactive textbooks,

online courses, and other digital resources enable the adaptation of the learning process to students' individual characteristics. As a result, students achieve deeper knowledge acquisition, while teachers are able to work more effectively with their learners. Additionally, the accessibility and diversity of digital educational resources are among their important advantages. Modern technologies support a variety of formats, from textual materials to graphics, video, and audio content. This allows students to learn information in the manner most suitable for them and makes the learning process more convenient (Kolykhmatov, 2018). The digital economy occupies a central place in the professional development of future teachers, as it imposes new requirements on the education system and transforms the forms and content of pedagogical activities. The formation of the digital society is characterised by three main trends: the digital economy, digital technologies, and the digital generation. These factors introduce new approaches to the educational process and necessitate adapting teaching to modern conditions. Digital technologies fundamentally change the educational environment, stimulating the renewal of traditional teaching methods and concepts (Li, 2021). They enable the creation of new teaching models aimed at fostering skills in independent research, data analysis, and development. Consequently, the effective and systematic integration of digital technologies in the modern education system is considered one of the key directions. Digital transformation in the education sector not only opens up new opportunities but also imposes significant demands on the professional development of teachers (Zaitsev, 2020). The widespread use of digital technologies in the educational process necessitates the renewal of teaching methods and pedagogical skills. Only educators who can adapt to the digital environment and effectively utilise modern technologies are able to organise students' learning efficiently (Kolykhmatov, 2020). Therefore, enhancing teachers' digital literacy and developing their competencies in information and communication technologies constitute key tasks of the modern education system.

The study of digital technologies and the analysis of their impact on human activity have been extensively conducted by scholars. The term "digital technologies" emerged in the second half of the 20th century and began to be actively integrated into the educational process. Digital technologies encompass graphical and animated information, interactive structures, as well as various educational tools. Among European researchers studying digital technologies are scholars such as M. Bond *et al.* (2021), who emphasised the importance of digital technologies in education and proposed ways to integrate them into the learning process. For example, C. Redecker & Y. Punie (2017) highlighted the advantages of using digital technologies as teaching tools and supportive elements in the educational process. They stressed that digital technologies facilitate student motivation and enhance collaboration between teachers and students, as well as among students themselves. Russian scholars have also been studying the role of digital

technologies in education. For example, S. Titova (2022) considers digital technologies as an effective tool for intensifying the educational process and preparing individuals for life in the information society. She identified several didactic functions of using digital technologies. These functions are aimed at increasing students' mastery of knowledge, organising information efficiently, and adapting the teaching process to individual characteristics. According to S. Titova (2022), the use of digital technologies in education performs several important didactic functions: it optimises the handling of educational information – enhancing the capabilities for rapid search, access, transmission, storage, collaborative processing, printing, classification, and structuring of information; it increases the informativeness of teaching by expanding the availability and diversity of information during the learning process; it facilitates students' independent learning and effective organisation of educational activities; it provides opportunities for autonomous search, research, analysis, and interpretation of information, thereby supporting the development of analytical and scientific research skills; it enables the creation of personalised learning strategies tailored to each student's individual characteristics; and it fosters conditions for analysing student achievements, conducting reflection, self-assessment, and peer assessment. Kyrgyz scholars have also been studying the role of digital technologies in education and contributing to their effective implementation. For example, the Educational and Methodological Department of Digital Technologies at the Kyrgyz-Russian Slavic University (KRSU) conducts activities related to the development of electronic education systems, the introduction of innovative technologies, and the training of faculty members. Additionally, the Jusup Balasagyn Kyrgyz National University (KNU) has been implementing various initiatives aimed at integrating digital technologies into the educational process. These studies and activities confirm the significant role of digital technologies in education and demonstrate that their effective use contributes to improving the quality of education.

■ MATERIALS AND METHODS

The study was conducted from February to April 2024. The primary objective of the experiment was to determine the impact of using digital resources in teaching pedagogical subjects on students' academic performance, learning motivation, and critical thinking skills. Additionally, by comparing the effectiveness of traditional teaching methods with digital learning, the role and potential of digital technologies in the educational process were thoroughly examined. The experiment involved 80 university students. Within the study, students were divided into two groups for the "Pedagogy" course: a digital group (40 students) and a traditional group (40 students). The instruction in the experimental digital group was conducted using digital educational resources. Students were provided with video materials, electronic presentations, and interactive platforms (such as Google Classroom and Kahoot) to complete

tests and assignments. Infographics and animated diagrams were also used to visualise information. At the end of the learning process, a test was administered, and the results of both groups were compared.

The experimental second group received instruction based on traditional teaching methods. This group was taught through lectures, textbooks, and printed materials. The teaching process primarily focused on the teacher's explanations and students' completion of written assignments. Throughout the experiment, informed consent was obtained from all participants, and the study was conducted fully in accordance with the Guidance Note of the European Commission on Ethics and Data Protection (2021). Students were informed in advance that their data would be kept confidential and used solely for scientific purposes. Data collection methods included testing, interviews, and observation. The purpose of the testing was to assess students' analytical thinking, information search and analysis, and creative problem-solving skills. Tests were administered in two stages, and the results of the digital and traditional teaching groups were compared.

Within the framework of the study, interviews were conducted with students and teachers. The interviews were organised in a semi-structured format using a set of pre-determined key questions. Each interview was conducted individually, allowing participants to share their experiences with using digital resources, as well as their opinions on the advantages and challenges of digital learning. Open-ended questions were asked during the interviews, providing participants the opportunity to express their thoughts freely and in detail. The responses were recorded and subsequently subjected to content analysis.

■ RESULTS AND DISCUSSION

Enhancing teacher competencies in digital education

Modern education requires teachers who effectively use digital technologies. To enable students to work confidently in a digital environment, teachers must master the following skills. Effective information search and utilisation involve the ability to efficiently locate, analyse, and apply relevant information within the learning process (Tregubova, 2020). Developing skills to work with digital tools – including interactive whiteboards, educational platforms, videoconferencing services, and other digital devices – is also essential (Li, 2021). To organise both open and extra-curricular lessons effectively, it is recommended to use webinars, online courses, and open educational resources (Redecker & Punie, 2017). Developing students' independent learning skills is equally important; this includes teaching students proper use of digital technologies and supporting their scientific research activities. By developing these skills, teachers can increase student engagement in the digital learning environment and create a modern education model (Imanaliev, 2023). These functions not only enhance the effectiveness of education but also assist teachers in planning the learning process and developing teaching strategies that take into account students' individual

characteristics (Sulaimanova *et al.*, 2021). Therefore, improving teachers' qualifications in information and communication technologies (ICT) and implementing continuous professional development strategies are essential for the effective use of digital technologies. The use of digital technologies increases student motivation and ensures active participation in the learning process. Modern digital resources enable the application of interactive and innovative methods in education, encouraging students to engage in independent research and deepen their knowledge (Turalbayeva *et al.*, 2021).

V. Kolykhatov (2018) identified four key principles related to the use of digital technologies in the educational process, which facilitate effective organisation of teaching and achievement of educational goals. The first principle is the hierarchical principle, which implies that the teacher must play a leading role in the learning process. The teacher manages the system, provides individual support to students, and regulates non-standard situations. The importance of the teacher's leadership function is especially emphasised in conditions where digital technologies are used. The second principle is the feedback principle, which allows students to evaluate the results of their activities and make improvements as needed. This principle highlights the importance of active communication between students and teachers through digital technologies, while feedback contributes to improving the quality of the learning process and promotes students' independent work (Kolykhatov, 2018). The third principle is the adaptive principle, which states that the educational process should be tailored to the individual characteristics of students. Digital technologies offer customised learning materials for students of various levels and learning styles, allowing them to learn at their own pace (Tregubova, 2020). The fourth principle is the integrative principle, which emphasises that digital technologies must be deeply and effectively integrated into the teaching process. This principle ensures the content and methodological alignment of digital tools with the lesson, meaning that technologies should support the achievement of educational goals (Sulaimanova *et al.*, 2021).

The use of digital technologies in education and the evolving role of the teacher merit careful examination. In the context of digital education, a teacher's technological competence is viewed at three main levels. At the first level, the teacher must possess basic digital literacy. This includes skills to create, process, copy, and transmit information in an electronic environment, as well as the ability to effectively use presentation technologies during the learning process. Additionally, the teacher should have developed the ability to search for and analyse necessary information using internet resources, including AI-based systems such as ChatGPT. At the next level, the teacher is expected to be ready to use digital technologies as tools to organise educational activities. At this level, the teacher can evaluate the quality and interactivity of subject-related internet resources, effectively deliver learning materials using software applications, and select and appropriately

use the most suitable educational platforms. The level of information literacy emphasises the teacher's abilities to perceive, retain, and process information. Additionally, this level focuses on developing skills for the full and purposeful use of digital technologies' capabilities. In recent

years, the Kyrgyz Republic has been actively implementing reforms aimed at digitalising the education system. This process aims to improve the quality of education, expand accessibility, and integrate modern technologies. The main directions of digitalisation are presented in Table 1.

Table 1. Main directions of digitalisation

No.	Directions	Content
1	Electronic educational platforms	The expansion of online platforms such as "Digital School" and "Bilim Bulagy" has become a widespread practice in the education sector. Moreover, digital textbooks and electronic resources play a crucial role in revitalising and enhancing the educational process.
2	Online learning and distance education	Following the COVID-19 pandemic, online learning formats have been actively implemented and widely adopted in universities and schools. Specifically, platforms such as Moodle, Zoom, and Google Classroom enable the effective organisation of remote teaching and learning processes.
3	Development of STEM education and programming	Educational programs focused on coding, robotics, and other STEM fields are being integrated into the education system. At the same time, IT education centres have been established, offering specialised courses in programming.
4	Provision of schools and higher education institutions with digital infrastructure	To create the necessary conditions for digital education, schools and higher education institutions are being equipped with computer hardware and stable internet connectivity. Additionally, electronic grade books and digital assessment systems have been implemented, leading to the automation of the educational process.
5	Artificial intelligence and innovations in education	The role of artificial intelligence in education is increasingly growing. Personalised learning, adaptive, and interactive learning platforms have been developed, enabling the optimisation of the educational process tailored to the student's level.

Source: compiled by the authors

The process of digitalisation of education in the Kyrgyz Republic is aimed at making learning more accessible, efficient, and modern. Reforms in this direction not only enhance the quality of education but also create conditions for mastering new technologies. However, challenges such as insufficient infrastructure, the need to improve teachers' IT competencies, and digital inequality remain critical issues that require resolution. Digital educational resources and their impact on the learning process warrant thorough analysis. Among digital educational resources, electronic and interactive textbooks, digital platforms, online courses, webinars, and other innovative formats occupy a special place. These resources assist students in mastering various pedagogical disciplines and expand their opportunities for independent learning. The renewed education system is designed to meet the demands of the modern digital economy, focusing on developing deep information analysis, creative thinking, and functional literacy. The primary goal of modernising secondary education is to improve students' functional literacy, develop cognitive abilities, foster critical thinking, and create conditions for mastering soft skills (Turalbayeva *et al.*, 2019).

Since 2017, the majority of general education institutions have transitioned to an updated educational content, a process integrated with modern technologies that has contributed to improving the quality of education. The new content includes updating educational programs, implementing a criterion-based assessment system, enhancing teachers' pedagogical skills, and delivering instruction in a digital environment. Active learning methods play a crucial role in developing students' intellectual potential. These methods aim to promote active knowledge acquisition, strengthen functional literacy, facilitate effective peer communication, foster creative problem-solving, and

develop critical thinking skills. The use of modern technologies in the learning process stimulates students' independent thinking and creates conditions for deep and conscious knowledge assimilation. The updated educational content is designed not only to teach practical skills but also to expand students' analytical abilities and opportunities for creative inquiry. As a result, the education system is being renewed in accordance with the demands of the digital age, contributing to the enhancement of society's intellectual and innovative potential.

One of the primary responsibilities of teachers is to instill human values and moral qualities in students, teach them to respect other cultures and viewpoints, as well as to nurture conscious and healthy children. Teachers play a key role in implementing the updated educational content; therefore, enhancing the professional development of educators remains a top priority. Professional development encompasses the specialised knowledge, skills, work experience, and behavioural norms that enable teachers to achieve success in their work. With the advancement of digital technologies and educational resources, developing and improving teachers' digital competencies has become an essential part of the modern educational process. One of the main advantages of digital educational resources is their accessibility, allowing learning to take place anytime and anywhere. This, in turn, fosters students' independent learning skills and prepares them for their future professional activities. Digital educational resources enable the customisation of the learning process according to the individual needs of each student, allowing for personalised education. They also contribute to broadening the worldview of future teachers and enhancing their level of information literacy. Interactive textbooks and online courses help students deepen their understanding of subjects, providing

opportunities to gain additional knowledge and practical skills. This, in turn, increases their competence and confidence not only in their professional activities but also in interactions with colleagues and employers. However, digital educational resources cannot fully replace traditional teaching methods such as lectures, seminars, and practical classes. Taking into account both their potential and limitations, it is important to combine digital and traditional teaching methods to achieve maximum results in the educational process. Proper integration of digital educational technologies into the learning process enhances teachers' professional competence and contributes to improving students' academic performance. The use of digital educational resources plays a significant role in developing future teachers' cognitive autonomy. This supports their effective engagement in the learning process and helps cultivate valuable skills for their professional careers. However, ensuring the quality of education requires a balanced integration of both digital and traditional teaching approaches.

Professional training is an educational system aimed at the accelerated development of necessary skills for mastering a specific profession. Digital technologies are transforming the educational process, significantly updating the role and content of the teacher's work. A modern teacher must systematically update courses, lectures, and practical classes according to new theoretical concepts, technologies, and empirical data (Kolykhmatov, 2018). It is also important to continuously analyse scientific and educational literature, electronic resources, and databases to provide the learning process with high-quality information. In the modern education system, the teacher acts not only as a knowledge provider but also as a guide directing students towards acquiring knowledge. The teacher trains students to effectively use information databases, assists in completing practical tasks, discussing case studies, and evaluating their achievements. Moreover, modern teachers must be able to select and effectively use technologies tailored to the content and objectives of their subjects, taking into account the individual characteristics of students to promote their harmonious development. Preparing qualified personnel is one of the key factors in improving the quality of education. Currently, developing teachers' skills in

the effective use of digital educational resources is among the main challenges. In response to this need, starting from the 2021-2022 academic year, the Isamidinov Pedagogical Personnel Targeted Training Institute introduced an elective course titled "Digital Technologies in Education" for students specialising in Pedagogy. This course has been incorporated into the curricula of all pedagogical specialties at the institute and is aimed at training future teachers to effectively utilise digital technologies.

In conclusion, digital educational resources facilitate the development of new teaching methods and contribute to improving the quality of education. In the modern education system, enhancing teachers' digital competencies and developing their skills for effective use of technologies significantly contribute to raising students' knowledge levels and intellectual potential. The impact and efficiency of digital education technologies are central to the discipline "Digital Technologies in Education", whose main goal is to advance students' professional and specialised competencies in the field of digital technologies. This course is focused on the use of modern digital resources such as ChatGPT, Padlet, Prezi, Canva, Wordwall, LearningApps, Quizzes, Kahoot, Mindmeister, and others. These tools play a significant role in developing students' skills in independently searching for and designing educational materials. Through practical exercises, students consolidate their theoretical knowledge and enhance their digital competencies by solving real-world problems (Kolykhmatov, 2020). Therefore, to effectively utilise digital technologies, it is essential to enhance educators' ICT qualifications and implement continuous professional development strategies.

Research outcomes and survey results

The use of digital educational technologies makes students' learning more effective and engaging. According to the survey results, 85.3% of students indicated that the use of digital resources and technologies facilitates learning and promotes deeper understanding. These technologies increase motivation for learning and expand cognitive autonomy. Figure 1 illustrates the survey results, reflecting the impact of digital resources on knowledge acquisition and motivation, as well as the level of technical difficulties encountered.

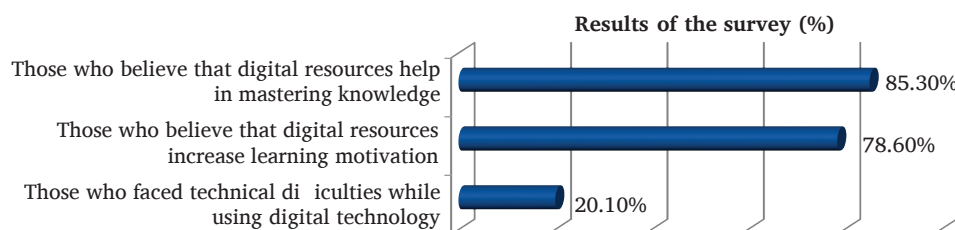


Figure 1. Survey results (assessment of learning effectiveness)

Source: compiled by the authors

Experimental Group 1 (40 students). In this group, the teacher conducted lessons using digital technologies and resources. The instructor actively utilised digital tools

during lectures and practical classes. The learning process was supported by video materials and interactive assignments, which increased students' engagement and made

the lessons more interesting. Digital resources also played an important role in assigning homework. For example, students created interactive tasks on the LearningApps platform, including quizzes, sorting, grouping, classification, crosswords, and video preparation assignments. The purpose of the test was to evaluate students' skills in information search and analysis, decision-making, and creative problem-solving. The test was conducted in two stages: in the first stage, students using traditional educational resources were assessed, and in the second stage, the results of students using digital educational resources were evaluated. Equal conditions and identical tasks were provided to students at each stage. The test results showed that students who used digital technologies demonstrated higher analytical and independent thinking skills. The study concluded that digital resources positively influence the learning process and contribute to the development of critical thinking skills. As a result, 82.1% of the students successfully passed the test. This result was 10.8% higher compared to the outcome of Group 2. The use of digital tools and resources increased students' interest in learning, making the educational process more engaging and effective.

Experimental Group 2 (40 students). The teacher conducted lessons using traditional teaching methods combined with interactive techniques and tasks. Each

lesson included practical assignments with interactive elements such as filling conceptual and semantic tables, question-and-answer methods, arranging answers in a specified order, multiple-choice selection, collaborative work, problem-solving situations, brainstorming, creating mind maps, project development, and others. These assignments activated the students' learning process and increased their engagement with the lessons. Additionally, the interactive elements encouraged students' independent work and creative thinking, which positively influenced their successful performance in high-stakes assessments. 72.3% of students successfully passed the test, while 27.7% demonstrated unsatisfactory results. Students in this group primarily used reproductive methods and glossary-based assignments for learning. Additionally, the abundance of material and insufficient preparation time created challenges for the students. A comparative analysis of the test results is presented in Table 2. These results indicate that the use of digital resources in learning methods was effective and contributed to increased motivation to study. The application of digital tools enhanced students' engagement and helped deepen their knowledge. The experiment's outcome underscores the necessity of extensive integration of digital technologies in the teaching process.

Table 2. Analysis of academic achievement

Group	Students passed successfully
Experimental Group 1 (using digital resources)	83.1%
Experimental Group 2 (traditional teaching method)	72.3%

Source: compiled by the authors

Based on the analysis, it was determined that digital resources made the learning process more effective and engaging, increasing students' interest and activity in the lessons. During the interviews, educators emphasised the necessity of technological and methodological readiness

for the successful implementation of digital teaching. These results confirmed that professional development of teachers holds special significance in the context of digital education. The results of the interviews are presented in Table 3.

Table 3. Opinions of students and teachers (interview results)

Opinion	Percentage of students
Digital resources help to visualise and clarify information	80%
Digital learning increases interest in the lesson	75%
Experienced difficulties using digital technologies	25%
Teachers' opinions (interview results)	Percentage of teachers
Digital resources increase the effectiveness of lessons	90%
Student active participation increases	85%
Preparing methodological materials for digital learning requires time	60%

Source: compiled by the authors

Conclusion based on the interview results: the use of digital resources was found to make the learning process significantly more effective and engaging. There was a noticeable increase in students' interest and activity during lessons. At the same time, it became evident that the successful implementation of digital learning requires teachers to have adequate technological and methodological

preparedness. In other words, professional development of teachers is a key factor in the context of digital education.

Overall results of the experiment. The use of digital resources in teaching pedagogical subjects has a positive impact on students' knowledge acquisition and motivation. The data obtained during the study revealed several important findings. Firstly, a clear improvement in the quality

of education was observed. Students using digital resources demonstrated significantly higher academic achievements compared to those taught by traditional methods. Specifically, in the experimental group (digital learning applied), 83.1% of students successfully passed the test, whereas only 72.3% of students in the traditional teaching group achieved successful results. This confirms that digital learning methods contribute substantially to a deeper mastery of knowledge. Secondly, an increase in students' interest in the learning process was noted. The majority of students (80%) noted that digital resources help visualise learning materials, making comprehension easier and the learning process more engaging. Additionally, 75% of students reported that digital teaching significantly increased their interest in the lessons. These factors demonstrate the direct positive impact of digital technologies on student motivation. Thirdly, the opinions of both students and teachers were studied. Among teachers, 90% emphasised that digital resources enhance the effectiveness of lessons, while 85% observed increased student active participation through digital learning. At the same time, 60% of teachers pointed out that preparing methodological materials for digital teaching requires considerable time and effort.

During the experiment, certain difficulties and obstacles were also identified. Twenty-five percent of teachers reported encountering challenges in using digital technologies. This situation underscores the necessity of continuous development of teachers' technological and methodological preparedness to successfully implement digital teaching. In conclusion, the results of the study confirmed that the use of digital educational resources positively impacts students' academic achievements and motivation to learn. However, to ensure the effectiveness of digital teaching, it is crucial to continuously improve teachers' professional training, particularly their technological and methodological skills. Such measures will enable the full utilisation of the opportunities provided by digital education and will contribute to raising the quality of the educational process to a new level.

In summary, under conditions of digital transformation, the professional development of educators is advancing along several key directions. First, teachers are focused on effectively utilising digital educational resources, gaining a deep understanding of their capabilities, and integrating these resources into their pedagogical activities (HSE, 2018). Second, there is an increasing need to master and continuously improve digital skills related to information search, analysis, and storage (Rostelecom, 2018). Third, educators are paying special attention to developing interactive teaching methods and implementing them through modern digital platforms. Furthermore, teachers' competencies are expanding in creating, structuring, and adapting learning materials to the educational process using digital technologies. Finally, according to E. du Plooy *et al.* (2024), finding a balance between digital and traditional teaching methods and creating a personalised learning environment that considers each student's individual needs have become important areas of professional development

for teachers. Digital technologies enable educators to make the learning process dynamic, interactive, and effective. They expand the accessibility of educational resources and facilitate the individualisation of instruction. Additionally, digital educational platforms assist teachers in monitoring student achievements, improving teaching methods, and enhancing the efficiency of lessons (Korol, 2014).

However, when using digital technologies, educators should not forget the importance of traditional teaching methods. Some complex topics require discussion, debates, and the development of practical skills, for which traditional pedagogical approaches remain relevant. Therefore, maintaining a balance between digital and traditional teaching methods is essential (Alenezi *et al.*, 2023). Although digital technologies and artificial intelligence have significantly impacted the educational process, the teacher's role remains irreplaceable. In traditional education, the teacher primarily serves as the main source of information, whereas in the current digital era, their role has shifted to that of a coordinator, guide, and motivator of the learning process. Teachers must not only transmit information but also teach students critical thinking, independent research, and the effective use of digital resources. They should integrate digital technologies appropriately into the teaching process and support the development of students' autonomous learning skills (Haleem *et al.*, 2022). As noted by S. Saleem *et al.* (2025), although artificial intelligence (AI) can personalise learning materials and automate the teaching process, it cannot perform essential functions such as establishing direct communication with students, providing emotional support, and fostering creative thinking. Teachers build personal relationships with students, understand their learning difficulties, and motivate them. AI serves as a tool to optimise the educational process but cannot fully replace the teacher's experience, pedagogical intuition, and creative approach. Therefore, by leveraging digital opportunities, teachers can ensure that the educational process is of high quality, dynamic, and effective. Proper and purposeful use of digital technologies helps improve educators' professional skills and elevate the quality of education to a new level. In summary, digital development is a contemporary necessity for educators. The digital transformation in education requires teachers to master new technologies and successfully integrate them into the teaching process. Digital competence enables teachers to conduct engaging and effective lessons, apply various teaching methods, and enhance students' academic achievements.

■ CONCLUSIONS

The research underscored the pivotal role of digital education technologies in the learning process and the enhancement of teachers' digital competence. The primary objective was to demonstrate how the integration of digital technologies could bolster the effectiveness and accessibility of education. A key finding of the experiment, which involved both university teachers and students, revealed

a notable improvement in knowledge retention among experimental groups utilising digital platforms (such as Google Classroom, Moodle, and Zoom) and interactive teaching methods (including video lessons, online testing, and digital simulations). Specifically, these groups showed a 25-30% increase in knowledge acquisition. Furthermore, the study observed a significant development in students' analytical thinking, critical approach, and self-directed learning abilities. Enhancing teachers' digital literacy also profoundly impacted the overall effectiveness of the educational process. The research confirmed the positive influence of digital educational technologies on the professional development of both students and educators alike. The study also highlighted three levels of technological competence essential for teachers: basic digital literacy, the ability to organise technological and professional activities, and information literacy. Moreover, the integration of digital technologies in education should adhere to four key principles: hierarchical, feedback, adaptive, and integrative, ensuring the teacher's guiding role, student self-assessment, individualised learning, and seamless technological fit within educational goals.

Despite these positive outcomes, the study identified several persistent challenges, including infrastructure deficiencies, digital inequality, and difficulties in providing comprehensive teacher training. These issues pose

significant barriers to the full realisation of digital education's potential. Therefore, for the effective and widespread adoption of digital technologies in education, systematic and continuous training for teachers is indispensable. Concurrently, substantial improvements in the technical support and infrastructure of educational institutions are paramount. Future research should focus on developing targeted strategies and models to overcome the identified infrastructure and digital inequality challenges, particularly in underserved regions. Further studies could also explore the long-term impacts of digital transformation on educational outcomes and delve into the efficacy of specific digital tools and pedagogical approaches in diverse educational settings. Additionally, research on sustainable professional development programs for educators, tailored to evolving digital landscapes, would be highly beneficial.

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■ REFERENCES

- [1] Alenezi, M., Wardat, S., & Akour, M. (2023). The need of integrating digital education in higher education: Challenges and opportunities. *Sustainability*, 15(6), article number 4782. doi: [10.3390/su15064782](https://doi.org/10.3390/su15064782).
- [2] Bond, M., Bedenlier, S., Marín, V.I., & Händel, M. (2021). Emergency remote teaching in higher education: Mapping the first global online semester. *International Journal of Educational Technology in Higher Education*, 18, article number 50. doi: [10.1186/s41239-021-00282-x](https://doi.org/10.1186/s41239-021-00282-x).
- [3] Diachuk, O. (2024). Adapting curricula to the requirements of the modern digital environment. *Professional Education: Methodology, Theory and Technologies*, 10(1), 10-21. doi: [10.69587/pemtt/1.2024.10](https://doi.org/10.69587/pemtt/1.2024.10).
- [4] Du Plooy, E., Casteleijn, D., & Franzsen, D. (2024). Personalized adaptive learning in higher education: A scoping review of key characteristics and impact on academic performance and engagement. *Heliyon*, 10(21), article number e39630. doi: [10.1016/j.heliyon.2024.e39630](https://doi.org/10.1016/j.heliyon.2024.e39630).
- [5] Guidance Note of the European Commission on Ethics and Data Protection. (2021, July). Retrieved from https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ethics-and-data-protection/he_en.pdf.
- [6] Haleem, A., Javaid, M., Qadri, M.A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3, 275-285. doi: [10.1016/j.susoc.2022.05.004](https://doi.org/10.1016/j.susoc.2022.05.004).
- [7] HSE. (2018). *12 solutions for new education*. Retrieved from https://www.hse.ru/data/2018/04/06/1164671180/Doklad_obrazovanie_Web.pdf.
- [8] Imanaliev, K. (2023). *Digitalization must be integral to education*. Retrieved from <https://kutbilim.kg/news/inner/kanybek-imanaliev-sanariptesh-tir-bilim-ber-protsessinin-azhyragys-b-l-g-bolushu-kerek/>.
- [9] Ismailova Navazi, N. (2025). ICT competence of a school leader. *Scientific Bulletin of Mukachevo State University. Series "Pedagogy and Psychology"*, 11(2), 53-59. doi: [10.52534/msu-pp2.2025.53](https://doi.org/10.52534/msu-pp2.2025.53).
- [10] Kochin, V.P., Vorotnitskiy, Yu.I., & Zherelo, A.V. (2020). Virtualization of educational institutions' network infrastructure. *Digital Transformation*, 1, 51-56. doi: [10.38086/2522-9613-2020-1-51-56](https://doi.org/10.38086/2522-9613-2020-1-51-56).
- [11] Kolykhmatov, V.I. (2018). *Modern teacher digital skills in the conditions of digitalization of education*. *Scientific Notes of the P.F. Lesgaft University*, 9, 152-158.
- [12] Kolykhmatov, V.I. (2020). Digital literacy and skills of a modern teacher. *Scientific Notes of the P.F. Lesgaft University*, 8(186), 156-160. doi: [10.34835/issn.2308-1961.2020.8.p156-160](https://doi.org/10.34835/issn.2308-1961.2020.8.p156-160).
- [13] Korol, A.D. (2014). Informatization of education and person-oriented principle: How to teach everyone in a similar way but differently. *Pedagogika*, 114(2), 64-74. doi: [10.15823/p.2014.005](https://doi.org/10.15823/p.2014.005).

- [14] Kurbatskiy, A.N., & Vorotnitskiy, Yu.I. (2017). [IT-education under conditions of digital transformation](#). *Digital Transformation*, 1, 7-12.
- [15] Li, Y. (2021). [Professional development of teachers in the context of education digitalization](#). *Professional Education and Society*, 3, 208-212.
- [16] Mozhayeva, G.V. (2017). [Digitalization in modern education: From online courses to data analysis](#). Tomsk: Tomsk State University.
- [17] Redecker, C., & Punie, Y. (2017). *European framework for the digital competence of educators: DigCompEdu*. Luxembourg: Publications Office of the EU. [doi: 10.2760/159770](#).
- [18] Rostelecom Center for Strategic Innovations. (2018). *Monitoring of global trends in digitalization*. Retrieved from https://www.company.rt.ru/projects/digital_trends/2018.pdf.
- [19] Saleem, S., Aziz, M.U., Iqbal, M.J., & Abbas, S. (2025). AI in education: Personalized learning systems and their impact on student performance and engagement. *The Critical Review of Social Sciences Studies*, 3(1), 2445-2459. [doi: 10.59075/c35qa453](#).
- [20] Serditova, N.E., & Belotserkovsky, A.V. (2020). Education, quality and the digital transformation. *Higher Education in Russia*, 29(4), 9-15. [doi: 10.31992/0869-3617-2020-29-4-9-15](#).
- [21] Sobchenko, T. (2021). Development of digital competence in the training of future teachers in Ukraine and People's Republic of China. *Scientific Bulletin of Mukachevo State University. Series "Pedagogy and Psychology"*, 7(1), 103-112. [doi: 10.52534/msu-pp.7\(1\).2021.103-112](#).
- [22] Sulaimanova, R.T., Asipova, N.A., & Muratalieva, M.A. (2021). Formation of pedagogical competence of future teachers. In E.G. Popkova & E. Zavyalova (Eds.), *New institutions for socio-economic development* (pp. 133-144). Berlin, Boston: De Gruyter. [doi: 10.1515/9783110699869-014](#).
- [23] Titova, S.V. (2022). [Digital technologies in language education: Theory and practice](#). Limerick: Litres.
- [24] Tregubova, T.M. (2020). Professional development of teachers: Conceptual ideas and benchmarking of best practices. *Bulletin of the Chuvash State Pedagogical University named after I.Ya. Yakovlev*, 2(107), 200-209. [doi: 10.37972/chgpu.2020.107.2.025](#).
- [25] Tsymbal, S. (2020). Teacher digital competence: Bringing education to the next level. *Humanities Studios: Pedagogy, Psychology, Philosophy*, 8(1), 22-26. [doi: 10.31548/hspedagog2020.01.022](#).
- [26] Turalbayeva, A., Zhubandykova, A., Nabuova, R., Buzaubakova, K., Mailybaeva, G., & Abdullina, G. (2021). Formation of information culture of students through information technology. *World Journal on Educational Technology: Current Issues*, 13(4), 794-805. [doi: 10.18844/wjet.v13i4.6265](#).
- [27] UNESCO. (n.d.). *Digital learning and transformation of education*. Retrieved from <https://www.unesco.org/en/digital-education>.
- [28] Zaitsev, K.A. (2020). [Study of online learning platforms in the digital educational environment](#). *E-Scio*, 7(46), 51-62.
- [29] Zakharov, G.V., & Korostelev, O.V. (2021). [Development of educational environment under digital transformation](#). *Innovations and Investments*, 12, 86-89.
- [30] Zakharova, I.G. (2010). [Information technologies in education](#). Moscow: Akademiya Publishing Center.

Санариптик трансформация шарттарында педагогдордун кесиптик өнүгүүсү

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Аннотация. Бул макаланын максаты – санариптик трансформация шартында педагогикалык кадрлардын санариптик көндүмдөрүн өнүктүрүү маселелерин изилдөө жана инновациялык технологияларды колдонуу жана аларды заманбап билим берүү чөйрөсүнө интеграциялоо. Изилдөөнүн жүрүшүндө санариптик билим берүү, педагогдордун санариптик компетенттүүлүгүн жогорулатуу боюнча стратегиялар жана кесиптик өсүүнүн негизги факторлору талданган. Макалада санариптик билим берүү технологияларынын окуу процессиндеги ролу жана мугалимдердин санариптик компетенттүүлүгүн өнүктүрүү маселелери каралган. Санариптик технологияларды интеграциялоо билим берүүнүн эффективдүүлүгүн жана жеткиликтүүлүгүн жогорулатууга багытталган. Изилдөөнүн жүрүшүндө Кыргыз Республикасынын билим берүү системасын санариптештирүү процесси, анын негизги багыттары жана алынган натыйжалар талданган. Педагогдордун технологиялык компетенттүүлүгүнүн үч деңгээли каралган: негизги санариптик сабаттуулук, технологиялык жана профессионалдык ишмердүүлүктү уюштуруу, маалыматтык сабаттуулук. Изилдөөнүн алкагында жогорку окуу жайларынын окутуучулары жана студенттери катышкан эксперимент жүргүзүлдү. Эксперименттик топтор санариптик билим берүү платформаларын (Google Classroom, Moodle, Zoom ж.б.) жана интерактивдүү окутуу ыкмаларын (видеоуроктор, онлайн тестирлөө, санариптик симуляциялар) колдонушту. Кириш жана жыйынтык тесттеринин натыйжаларын салыштыруу студенттердин билим деңгээлинде болгон өзгөрүүлөрдү талдоого мүмкүндүк берди. Эксперименттин натыйжалары санариптик технологияларды колдонгон топто билимдерди өздөштүрүү көрсөткүчтөрү 25-30% га жогорулаганын көрсөттү. Мындан тышкары, студенттердин аналитикалык ой жүгүртүүсү, критикалык мамиле жана өз алдынча билим алуу өнүккөнү байкалган. Мугалимдердин санариптик сабаттуулугун жогорулатуу ошондой эле билим берүү процессинин эффективдүүлүгүнө чоң таасирин тийгизди. Жүргүзүлгөн изилдөө санариптик билим берүү технологияларынын студенттердин жана педагогдордун кесиптик өнүгүүсүнө оң таасирин тийгизгенин тастыктады. Бирок, инфраструктуранын жетишсиздиги, санариптик теңсиздик жана мугалимдерди окутууда кыйынчылыктар сыяктуу көйгөйлөр чечилбей калды. Санариптик технологияларды эффективдүү колдонуу үчүн мугалимдерди системалуу окутуу жана билим берүү мекемелеринин техникалык камсыздандыруусун жакшыртуу зарыл.

Негизги сөздөр: санариптик билим берүү; мугалимдердин компетенттүүлүгү; инновациялык технологиялар; онлайн окутуу; санариптик сабаттуулук; интерактивдүү методдор; профессионалдык өнүгүү

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Аннотация. Целью данной работы было исследовать вопросы развития цифровых навыков педагогических кадров в условиях цифровой трансформации образования, а также проанализировать использование инновационных технологий и их интеграцию в современную образовательную среду. В исследовании были рассмотрены ключевые аспекты цифрового образования, стратегии повышения цифровой компетентности педагогов и основные факторы профессионального роста. В статье рассмотрена роль цифровых образовательных технологий в учебном процессе и вопросы развития цифровой компетентности учителей. Интеграция цифровых технологий была направлена на повышение эффективности и доступности образования. В исследовании был проанализирован процесс цифровизации системы образования Кыргызской Республики, его основные направления и полученные результаты. Рассмотрены три уровня технологической компетентности учителей: базовая цифровая грамотность, организация технологической и профессиональной деятельности, информационная грамотность. В рамках исследования был проведен эксперимент с участием преподавателей и студентов высших учебных заведений. Экспериментальные группы использовали цифровые образовательные платформы (Google Classroom, Moodle, Zoom и др.) и интерактивные методы обучения (видеоуроки, онлайн-тестирование, цифровые симуляции). Сравнение результатов входного и итогового тестирования позволило проанализировать изменения в уровне знаний студентов. Результаты эксперимента показали, что в группе, использующей цифровые технологии, показатели усвоения знаний повысились на 25-30 %. Кроме того, было отмечено развитие аналитического мышления, критического подхода и самостоятельного обучения студентов. Повышение цифровой грамотности учителей также оказало значительное влияние на эффективность образовательного процесса. Проведенное исследование подтвердило положительное влияние цифровых образовательных технологий на профессиональное развитие студентов и педагогов. Однако остались нерешенными проблемы, связанные с нехваткой инфраструктуры, цифровым неравенством и трудностями в обучении педагогов. Для эффективного использования цифровых технологий необходимо проводить систематическое обучение учителей и улучшать техническое обеспечение образовательных учреждений.

Ключевые слова: цифровое образование; компетентность учителей; инновационные технологии; онлайн-обучение; цифровая грамотность; интерактивные методы; профессиональное развитие